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RELATIONSHIP BETWEEN IRAN'S NATIONAL FOOTBALL TEAM RESULTS AND CITIZENS' HAPPINESS

Siroos AHMADI
Department of Sociology, Yasouj University, Yasouj, Iran

ABSTRACT

The influence of success and failure in international sporting competitions on the psycho-social life of citizens has been under-researched. This one-group pre-post-test design aimed to investigate the influence of the results of Iran's national football team in the 2015 AFC Asian Cup on the happiness in Iranian citizens. The study was conducted in three stages: 1) before the start of the competitions; 2) after the qualifying rounds; and 3) after the team's knockout loss in the quarter-finals. A sample of 320 respondents was drawn by means of the multistage sampling method from the citizens of Yasouj in Iran (age range=18 to 50 years). The Oxford Happiness Inventory (OHI) was used for collecting data. The results show that happiness significantly increased in the qualifying round, however, happiness plummeted after the team's loss against Iraq in the quarter-finals. The present study concludes that the results of national football teams in international competitions can affect the happiness of citizens.

Key words: Oxford Happiness Inventory; Football; AFC Asian Cup; Iran.

INTRODUCTION

Happiness is the main goal of life for most people and they want to be happy and satisfied with their lives (Baron & Branscombe, 2011). Broadly speaking; happiness is synonymous with subjective well-being (Diener *et al*., 2000) and satisfaction with life (Veenhoven, 2007). Happiness has been defined in a number of ways (Veenhoven, 1984).

Firstly, several definitions depict it as an affective state of mind. Wessman and Ricks (1966) found happiness as an overall evaluation of the quality of the individual's own experience when conducting his/her vital affairs. Similarly, Fordyce (1972) has stated that happiness is a particular kind of emotion or mainly the evaluation made by the individual in accounting for his/her positive and negative feelings.

Secondly, happiness has been defined as a cognitive fact, which is the consequence of a deliberate evaluation process. McDowell and Newell (1987) described happiness as a personal assessment of the conditions of an individual which is compared to a standard reference or to the wishes of an individual. Shin and Johnson (1978) also revealed that happiness is a global assessment of a person's quality of life based on his/her selected standards. In this sense, some accounts rely on the active achievement of life goals, while others rather stress the absence of unfulfilled aspirations (Veenhoven, 1984). Happiness has also been represented as an attitudinal fact. Sumner (1996) identified happiness as a certain positive attitude towards life. Lieberman (1970) reports that even before the age of

18, an individual becomes geared to a

certain stable level of satisfaction, which is then maintained throughout life. Some of these definitions stress the consistency in an effective response, while others rather see it as a belief system.

Thirdly, several definitions observe happiness in a mixed way. For Chekola (1974), happiness includes realising a life-plan, the absence of serious dissatisfaction, like an attitude of being displeased with or disliking one's life. Diener (2000) also characterised happiness as a positive mental state that involves four basic components: *global life satisfaction* (feeling generally happy with life); *satisfaction with important life domains* (being satisfied with work, relationships and family); *positive feelings* (often experiencing positive emotions and moods); and *negative feelings* (experiencing negative feelings or emotions less often or, preferably, rarely). Fourthly, Veenhoven (2006) has distinguished between overall happiness and components of happiness and has assumed that the latter function as sub-units of the overall evaluation of life. He defined overall happiness as the degree to which an individual judges the overall quality of his/her life as a whole, favourably.

Happiness includes a variety of functions regardless of how it is defined. In general, individuals who are happy, have more job productivity (Borman *et al*., 2001), higher quality of social relationships (Lyubomirsky *et al*., 2005), healthier life (Xu & Roberts, 2010), more resistance to diseases (Cohen *et al*., 2003), less prone to depression (Maruta *et al*., 2000), longer life (Danner *et al*., 2001; Diener & Chan, 2011), better ability to solve problems (Carr, 2004), higher self-esteem and a sense of personal control (Myers & Diener, 1995), and more optimistic about the future (Kassin *et al*., 2011). Happiness has also been found to contribute to nation- building (Hong, 2011).

Based on the diverse functions of happiness in psychological and social backgrounds, it is imperative to build it up. As a result, many efforts have been made to improve happiness by recognising the factors that influence it. A range of factors has been reported in related literature. Diener *et al*. (1999), stressing personality characteristics, believe that happy individuals are extrovert, optimistic, with high self-esteem and an internal locus of control. Drawing on cross-cultural studies, Carr (2004) has pointed out that individuals, who live in countries with a stable democracy, devoid of political oppression and military conflict, are happier. He also believes that individuals in cultures where social equality is realised more, happiness is seen more often. Lykken (1999) found that happiness has a genetic foundation. Some researchers explain it as being based on relationship with others, for instance Myers (2000) believes that married individuals are happier than single people. For Argyle (2001), close supportive relationships between parents and children, among siblings and extended family members and confiding relationships with close friends strengthen happiness.

According to Seligman (2002), individuals, who engage in religion and spirituality, are happier. This is because religion provides a belief system that allows individuals to make sense of their lives and be optimistic about the future. Other researchers report happiness as being based on environmental causes. Diener (2000) believes that individuals in richer countries are happier, however, the relationship between wealth and happiness at the individual level is changeable and wealthier persons are not necessarily happier. Ulrich *et al*. (1991) believe that happiness is observed more where plants, water and viewing the

natural environment are concerned.

Cunningham (1979) points out a temperate climate, Campbell *et al*. (1976) the quality of a house, and Hills and Argyle (1998) refer to the influence of music. Sarafino (2002) found that physical condition is a factor contributing to happiness and believes that physical health and exercise promote happiness. Relying on the relationship between productivity and happiness, some believe that employed and educated persons have greater happiness (Diener *et al*., 1999). With reference to leisure time, some have noted that rest, relaxation, good food and free activities bring more happiness (Argyle, 2001).

It seems that successes and failures of national athletes in international competitions might influence various aspects of psycho-social life. Integration of different ethnic groups and social classes (Muller *et al*., 2008), strengthening moral values (Bockrath & Franke, 1995), reinforcing good feelings among people (Forrest & Simmons, 2003), increasing national pride (Denham, 2010), enhancing national identity (Ahmadi, 2007; Hong, 2011), developing good international relations (Ilmarinen *et al*., 1984), and improving national integration (Lever, 1983) are some psycho-social functions of sport success or failure that have been studied scientifically.

Van Hilvoorde *et al*. (2010) found that the longer a national team remains successful in a tournament, the more people would be drawn into the celebration of national pride. This implies that national sporting performance and success could play an important role in this regard and could elevate the person's psychological characteristics. Although only a small number of studies have been conducted within this context, a study by Hallmann *et al*. (2012) involving 2006 German citizens, reported that 65.6% of the respondents felt happy after the success of German athletes in major events, like the world championship or Olympic Games. In a study on European citizens (Belgium, Britain, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain), during the period 1974-2004, Kavetsos and Szymanski (2010) suggested that hosting the Olympic Games, FIFA World Cup and European Cup improved the happiness among the people of the host countries, however, the influence of national athletic success on people's happiness was not statistically significant. This is mainly because of some technical reasons and does not deny logical relationship between football and happiness.

In Iran, football (a game played by two teams of 11 players in which players try to score goals by kicking a round ball into a large net), is the most popular and extensively practised sport in the country, because of the large number of football clubs, countless footballers, considerable financial investments and vast media coverage. Therefore, it allows Iranians to pay special attention to the successes or failures of Iran's national football team. Although this topic has received no scientific scrutiny in Iran, evidence suggests that success and failure of Iran's national football team influences socio-psychological life of Iranians. For instance, Ahmadi (2007) reported a significant relationship between the results that Iran's national football team achieved in the 2006 FIFA World Cup and the national identity of Iranian citizens.

After three consecutive successful championships in the Asian Cup in 1968, 1972 and 1976, Iran's national football team failed to win a championship in the next tournaments, 1980-2011. However, Iran as a delegate of Asia, managed to qualify for the Football World Cup held in Argentina 1978, France 1998, Germany 2006 and Brazil 2014. Employing

Carlos Queiroz, the well-known coach, who had coaching experience with Manchester United, Real Madrid and

the Portuguese national team, led to Iran's qualification for the 2014 World Cup in Brazil, with acceptable matches particularly against Argentina (runner-up of the tournaments). A short period between the World Cup (June 2014 in Brazil), and the AFC Asian Cup (January 2015 in Australia), invoked the belief that the Iranian national football team had an excellent chance to be successful after 40 years. This belief directed public attention toward football and the national team to such an extent that football again became a matter of national pride and public support.

RESEARCH PROBLEM

The association between national athletic success or failure and happiness experienced by citizens is often discussed in the media. However, this is the first study undertaken to measure the relationship empirically by employing a longitudinal survey during a major sport tournament. Therefore, the research question is whether the success or failure of the Iran national football team in the 2015 AFC Asian Cup would have a significant effect on the happiness experienced by the citizens.

METHODOLOGY

Research design

The present study is a quasi-experimental design that was conducted by using one-group pre- post-test design (O X1 O X2 O). In this research, the treatments were the games played by the Iran national football team without researcher intervention. The pre-test was conducted before commencing the AFC Asian Cup (O) during 6, 7 and 8 January 2015, the post-test 1 was conducted after the qualifying round (X1 O) on 19, 20 and 21 January 2015, and the post- test 2 was conducted after the team was knocked out by Iraq in quarter-final (X2 O) on 23, 24 and 25 January 2015. The research design was a panel type and the study was carried out on the same group.

Subjects

The population for the study consisted of 18 to 50 year-old individuals in Yasouj, the centre of Kohgiluyeh and Boyerahmad Provinces in the southwest of Iran, which is of strategic importance because of supplying at least a quarter of the oil exports of the country. At the 2011 census, its population was 10 8505 of which 55 337 individuals were in the 18 to 50 age group (Statistical Centre of Iran, 2011).

Based on previous research (Ahmadi, 2007), as well as a pilot study, using Cochran's (1977) sampling formula and determining p=0.7, q=0.3, t=1.96 and d=0.05, 320 citizens were selected as a sample size by using the random multistage sampling method from 14 areas. The data was collected by means of face-to-face interviews with competent individuals who were following the Iran national football games and were willing to participate in the research. They were told that they would be interviewed several times. Given that the study was panelled and it was necessary to gather information in Post-test 1 and Post-test 2 as soon as possible, (maximum within 72 hours), access to 30 cases in Post-

test 1 and 38 cases in Post-test 2 was not possible. Therefore, the sample size reduced to 282 participants.

Measurement tool

The questionnaire that was used in this research was the Oxford Happiness Inventory (OHI) that was developed by Argyle *et al*. (1989). The OHI is a 29-item instrument designed to measure subjective well-being. The response to the items were based on a 4-point Likert Scale (strongly disagree=0 to strongly agree=3), and the range of scores were from 0 to 87. The respondents chose 1 of 4 sentences that were constructed to reflect levels of happiness ranging from the lowest to extreme levels of happiness (0=*I do not feel happy*; 1=*I feel fairly happy*; 2=*I am very happy*; 3=*I am incredibly happy*).

The OHI has been employed in diverse countries around the world (Francis *et al*., 1998; Stewart *et al*., 2010). Noorbala and Alipoor (1999) measured the psychometric properties of the OHI in Iran and extracted 5 factors, including satisfaction with life (11 items), positive mood (8 items), mental health (6 items), efficacy (4 items) and self-esteem (2 items) that were able to explain 57.1% of the variance. They showed that, the OHI was an appropriate scale for measuring the degree of happiness among Iranian people. In this study, the reliability coefficient was checked by using Cronbach's Alpha in which, the values for the total scale and each subscales are reported (Table 1). The reliability coefficients are acceptable at all of the stages.

Table 1. **CHRONBACH'S ALPHA COEFFICIENTS FOR OHI AND SUBSCALES**

Variables	**Pre-test**	**Post-test 1**	**Post-test 2**
OHI	0.95	0.96	0.96
Satisfaction with life	0.89	0.91	0.90
Positive mood	0.85	0.84	0.85
Mental health	0.78	0.84	0.82
Efficacy	0.78	0.81	0.80
Self-esteem	0.80	0.79	0.79

Analysis of data

The one-way repeated measure ANOVA was applied for the comparison of the mean happiness scores for the Pre-, Post (1)- and Post (2)-tests within the age groups and level of education. To establish where the differences were, multiple comparisons via the paired t-test was applied. In addition, the independent samples t-test was used to compare the mean happiness based on gender and marital status.

RESULTS

Descriptive results of the demographic characteristics are shown in Table 2. The majority of the respondents were male, single, academic and in the age group of 18 to 29 years old.

Table 2. **DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS**

Characteristics	N		Frequency	%
Gender	282	*Male*	170	60.3
		Female	112	39.7
Marital status	282	*Married*	106	37.6
		Single	176	62.4
Education	282	*Less Diploma*	42	14.9
		Diploma	48	17.0
		Academic	192	68.1
Age	282	*18-29*	231	81.9
		30-39	32	11.3
		40-50	19	6.7

A summary of the scores for OHI and subscales, during the Pre-, Post-test 1 and Post-test 2, are presented in Table 3. The mean score of the OHI and its subscales increased in Post-test 1 and then decreased in Post-test 2.

Table 3. **SCORES FOR OHI AND SUBSCALES OF TESTING SESSIONS**

Test	Variables	N	Min	Max	Mean±SD
Pre-test	OHI	282	0	89	53.8±17.5
	Satisfaction with life	282	0	33	20.1±6.6
	Positive mood	282	0	24	13.9±5.0
	Mental health	282	0	18	9.9±3.7
	Efficacy	282	0	12	6.4±2.8
	Self-esteem	282	0	6	3.4±1.6
Post-test 1	OHI	282	0	93	60.3±17.8
	Satisfaction with life	282	0	33	21.3±6.7
	Positive mood	282	0	24	15.6±4.8
	Mental health	282	0	18	11.8±3.7
	Efficacy	282	0	12	7.9±2.7
	Self-esteem	282	0	6	3.7±1.5
Post-test 2	OHI	282	0	93	48.4±19.1
	Satisfaction with life	282	0	33	17.1±7.1
	Positive mood	282	0	24	12.7±5.1
	Mental health	282	0	18	9.4±3.9
	Efficacy	282	0	12	6.1±2.8
	Self-esteem	282	0	6	2.1±1.5

As shown in Table 4, One-Way repeated measure ANOVA was applied to compare the mean happiness of the different stages of testing. A statistically significant F-value showed that there were differences in the mean scores for happiness.

Table 4. **ONE-WAY REPEATED MEASURE ANOVA FOR OHI AND SUBSCALES**

Variables	N	Mean±SD Pre-test	Post-test 1	Post-test 2	F	p-Value
OHI	282	53.8±17.5	60.3±17.8	48.4±19.1	43.1	0.00
Satisfaction with life	282	20.1±6.6	21.3±6.7	17.1±7.1	41.2	0.00
Positive mood	282	13.9±5.0	15.6±4.8	12.7±5.1	32.1	0.00
Mental health	282	9.9±3.7	11.8±3.7	9.4±3.9	46.4	0.00
Efficacy	282	6.4±2.8	7.9±2.7	6.1±2.8	43.4	0.00
Self-esteem	282	3.4±1.6	3.7±1.5	2.1±1.5	15.1	0.00

In order to isolate where the differences were, a series of multiple comparisons via the paired t-test were performed and the results are shown in Table 5. The increasing mean happiness and its subscales at the Post-test 1 was compared to the Pre-test and the decreasing mean happiness and its subscales in the Post-test 2 was compared to those of Post-test 1 and the Pre-test. With the exception of the case of the mean efficacy of the Post-test 2 to the Pre-test, the remaining comparisons were statistically significant. (NS=Not significant)

Table 5. **MULTIPLE COMPARISONS USING T-TEST FOR PAIRED SAMPLES**

Variables	Mean Pre-test	Post-test 1	Post-test 2	Differences t-Value	df	Sign.
Happiness	53.8	60.3	–	-5.2	281	0.000
	–	60.3	48.4	9.1	281	0.000
	53.8	–	48.4	3.7	281	0.000
Satisfaction with life	20.1	21.3	–	-2.6	281	0.009
	–	21.3	17.1	9.1	281	0.000
	20.1	–	17.1	5.7	281	0.000
Positive mood	13.9	15.6	–	3.1	281	0.002
	–	15.6	12.7	5.6	281	0.000
	13.9	–	12.7	2.1	281	0.034
Mental health	9.9	11.7	–	7.2	281	0.000
	–	11.7	9.5	2.8	281	0.000
	9.9	–	9.5	1.6	281	NS
Efficacy	6.4	7.8	–	-6.9	281	0.000
	–	7.8	6.1	8.6	281	0.000
	6.4	–	6.1	1.5	281	NS
Self-esteem	3.4	3.7	–	2.4	281	0.018
	–	3.7	3.1	5.4	281	0.000
	3.4	–	3.1	2.5	281	0.014

To clarify the influence of football results on happiness and recognition of the role of the confounding variables, mean happiness in terms of the demographic variables, were examined in all 3 stages and the results are reflected in Table 6.

The results indicate that mean happiness was statistically different in terms of the education level at Post-test 2. This could be the consequence of educated people having a higher ability to manage their emotions and people, while those with a lower education not having enough ability to control them. As a result, the decline in the happiness at Post-test 2 is more

significant among people with a lower education.

Table 6. **COMPARISON OF HAPPINESS WITHIN DEMOGRAPHIC VARIABLES**

Demographic variables		**Mean Happiness** Pre-test	Post-test 1	Post-test 2
Gender	*Male*	57.8	59.5	49.4
	Female	47.5	61.4	46.9
		t=5.10; p=0.000	t =0.89; p=0.375	t=1.10; p=0.289
Marital status	*Married*	52.4	58.7	46.2
	Single	54.6	61.2	49.7
		t=1.10; p=0.309	t=1.10; p=0.258	t=1.50; p=0.135
Education	*Less than diploma*	50.4	55.3	34.4
	Diploma	50.0	62.8	44.9
	Academic	55.4	60.7	52.3
		F=2.80; p=0.061	F=2.20; p=0.108	F=18.10; p=0.000
Age	*18-29*	54.7	59.6	48.8
	30-39	48.4	60.5	48.1
	40-50	51.3	69.0	43.7
		F=0.98; p=0.371	F=2.80; p=0.314	F=0.30; p=0.740

DISCUSSION

This study was carried out with the aim of exploring the influence of Iran national football team's successes and failures in the 2015 AFC Asian Cup on the happiness of citizens. The word 'happiness' has a number of different uses, such as feeling, mood, behaviour, attitude and life (Chekola, 2007). However, the focus is on the OHI with five subscales including satisfaction with life, positive mood, mental health, efficacy and self-esteem. The research findings show that the happiness of the citizens increased significantly after the qualifying round in which Iran national football team achieved three successes against the Arabian teams (Qatar, Bahrain and UAE). Yet happiness decreased considerably after losing against Iraq in the quarter-final and deprived them of reaching the semi-final.

The research finding is theoretically consistent with the outlook of Evans and Kelley (2002) and Van Hilvoorde *et al*. (2010), who believe that national athletes in international competitions could have an influence on the national pride and happiness of the people. The results were empirically well matched with the results of Hallmann *et al*. (2012) who reported that the German citizens felt happy after the success of German athletes in international competitions.

Although the research finding is compatible with the results of Kavetsos and Szysmanski (2010), who stated that hosting international sport competitions increased the happiness of the people of the host countries. Some results are not consistent with Kavetsos and Szysmanski (2010), who reported no significant relationship between national athletic

success and the happiness of citizens.

There are several reasons for this dissimilarity in the research of Kavetsos and Szysmanski (2010): (1) the statistical analysis of the data covers 12 dissimilar countries as one entity without considering each country separately; (2) they point out that data collection was conducted by the Euro Barometer Survey Service twice each year [spring and autumn], and the period of data gathering was not necessarily immediately after the success or failure in sporting competitions; (3) happiness was measured by one general question, namely "On the whole, are you very satisfied, fairly satisfied, not very satisfied, or not at all satisfied with the life you lead?", thus there could not be precise and distinctive scale scoring; (4) the data, which was included from a country, were based on responses in varying years, for instance for Germany the data prior to 1992 existed for West Germany or the available data for Greece started from 1981 and for Spain and Portugal from 1985; (5) they suggested that as the results stem from a sample of European nations in which football is the dominant sport and in other regions of the world where football is not a prominent sport, one might anticipate dissimilar outcomes.

The significant increase of happiness among Iranian citizens after the success of the Iran national football team in the qualifying round and significant reduction of the happiness after losing against Iraq in the quarter-final, are basically representing the conflict between the Iranians and the Arabs, which has a historical origin. In addition, this conflict has also been viewed in other countries, for example Germany–England (Barrett, 2000), and Brazil–Argentina. Three victories in the group stage against Arabian teams (Qatar, Bahrain and UAE), were in public demand by Iranian citizens and it brought them more happiness. However, failure against Iraq, another Arabian team, triggered memories of the eight-year war experience with Iran and the Iranians found their misery to be mostly stemmed from that country. Consequently, it caused the happiness of the Iranians to plummet, as a wave of sorrow overtook them completely. Perhaps, if such a failure had happened against the Australian or East Asian teams, such outcomes would never have surfaced among the Iranian citizens.

There is no significant relationship between the demographic variables of age, marital status, and education level with citizens' happiness in Post-test 1 and Post-test 2. This suggests that the significant increase and decrease of happiness are essentially because of the results of the Iran national football team. Considering two points seems to be necessary here. Firstly, although the effect of some demographic variables, such as gender, marital status, education and age are controlled there are some other variables in micro level similar to occurrence of positive or negative events in the personal life that can affect the relationship between football games and citizens' happiness. However, the researcher was not able to measure them. Secondly, no specific and important event occurred by the Pre-, Post-test 1 and Post-test 2 at the micro level in Iran. Thus, the study results have not been influenced by any additional variable.

PRACTICAL APPLICATION

Happiness is an important psycho-social requirement in diverse societies that is considered by states in particular because of its various functions (Carr, 2004). A significant effect of national athletic success on happiness suggests that different countries can answer positively to this fundamental need as a key life goal (Baron & Branscombe, 2011), that can contribute to the building of a nation (Hong, 2011) by providing success of national

athletic teams in international sport competitions. Therefore, countries should invest in sport.

CONCLUSION

Most previous research on happiness and sport have concentrated on the happiness of the athletes (Medvec *et al*., 1995; Downward & Rasciute, 2011), and on medical studies of individuals during sport events (Kirkup & Merrick, 2003; Wilbert-Lampen *et al*., 2008) on a micro level. However, the present study has tried to focus on this on a large-scale. Consistent with other studies, the influence of sport on national integration (Lever, 1983), international relations (Ilmarinen *et al*., 1984), strengthening moral values (Bockrath & Franke, 1995), good feelings among people (Forrest & Simmons, 2003), national identity (Ahmadi, 2007), integration of different ethnic groups and social classes (Muller *et al*., 2008), and national pride (Denham, 2010) has been reported. The present study confirmed the significant effect of sport on happiness and has shown that successes and failures in sport could influence psycho-social life of citizens on a large scale. However, some limitations need to be considered.

Firstly, this study concentrated on short-term effects of national athletic success or failure, however, the long-term effects are also important and should be investigated. Secondly, as the data was collected in a very short period (up to 72 hours after a football match), and having cold weather conditions during the tournament in Iran, unavoidably the sample size was not very large. Thirdly, although the majority of the respondents in the age group of 18 to 29 years is acceptable concerning the population composition of Iran as a young country, it should be regarded in the countries with a different age composition. Fourthly, although the effect of demographic variables on the relationship between success or failure of sport matches and happiness was examined, it was not possible to measure some personal incidents, such as disease, divorce, etc., among respondents during data collection, which could influence the increase or decrease of their happiness.

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Prof Siroos AHMADI: Department of Sociology, Yasouj University, Yasouj, Iran. Tel.: +98 743 324 2151, Fax.: +98 743 324 2151, Mobile: +98 917 306 8289. Email: Sahmadi@yu.ac.ir

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RELEVANCE OF OLYMPISM EDUCATION AND SPORT-FOR-DEVELOPMENT PROGRAMMES IN SOUTH AFRICAN SCHOOLS

Cora BURNETT
University of Johannesburg, Doornfontein Campus, John Orr Building, Johannesburg,

ABSTRACT

The phasing out of physical education (PE) in South African public schools in the 1980s has left a void relating to the relative inability to deliver on strategic outcomes of government departments. Contemporary Life Orientation (LO) and PE curricula and practices in public schools (especially those in impoverished communities) rely on external implementing agencies for delivery. Global agencies, such as the International Olympic Committee and international sport federations deliver on mega sport event legacy programmes, often through school-based programmes. Current sport-for-development and Olympic-related educational practices in search of a meaningful PE model based on a human justice framework that will foster optimal physical activity participation opportunities for all in different settings is examined. A Foucauldian lens of governmentality provides a conceptual framework for a multi- agency model of good governance, and illuminates crucial insights in terms of how sport, as a dominant paradigm, perpetuates a persuasive framework for neoliberal thinking and practices. Many such practices are entrenched in competitive sport and are perpetuated by the sport ethic. Some key questions remain since they relate to the necessity for constructing relevant PE curricula and models that can leverage global content and mega sport event legacies in an integrated and sustainable way.

Key words: Physical education; Olympism education; Sport-for-development; Schools.

INTRODUCTION

Physical education and school sport in South Africa are key government priorities, and the government is seeking a cost-effective model to deliver on envisaged educational and sport- focused outcomes (SRSA, 2012, 2013a & b). At a recent national multi-stakeholder workshop (26 January 2016), the Department of Basic Education called on PE experts to develop ‘big ideas’ for open sources for PE as a topic in the Life Orientation Curriculum Assessment Policy Statement (CAPS) (DBE, 2016).

This initiative is underpinned by a human rights based approach driven by the Technical Support Unit of the Department of Basic Education. This unit prioritised writing LO textbooks, teacher training, public engagement and research (DBE, 2016). During the workshop it became clear that LO and PE have congested policy spaces, with a plethora of implementing agencies delivering diverse life skills and sport-related programmes. The persuasiveness of the competitive sport paradigm has significant political traction, and mass sport participation

programmes are funded by SRSA (Sport and Recreation South Africa) to align PE and school sport to deliver on this competitive sport agenda.

Since the new political dispensation was realised in 1994, South Africa has emerged as the continent’s leader propagating the 'power of sport', when the then President Mandela,

stated:

> Sport has the power to change the world. It has the power to inspire. It has the power to unite people in a way that little else can. Sport can awaken hope where there was previously despair (Nelson Mandela, Laureus World Sports Awards Ceremony, 2000).

Government's pro-poor policies focus on the redistribution of wealth and implementing mass sport participation programmes within a Sport-for-All framework (The Presidency, 2014). The emphasis on science, mathematics and English as core subject areas in the lower quantile (no- fee or poorer) schools, contributed to the outsourcing of sport- and life-skills related subjects. Even relatively better resourced schools face various challenges in implementing quality programmes, since most of the public schools abolished PE in the mid-1980s (Van Deventer, 2007). To some extent, this void has been filled by social entrepreneurs (non-governmental organisations) delivering diverse physical activity programmes, many of which originated as sport event legacy projects (Burnett, 2015).

South Africa has increasingly hosted international sporting events with the pinnacle being the 2010 FIFA World Cup and the 2022 Commonwealth Games (Cornelissen, 2004; www.durban- 2022.com). The 2010 FIFA World Cup attracted influential sport-for-development agencies delivering value-based education and sport activities at schools, such as the high profiled GIZ/YDF (Youth Development through Football of the German Development Corporation), programme, co-funded by the European Union (Burnett & Hollander, 2013). Global stakeholders, like the IOC (International Olympic Committee) and United Nations' International Working Group for Sport Development and Peace (chaired by the Deputy Sport Minister of South Africa), promoted the delivery of sport-related social transformation programmes at schools (Kidd, 2008, 2011, 2013).

AIM OF RESEARCH

Thus, the time is ripe for the development of an innovative and globally informed, yet indigenised PE curriculum and school sport practices to which Olympism education and sport- for-development programmes can contribute. It is against this background that the paper aims to address:

(1) Olympism, Olympic education and Olympism education;
(2) Sport-for-development approaches through a Foucauldian lens of 'governmentality';
(3) Educational paradigm for enriching PE and school sport; and
(4) Recommendations for informing policies and practices.

CONCEPTUAL FRAMEWORK OF OLYMPISM

Ideologies of Olympism

In the late 19th Century, Pierre de Coubertin regarded Olympism as a valuable educational tool for the youth and the IOC was the driving force for propagating it globally. With its roots in Ancient Greek philosophy, Olympism presented a fusion of Western Christianity and democratic cosmopolitanism proposed by Thomas Arnold and the English school system. From the outset, Olympism as an ideology was enshrined in myth and the socio-

political realities of the day (Monnin, 2012).

The IOC's concept of Olympism is captured in the Olympic Charter as a "philosophy of life", which places sport at the service of creating a "peaceful society" (IOC, 2013a:11). Olympism is further considered to represent a human rights perspective and fundamental ethic principles of non-discrimination, filtered by values of fair play and equality. It is this vision that resonated with the United Nations and led to the president of the IOC obtaining UN observer status in 2009. The partnership inspired the current strategic drive of the IOC to deliver on six of the Sustainable Development Goals (IOC, 2015). Olympism and its practices are not unproblematic and have attracted criticism from many sectors.

The idealistic model of an integrated mind, body, emotion, and conscience premised on 'universal ethical principles' is increasingly questioned. MacAloon (2016:62) states that Pierre de Coubertin was unsuccessful in connecting "his intuitions and insights on the discursive and pragmatic levels", being ignorant of Emile Durkheim's social theory at that time. However, he created a global sport festival with rituals and layered symbolic codes that lasted more than a century (Meinberg, 2016). Olympic values of fair play, leadership, excellence, respect, friendship and finding joy in effort, reached global acceptance and relevance through the Olympic Movement (Devitt, 2012). For the IOC, the internationalisation of Olympic ideals and values assumed a high level of compatibility with different cultures - a display of "a kind of multi-functionality" (Lenk, 2016:19).

Kohe (2010:488) is sharp in his criticism of Olympic idealism being integrated into PE curricula, and advocates for vital critical socio-political components in demystifying "contemporary illusions about sport, orthodox understandings of Olympic history and the IOC's idealistic and corporate propaganda". Inherent in this criticism is the construction of assumed universalism. Guest (2009) questions the assumed *universalism* and its relevance as a homogenising ideology for grassroots sports programmes in Africa. The universality and stability of such an ideology is also questioned by Teetzel (2012), who states the inevitability of change and need for new contextual interpretations.

Concepts may have some element of stability, but are differently interpreted in particular time periods and geographic locations, where they appear as unique or adapted conceptions. The concept of Olympism cannot defy *realistic expressions of time and place*, as is argued by Parry (2006:91), who states that for universal validity of Olympic values "each nation can sincerely commit itself, general by its own culture, location, history, tradition and projected future".

MacAloon (2016) equally emphasises the dynamic nature of cultures, whereas Sahlins (2000) refers to it as the indigenisation of modernity. In this sense, Olympic values are reflective of a *colonising process* and the promotion of consumerism in a highly commercialised environment (Lenskyi, 2012). As encapsulated by Badiou's Kantian ideas and Césaire's advocacy for an international left, radical thinking and agency challenge the status quo of powerful neo-colonial networks (Pithouse, 2013). A mega sport event often provides the stage for stakeholders to act out their mandates, often dictated by global powerhouses from the Global North. Thus, the critique is also directed towards the absorption of (sport) development policies and programmes by implementing agencies from the Global South (Patsantaras, 2008).

New World black thinkers like C.L.R. James and W.E.B. Du Bois warn against neo-liberal thinking and structuring debates to perpetuate Western-centric practices (Pithouse, 2013). Socio-political constructs have the facade of political agency, but fail to deliver equitable opportunities for all. Most legacy programmes linked to sport events lack sustainable resources and local ownership to effect meaningful local social impact. For this reason, Darnell (2007:607) advocates that "sport [for] development work be integrated into all forms of development inherent in diverse social settings", and proposes that it should harbour a self- critical edge.

The following section offers 'governmentality' through the lens of Foucault as the conceptual framework against which notions of educational sports legacy programmes might be understood. Two main educational thrusts associated with the Olympic Games and other mega- events relate to PE curricula and sport for development programme implementation.

Foucauldian lens of 'governmentality'

With multiple agencies delivering diverse content, the question emerges relating to how the diverse content and plethora of implementing agencies will deliver on an integrated or synthesised model based on good governance principles. Other dimensions for school curriculum infusion include issues relating to active citizenship, consumerism, the politics of the body and ideological tensions.

Michel Foucault and other political theorists engaged with the phenomenon of governmentality in a neo-liberal, modernist context, which implies a high level of reflective self-governance, active citizenry (youth), and increased consumerism (Chatziefstathiou, 2012b). This requires a critical view of heightened levels of consumer culture at mega-events, especially as it also intersects with the discourse of development and the affordability of global sporting events in developing economies of the Global South. Chatziefstathiou and Henry (2009) reflect on tensions between neo-liberalism, socialism, capitalism and conservatism. They question the unequal power relations and popularise bourgeois games and an Olympic sporting movement despite the rhetoric of social equality that would be promoted by sport event legacy programmes (Chatziefstathiou, 2006).

Governmentality transcends binary oppositions and abstractions whilst harbouring a universal imagination of rule embedded in social processes and individuation practices evident in embodied discipline and surveillance (Vrasti, 2013). For Foucault (2013), disciplinary power has a regulatory function with identified roles and responsibilities within a social hierarchy.

With the disciplinary power invested in controlling bodies of sport (the IOC and international sport federations), different surveillance techniques are utilised to ensure homogenisation and a shared pool of resources and knowledge to achieve collective goals. Olympic and Olympism education and sport-for-development programmes deliver disciplinary effects through 'good governance'. It also cascades to the formation of a sport ethic, regulations (anti-doping), and coaching practices to ensure the docility and obedience of athletes, who in turn echo sport virtue and value participation to all sectors of society (Markula-Denison & Pringle, 2007).

The quest for sustainable sport event legacy impact is often translated into the delivery of

programmes through existing systems, of which PE seems to be an obvious channel. A generic thread speaks to value education as proposed by bid specifications, a value education for potential host cities and countries that would inevitably also package it in a national framework.

Olympic education versus Olympism education

Advocating for constructivist pedagogies for Olympism education and its location within a PE context underpinned by critical pedagogy, requires a repositioning of the field (Culpan & Wigmore, 2010). Less critical conceptualisations found expression in Olympic education toolkits and globalised programmes often associated with IOC legacy programmes implemented under the jurisdiction of National Olympic Committees (NOCs) and Olympic Academy Commissions (Culpan & McBain, 2012).

Many of these programmes can be placed on a continuum of a 'factual and historical' approach (traditional Olympic education), a holistic approach, and full integration within the PE and school sport framework to foster critical thinking through experiential learning (Olympism education) (Culpan, 2015). The proposed constructivist framework for Olympism education proposes a new way of thinking about teaching, learning and knowledge construction by connecting "sport and movement experiences with lived and authentic contexts" (Culpan & McBain, 2012:99). Olympism offers a synthesis of the psychological, social and critical dimensions of constructivism in a pragmatic way to develop from experiential learning and humanist positioning to sharpen independent thinking and self-reflection (Culpan, 2015).

Several influential models exist, such as that of Naul (2008) and an extended version on a didactic matrix provided by Nikolaus (2016). Binder (2010, 2012) developed generic material on Olympic education as value-based education for global implementation of the Olympic Values Education Programme (OVEP). Diverse models and evaluations report moderate but positive effects, such as the Olympic Education Programmes in Lithuanian schools (Šukys & Majauskiene, 2014), and Greek schools (Hassandra *et al*., 2007). Parry (2012) refers to relatively short-term effects of legacy programmes, yet acknowledges the potential positive contribution of such programmes at the Youth Olympic Games and for the upcoming Olympic Games in Rio in 2016.

Olympism education seems to reach beyond the Olympic Games as a global sporting event by informing mainstream value-based PE and physical activity programmes, specifically in an Olympic host country (Parry, 2012). It is in this vein that sport for development as social movement successfully intersects by propagating sustainable value education programmes associated with sport and physical activities (Kidd, 2008; Culpan, 2015).

Sport-for-development and value education

Kay (2012) described how sport-for-development carries a high level of political significance with recognition as an *Olympic legacy concept*. The concept of legacy and 'development' of Third World nations though elite and sport-for-development (life skill-based) programmes are premised on the bourgeois concept of catching up the historical delay. Global integration that allows for the flow of foreign capital and expertise frames an image of political agency for development work in different spheres, including in different sports practices (Pithouse, 2013).

Many dominant approaches are mostly reductionist, and are informed by positivist logical modelling, with the implication that sport may serve as an antidote to many social ills, and that sport is inherently 'good' (Coakley, 2011). This trail of thought assumes a deficit model of vulnerable populations who are inevitably deviant and in need of sport for personal development and empowerment. Coalter (2013) speaks out against this deficit model approach and argues that impoverished populations should be understood in the context of their living conditions. People are not merely mechanisms in linear processes of growth and development, and sport participation delivers very varied results with specific effects for specific populations under certain conditions.

Over statement of positive effects of value-based *sport-for-development programmes* resonate with similar sentiments about Olympism as critical scholars contribute to a body of knowledge from a grounded theoretical perspective (Darnell, 2007; Burnett, 2015; Sugden, 2015). Political activists, such as Samir Amin (2006:4), Director of the Third World Forum, openly questions the hypocrisy of political powers and their hegemony in the UN, as they deliver development by standing united in their "fight against poverty". Kidd (2011) argues for the opening up of sport-for-development phenomena to address the educational needs of young people in local settings.

The *focus on youth* (male and female) and establishment of the Youth Olympic Games (YOG) in 2010, was expressed at the XIII Olympic Congress in Copenhagen as follows:

> The Olympic Movement must strive to extend its remit and to increase its influence with young people across the world, using sport as a catalyst for their education and development. (IOC, 2013b:56)

The IOC's focus on young people is motivated by both moral and commercial interests. The young market has to be captured as evidenced in the 2012 London's International Inspirations Project, the incorporation of social networking technologies and inclusion of BMX bicycle racing in the Olympic programme. Establishing the Youth Olympic Games as educational flagship initiative was a key drive by the IOC to reach out to young people globally (Chatziefstathiou, 2012a).

A youth strategy was approved by the IOC Executive in November 2011 with a vision to demonstrate the Olympic Movement's accountability for utilising sport as the service to children and youth through advocacy, activation and education. OlympAfrica Centre Programmes and the Sport for Hope Programme in Zambia in partnership with local sport clubs and schools fulfil such educational and development roles. In local contexts, NGOs deliver

sport-for-development programmes, provide sport participation opportunities, and life skill education that aim to address social issues (HIV/AIDS) and lifestyle disease profiles, such as obesity (IOC, 2013a).

At grassroots level, the coach plays a significant role in modelling and facilitating positive youth development (PYD), which entails a mentorship role and longitudinal involvement with participants (Camiré *et al*., 2014). Olympic education programmes implemented by volunteers or teachers, and sport-for-development programmes implemented by peer-educators facilitate the acquisition of life skills through a reciprocal social learning process.

Since the 2000 Sydney Olympic Games, host cities increasingly showcase *human legacy* profiles. The Sydney Games attracted international attention to human rights issues related to their indigenous populations and scrutiny of the nation's self-consciousness (Rowe, 2012). Although indigenous leaders endorsed the bid and gold medallist Cathy Freeman became a symbol of hope and freedom for the Aborigines, systemic dispossession continued to have lasting effects in marginalising indigenous populations (Lenskyi, 2002).

The historical significance of the 2004 Athens Olympic Games framed the historical roots and showcased the Hellenic heritage with educational programmes from 2005 to 2008, and was replaced by *kallipateira* (Aroni, 2013). Lessons addressed issues of human rights, diversity, multiculturalism and social solidarity. Brownell (2009) reflected on the promotion of national identity and patriotic education of the Chinese government through celebrated sport heroes. *Suzhi* (quality) education was enriched by the Olympic Education programme, which also contributed to the reconfiguration of Chinese national identity within a global context.

The 2012 London Olympics reached out to the youth of the world in an ambitious programme, International Inspirations, whereas the 2016 Rio Olympic education programme aimed at delivering access to sport participation to the most vulnerable children in the quest for social inclusion (Todt, 2015, 2016). Based on the *Get Set* programme of the 2012 London Olympics, Korea still has to integrate the values of Confucianism related to the virtues of humanism, justice, respect, wisdom and faith into their Olympic education programme (Hong, 2016). The fusion of sport-for-development and Olympic education programmes in developing context questions, the real and lasting effects on social exclusion and social vulnerability for marginalised populations (Sanford *et al*., 2006; Knijnik & Tavares, 2012).

It is necessary to utilise the event leverage potential in the broader development framework (Chalip, 2006). The UN's action plan, Agenda 21 and the IOC's focus on delivering on the SDGs (Agenda 2020) currently provide strategic direction for human legacy planning and implementation where Olympic education has a key role to play (Homma & Masumoto, 2013).

IMPLICATIONS FOR SOUTH AFRICAN SCHOOLS

Conflicting paradigms of sport and formative education as envisaged by a fusion of physical, Olympism and value education require critical reflection and indigenised relevance. The question remains to what extent an integrated body of knowledge and fusion of value education would be able to deliver on the multi-levelled expectations of agencies with meaningful impacts on local communities, schools and individual learners. What are the implications of Olympism

education and sport-for-development for PE and school sport in South Africa? This question is posed at the beginning of the new curricula and practice developments where the National Department of Education, in partnership with SRSA, are searching for a cost-effective and innovative model. PE curricula could meaningfully benefit from the holistic, value-based approach advocated by Culpan (2015) who presented an integrated model for Olympism education located within the school sport and PE curriculum.

This offers a sound and relevant approach where the psychological, social and critical paradigms intersect for holistic and self-reflective learning. Global processes of commodification and heightened consumerism associated with such events, which are increasingly held in developing countries at high cost to its citizens, should be questioned. The unequal power relations and rhetoric of equality within competitive sports should also be scrutinised to ensure open access and sport for all, and not only for the highly talented (Chatziefstathiou, 2012b). South African learners should be exposed to a critical paradigm that questions human rights transgressions and the hidden agendas of powerful agents in global sports. Such a paradigm may produce critical voices and form an essential part in developing active citizenship (Darnell, 2010).

Foucauldian insights on new-liberal ideas and universal models of good governance should incorporate contextual and nuanced understandings where individuals engage in sports and physical activity for multiple reasons – from nation-building, active citizenship and social transformation to positive health and other psycho-social learning outcomes.

CONCLUSION

The democratisation of the Olympic movement and its reliance on strategic partnerships informs a Foucauldian perspective in explaining institutionalised power relations with the institutional centrality of the IOC within a complex web of stakeholder relationships. National governments and schools may claim ownership and agency with development programmes to counter neo-liberal ideas and content in opposition to indigenous knowledge. Thus, enriching PE curricula with value-based and Olympism or event-driven (Olympic) education in South African schools should be scrutinised and filtered for national and indigenous relevance.

In South Africa, schools are central to the delivery of value-based programmes, and due to the relative short time span of sport-legacy programmes, civic society agencies (NGOs) are the main implementing agencies. Such agencies are relatively easy to attract as implementing partners, yet they are highly dependent on external funds. Thus, this sector is highly donor- dependant and equipped for delivering narrow focused programmes on prioritised SDGs, such as gender empowerment or HIV/AIDS prevention (Coalter, 2013). Reconceptualising the UN- IOC partnership with cascading stakeholder re-positioning could bring synergies and bridge silo-delivery mechanisms for the inclusive delivery of quality physical and sport programmes, with Olympism education and/or Olympism education as the means.

The infusion of such educational content in the PE curriculum would provide learners with a body of knowledge that could foster critical thinking, bring the global to the local in debate and practice as sustainable mega sport event legacies. The following recommendations may contribute to a meaningful and impactful practice: (1) adapt social policies of SRSA and the

Department of Basic Education to ensure equal participation opportunities for all through quality, value-based PE programmes; (2) ensure that mega-event sport legacy programmes are absorbed by PE and school-based sport programmes within an educational framework (2022 Commonwealth Games educational programmes); (3) offer education and training material and courses for teachers and peer-educators to ensure quality programme implementation; and (4) form partnerships for optimal stakeholder alignment and

coordinated implementation where the government sector takes the lead.

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Prof Cora BURNETT: Department of Sport and Movement Studies, University of Johannesburg, Doornfontein Campus, John Orr Building, Johannesburg, Republic of South Africa. Tel.: +27 (0)5596963, Email: corab@uj.ac.za

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COMBINED ASSOCIATIONS OF TELEVISION VIEWING AND PHYSICAL ACTIVITY WITH OVERWEIGHT/OBESITY IN TAIWANESE ELDERLY ADULTS

Shao-Hsi CHANG[1], I-Yao FANG[2], Ming-Chun HSUEH[2] & Yung LIAO[3]
[1] *Graduate Institute of Sport, Leisure and Hospitality Management, National*

Taiwan Normal University, Taipei, Taiwan
[2] *Department of Physical Education, National Taiwan Normal University, Taipei, Taiwan*
[3] *Department of Health Promotion and Health Education, National Taiwan Normal University, Taipei, Taiwan*

ABSTRACT

This study investigated the combined association of TV viewing and physical activity (PA) with overweight/obesity in Taiwanese elderly adults. A telephone-based survey was conducted in 2013. Self-reported data (height, weight, TV viewing time, and PA time), were collected from a nationally representative sample of 1031 adults aged >55 years. Unadjusted and adjusted binary logistic regression models were used to calculate the odds ratios (ORs) of overweight/obesity (BMI≥25kg/m^2) according to four combined TV (2h/day) and PA (150min/week) categories. In total, 60.4% of the sample was overweight/obese. After adjustment for potential confounders, significantly higher ORs of overweight/obesity were observed in the high TV/sufficient PA (OR=1.96; 95% CI=1.31-2.95) and high TV/insufficient PA (OR=1.93; 95% CI=1.34-2.78), categories compared with the low TV/sufficient PA category. Consistent with those in high-income countries, Taiwanese elderly adults, who engage in more than two hours of TV viewing per day, are at a higher risk of being overweight/obese, regardless of whether they meet PA recommendations. Additional studies are required to identify at-risk populations and the associated correlates of prolonged TV viewing to design effective interventions.

***Key words*:** Physical activity; Sedentary behaviour; Body Mass Index; Obesity; Elderly.

INTRODUCTION

A high body mass index (BMI) has been linked to mortality worldwide and is a risk factor for non-communicable diseases, such as cardiovascular disease, Type 2 diabetes, and certain types of cancer (WHO, 2009). As observed in Western countries (Vasunilashorn *et al*., 2013), an increasing prevalence of overweight (including obesity) has been reported in nearly half (46.7%) of Taiwanese older adults (Health Promotion Administration, Ministry of Health and Welfare, 2008). Therefore, to develop overweight/obesity prevention initiatives, acquiring a clearer understanding of the modifiable behavioural risk factors of overweight/obesity in Taiwanese elderly adults is imperative.

Prolonged sedentary behaviour periods, such as television (TV) viewing and insufficient physical activity (PA), are established independent behavioural risk factors for overweight (Martínez-González *et al*., 1999; Hu *et al*., 2003; Bowman, 2006; Cheriyath *et al*., 2010; Ekelund *et al*., 2011). The findings of recent studies are relevant to the examination of the combined effect of sedentary behaviour and PA on weight status because determining how increasing levels of sedentary time in combination with various PA levels may contribute to the risk of overweight is crucial (Eisenmann *et al*., 2008; Laurson *et al*., 2008; Sugiyama *et al*., 2008; Patel *et al*., 2010; Sisson *et al*., 2010; Liao *et al*., 2011; Inoue *et al*., 2012; Veerman *et al*., 2012; Chu & Moy, 2013; Maher *et al*., 2013).

These findings can be critical for determining target behaviours to treat and prevent the excess weight epidemic. For example, several studies have emphasised that both sedentary behaviour and PA time were critically associated with overweight (Eisenmann *et al*., 2008; Laurson *et al*., 2008; Sisson *et al*., 2010; Liao *et al*., 2011; Chu *et al*., 2013). Otherwise, sedentary behaviour might be as critical as PA for avoiding overweight/obesity (Sugiyama *et al*., 2008; Patel *et al*., 2010; Inoue *et al*., 2012), whereas PA has been identified as a stronger behavioural risk factor for overweight compared with sedentary behaviour (Maher *et al*., 2013). However, the evidence presented regarding the combined association of sedentary behaviour and PA with the risk of overweight/obesity is inconsistent. Moreover, most studies have focussed on youth and adult populations, with fewer studies focussing on older adults. Inoue *et al*. (2012) investigated Japanese older adults and revealed that watching TV for less than two hours was associated with a lower risk of overweight/obesity, regardless of the PA level (300 minutes/week). However, more information is required for understanding the association between health behaviour and overweight/obesity in older adults from various countries.

TV viewing is a marker of an overall pattern of sedentary behaviour (Sugiyama *et al*., 2008), which constitutes a large proportion of the leisure time of older adults (Harvey *et al*., 2013). According to the 2010 Taiwan Social Change Survey, TV viewing is a major leisure-time activity. The Taiwan Social Change Survey (2010) and a study by Chang *et al*.(2015) reported that nearly half (47.4%) of Taiwanese elderly adults view TV for more than two hours per day. Furthermore, compared with Western countries, the Taiwanese population exhibited a higher prevalence of physical inactivity (Bauman *et al*., 2009). However, how different combinations of TV viewing and PA might influence the health of Taiwanese older adults remains unclear. Therefore, this article provides epidemiological evidence on the combined association of TV viewing and PA with the risk of overweight/obesity among Taiwanese elderly adults.

METHODOLOGY

The study protocol was approved by the Ethics Committee of the National Taiwan University before the survey was conducted (201309ES003). The telephone-based research service company did not offer any reward.

Participants

The cross-sectional survey data was derived from a random-digit-dialling telephone-based survey conducted from June to July 2013 by a telephone-based research service company in Taiwan. In December 2013, the population and land area of Taiwan was estimated at 23,373,517 and 36,192.8km^2, respectively. A total of 25.34% of the total Taiwanese population

aged 55 years and over (5,923,910 residents) were the target population for this study. The required sample size for this study was calculated to be 1,067 elderly adults, with a 95% confidence level and 3% confidence interval (CI), as derived in a previous survey (Hsueh *et al*., 2015). A stratified random sampling method was used to select respondents by gender, age (55–64 years and 65 years and older), and area of residence. Finally, among the 1,068 elderly adults who responded to the survey, 1,031 responses (55.7%) were considered valid

for analysis after cleaning the data.

Measurements

The outcome variable was the BMI of the participants where the calculation was based on their self-reported height and weight. The BMI was dichotomised into normal (<25kg/m^2) and overweight/obesity (≥25kg/m^2) according to the international classification proposed by the World Health Organization (WHO, 2004).

The exposure variable was the length of TV viewing time, which was calculated as the amount of time spent watching TV on weekdays and on the weekend divided by 7, and the average TV viewing time per day (hours/day) over the 7 days immediately before the interview. This item was reported to demonstrate a high test-retest reliability (interclass correlation coefficient=0.76; Spearman ρ=0.78), according to the Older Adults' Sedentary Time questionnaire (Gardiner *et al*., 2011). The total TV viewing time was dichotomised into low TV viewing (<2 hours/day) and high TV viewing (≥2 hours/day) categories because this cut-off point has been reported as a health risk in previous studies (Grontved & Hu, 2011).

The Short Version of the International Physical Activity Questionnaire-Taiwan computer-assisted telephone interview (IPAQ-Taiwan CATI) (Liou, 2006), was administered to assess moderate-to-vigorous physical activity (MVPA) and walking, the test-retest reliability of the IPAQ-Taiwan CATI was 0.96. The intraclass correlation coefficients (ICCs) of the content validity indices were 0.82 for language similarity and 0.93 for semantic similarity between the English and Taiwanese versions of the IPAQ-Taiwan CATI. The concurrent validity for comparisons of the IPAQ self-administered short questionnaire and the IPAQ-Taiwan CATI was 0.84 (ICC) (Liou, 2006). PA time was calculated and dichotomised into sufficient PA (≥150 minutes/week) and insufficient PA (<150 minutes/week) categories based on public health guidelines (Haskell *et al*., 2007). According to the levels of TV viewing time and PA, participants were categorised into the following four groups: low TV/sufficient PA; low TV/insufficient PA; high TV/sufficient PA; and high TV/insufficient PA.

The sociodemographic variables obtained from the research company included participant gender, age (55-64 or 65 ≥ years), residential area (rural or urban area), marital status (married or unmarried), job status (employed or unemployed), educational level (lower than high school or college graduate or postgraduate degree), and living status (alone or with others).

Data analysis

Data for 1,031 elderly adults who provided complete information for the study variables were analysed. A chi-squared test was performed to identify the sample characteristics among the four groups based on various combinations of TV viewing time and PA (TV/PA). Binary logistic regression was conducted to estimate the odds ratios (ORs) of overweight/obesity on

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the basis of the TV/PA categories. Two regression models were tested: Model 1 (unadjusted) and Model 2 (all adjusted for gender, age, residential area, marital status, job, education level, and living status). Previous research identified these variables as potential

confounders (Inoue *et al*., 2012). The low TV/sufficient PA category was the reference for the analysis, which was conducted using SPSS Version 24.0 with the level of significance set at $p<0.05$.

RESULTS

Table 1 shows the socio-demographic characteristics of the sample and category levels.

Table 1. **CHARACTERISTICS OF SAMPLE ACCORDING TO COMBINED TV VIEWING AND PHYSICAL ACTIVITY**

Groups	% of Total (N=1031)	% Low TV/ suffic. PA (n=226)	% Low TV/ insuffic. PA (n=316)	% High TV/ suffic. PA (n=180)	% High TV/ insuffic. PA (n=309)	p
Gender						0.79
Male	44.4	46.9	44.9	43.4	42.7	
Female	55.6	53.1	55.1	56.7	57.3	
Age (year)						0.58
55–64	54.6	55.3	55.7	57.2	51.5	
65≥	45.4	44.7	44.3	42.8	48.5	
Residential area						0.18
Rural	37.4	38.5	41.8	34.4	34.0	
Urban	62.6	61.5	58.2	65.6	66.0	
Marital status						<0.001**
Married	85.2	90.7	88.0	83.9	79.0	
Unmarried	14.8	9.3	12.0	16.1	21.0	
Job status						<0.001**
Unemployed	69.4	56.2	66.8	71.1	80.3	
Employed	30.6	43.8	33.2	28.3	19.7	
Education level						0.02*
Low education	76.3	77.0	70.3	78.9	80.6	
High education	23.7	23.0	29.7	21.1	19.4	
Living status						0.42
Alone	7.1	6.2	6.6	5.6	9.1	
With others	92.9	93.8	93.4	94.4	90.0	
BMI (kg/m^2)						<0.001**
Normal weight	56.0	63.3	62.7	47.8	48.5	
Overweight	44.0	36.7	37.3	52.2	51.5	
TV view. (hrs/day)						<0.001**
Low TV, <2	52.6	41.7	58.3	0.0	0.0	
High TV, ≥2	47.4	0.0	0.0	36.8	63.2	
PA (min/week)						<0.001**
Insufficient <150	60.6	0.0	50.6	0.0	49.4	
Sufficient 150≥	39.4	55.7	0.0	44.3	0.0	

BMI=Body Mass Index TV=Television PA=Physical activity
*p<0.05 **p<0.001

Overall, 44.4% of the respondents were males, 54.6% were aged 55-64 years, 37.4% lived in rural areas, 85.2% were married, 69.4% were unemployed, 76.3% had an education level of lower than high school, and 7.1% lived alone. In addition, 44.0% of the sample were overweight (including obese), 47.4% were engaged in high TV viewing, and 60.6% reported insufficient PA. A chi-squared test revealed proportional differences in marital status

(p<0.001), job status (p<0.001), educational level (p=0.02), BMI status (p<0.001), TV viewing (p<0.001), and PA (p<0.001).

Table 2. **ADJUSTED ORs FOR OVERWEIGHT ACCORDING TO COMBINED TV VIEWING AND PHYSICAL ACTIVITY**

TV/PA categories	N (% Overw.)	Model 1		Model 2	
		OR (95% CI)	p-Value	OR (95% CI)	p-Value
Low TV/ Sufficient PA	226 (36.7)	1.00 (ref.)	–	1.00 (ref.)	–
Low TV/ Insufficient PA	316 (37.3)	1.03 (0.72–1.46)	0.880	1.09 (0.76–1.56)	0.660
High TV/ Sufficient PA	180 (52.2)	1.88 (1.26–2.81)	0.002*	1.96 (1.31–2.95)	0.001*
High TV/ Insufficient PA	309 (51.5)	1.83 (1.29–2.59)	<0.001**	1.93 (1.34–2.78)	<0.001**

TV=Television PA=Physical Activity Overw.=Overweight *p<0.05 **p<0.001 Model 1=Unadjusted Model 2=All adjusted (gender, age, residential area, marital status, job, education level, living status)

Table 2 shows the ORs for being overweight (including being obese) based on the TV/PA categories for the total sample. Compared with the low TV/sufficient PA category in Model 1, a significantly higher OR for being overweight/obese was observed between the high TV/sufficient PA (OR=1.88; 95% CI=1.26-2.81) and high TV/insufficient PA (OR=1.83; 95% CI=1.29-2.59) categories, but no significant association was observed in the low TV/insufficient PA category (OR=1.03; 95% CI=0.72-1.46). After adjustment for all of the socio-demographic variables in Model 2, most of the associations showed a higher likelihood of being overweight/obese in both the high TV/sufficient PA (OR=1.96; 95% CI=1.31-2.95) and high TV/insufficient PA (OR=1.93; 95% CI=1.34-2.78) categories, regardless of their PA status. No significant association was observed in the low TV/insufficient PA category (OR=1.09; 95% CI=0.76-1.56).

DISCUSSION

This study examined the combined association of TV viewing and PA with overweight/obesity among a sample comprising 1,031 Taiwanese elderly adults aged 55 years or older. The results reveal that excessive TV viewing time (≥2 hours/day) was associated with a greater likelihood of being overweight/obese, regardless of whether the participants had sufficient PA (≥150 minutes/week). The regression models revealed that Taiwanese elderly adults who watched TV for more than two hours per day were 1.93-1.96 times more likely to be overweight/obese, regardless of the time they spent engaging in PA. These results are consistent with the findings of previous studies involving adults in Australia and the United States, as well as older adults

in Japan (Sugiyama *et al*., 2008; Patel *et al*., 2010; Inoue *et al*., 2012). However, these findings differ from the evidence on children or young people in the United States (Eisenmann *et al*., 2008; Laurson *et al*., 2008; Sisson *et al*., 2010). Watching TV for more than two hours per day has been considered to have a negative impact on the health of older adults (Inoue *et al*., 2012; Veerman *et al*., 2012), which is crucial for developing strategies

aimed at reducing the length of time spent watching TV to prevent elderly adults from gaining excess weight or becoming overweight/obese.

This study shows that older adults who engage in excessive TV viewing (≥2 hours/day), but sufficient PA (≥150 minutes/week), have similar or even slightly higher prevalence of being overweight/obese compared with those who engaged in excessive TV viewing and insufficient PA. A possible reason for this could be that PA does not play a protective role in the prevalence of being overweight/obese, which could be partially explained by the health benefit of low- intensity activity for elderly adults (Healy *et al*., 2007; Inoue *et al*., 2012). Although attaining the recommended level of PA is beneficial in protecting against weight gain, moderate-to- vigorous PA is difficult to perform with increasing age (Nelson *et al*., 2007). Another possible reason is that the fitness conditions of elderly adults, including muscle strength recession, cause decreased body flexibility or metabolic dysfunction with aging (Hamilton *et al*., 2007; Inoue *et al*., 2012; Stathokostas *et al*., 2013).

PRACTICAL APPLICATION

In an effort to reduce the TV viewing time in older adults, previous interventional studies have confirmed specific types of activity that may reduce the length of time spent watching TV while increasing the amount of PA for older adults, such as going outdoors daily or receiving individual consultation to reduce sedentary time (Jacobs *et al*., 2008; Fitzsimons *et al*., 2013). Future interventional studies could evaluate these strategies to lower the risks of older adults being overweight/obese, which might benefit their health benefit.

Several limitations encountered while conducting this study should be addressed. Firstly, this was a cross-sectional study; therefore, causality could not be inferred. Secondly, the main variables (PA, TV viewing time and BMI) were self-reported and might have contributed to recall bias (Haskell *et al*., 2007; Hallal *et al*., 2010). Thirdly, this study did not measure other variables, such as total time of sedentary behavior, light-intensity activity, smoking and unhealthy dietary behaviours, which might have confounded the results (Inoue *et al*., 2012). Despite these limitations, the strength of this research is that the study sample was extracted using a stratified random sampling technique by a telephone survey company. Therefore, the findings can be crucial and representative of Taiwan's elderly adult population.

CONCLUSIONS

The findings of this study support evidence that older adults who watch TV for more than two hours per day demonstrate a higher risk of being overweight/obese, regardless of whether they engage in sufficient PA. For obesity prevention, targeting older adults is critical for reducing the length of time they spend watching TV. Further study is necessary to identify at-risk populations and the associated correlates of prolonged TV viewing, thus allowing for the design of effective interventions for older adults.

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Dr Candidate Ming Chun HSUEH: Research Fellow of Department of Physical Education, National Taiwan Normal University, 162, Heping East Road Section 1, Taipei, Taiwan. Tel.: +886277343222, Email: boxeo19912016@gmail.com

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EQUINE-ASSISTED THERAPY AS INTERVENTION FOR MOTOR PROFICIENCY IN CHILDREN WITH AUTISM SPECTRUM DISORDER: CASE STUDIES

Monique DE MILANDER, Samantha BRADLEY & Rykie FOURIE
Department of Exercise and Sport Sciences, University of the Free State, Bloemfontein, Republic of South Africa

ABSTRACT

Children with Autism Spectrum Disorder display a range of challenging difficulties in all aspects of their daily living routines. Due to these challenges, parents look for various interventions that will improve the quality of life of their children. The objective of this study was to determine whether an Equine-Assisted Therapy (EAT) intervention would result in an improvement of balance, upper-limb coordination and strength. Two case studies were conducted, where one female (9 years and 4 months) and one male (8 years and 7 months) participated in a 10-week EAT intervention. Motor proficiency was evaluated by means of a pre-post-test research design using selected composites of the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2). Individual changes were observed in balance, upper-limb coordination and strength. EAT interventions could provide a suitable alternative approach for children on this spectrum who experience impairments in low muscle tone, repetitive motor movements, poor motor planning, postural instability, difficulty sequencing a task, as well as poor gross motor performance. Larger studies involving more participants are suggested to ascertain if these findings can be generalised.

***Key words*:** Autism Spectrum Disorder; Equine-assisted intervention; Motor proficiency; Bruininks-Oseretsky Test of Motor Proficiency; Balance; Upper-limb coordination; Strength.

INTRODUCTION

Pervasive developmental disorder (PDD) is defined in the Diagnostic and Statistical Manual of Mental Disorders as severe and pervasive impairment in social interaction skills, communication skills, or the presence of stereotyped behaviour, interest and activities (APA, 2000). Furthermore, Auxter *et al*. (2010) state that PDD consists of four disorders, autistic disorder, Rett syndrome, PDD (not otherwise specified, PDD-NOS), and Asperger's syndrome. Alternatively, the term Autism Spectrum Disorders (ASD) are also used for PDD (Auxter *et al*., 2010). The causes of ASD are still unknown. Each type of ASD demonstrates neurological impairment and is normally evident by the age of three (Lotan, 2007; Auxter *et al*., 2010).

According to the Diagnostic and Statistical Manual of Mental Disorders, fifth edition, (DSM 5) (APA, 2013), the prevalence of ASD is currently estimated to be at least 1% of the population. Boys are also currently being diagnosed more often than girls, estimating the ratio to be 4:1 (Rice, 2009; Van den Hout & Bragonje, 2010; APA, 2013). The prevalence of ASD

is also increasing (Sams *et al*., 2006; Matson & Kozlowski, 2011; Baio, 2012). However, it is not clear if the increase is due to the changes in the diagnostic criteria or the improvement of the recognition of ASD (Van den Hout & Bragonje, 2010; APA, 2013).

ASD is a lifelong condition and therefore, the need persists to identify appropriate interventions (Sams *et al*., 2006; Lotan, 2007; Gabriels *et al.,* 2012) to address the deficits in functioning that are associated with the condition. A variety of interventions have been proposed to improve specific areas of function in children with ASD (Van den Hout & Bragonje, 2010; Wuang *et al*., 2010; O'Haire, 2013). These include verbal communication skills (Sams *et al*., 2006; Keino *et al*., 2009; Memishevikj & Hodzhikj, 2010), social interaction skills (Redefer & Goodman, 1989; Sams *et al*., 2006; Burrows *et al*., 2008; Solomon, 2010), as well as problem behaviour (Lotan, 2007; Van den Hout & Bragonje, 2010; Viau *et al*., 2010). Another domain of development that is rarely reported is that of the motor functioning of children with ASD (Stone *et al*., 1999; Baranek, 2002; Kimberly *et al*., 2010). Although children with ASD struggle with social, communication and behaviour problems, the literature reports that they do have motor deficits as well (Baranek, 2002; Auxter *et al*., 2010). These deficits include low muscle tone, repetitive motor movements, poor motor planning, postural instability (Baranek, 2002), difficulty sequencing a task (Baranek, 2002; Auxter *et al*., 2010) and poor gross motor performance. They also perceive themselves as motor incompetent (Emck *et al*., 2009).

Research conducted by Ghaziuddin and Butler (1998) on the motor proficiency levels of children with ASD indicated that the children showed impaired coordination as assessed by the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP). The findings of Ghaziuddin and Butler (1998) is in agreement with Kimberly *et al*. (2010) who reported a difference between the motor coordination levels of children with ASD compared to typical developing children. This clearly indicates that although motor performance is not a core element of ASD, appropriate interventions should be established to improve the motor functioning of children diagnosed with ASD (Kimberly *et al*., 2010).

An alternative intervention gaining interest among therapists is animal assisted intervention (AAI) (Lotan, 2007; Van den Hout & Bragonje, 2010; O'Haire, 2013). AAI refers to a goal- directed intervention in which an animal meeting specific criteria is an integral part of a treatment that assists in the healing process and rehabilitation of children with acute or chronic diseases (Martin & Farnum, 2002; Rothe *et al*., 2005). A variety of activities, such as caring for the animal, knowledge and games are included in a typical AAI session (O'Haire, 2013).

Research evidence is very limited with regard to AAI, specifically regarding children with ASD (Van den Hout & Bragonje, 2010; O'Haire, 2013). O'Haire (2013) pointed out that the majority of these papers (13/22) had been published since 2008. The various animals used in these studies were as follows: dolphins (5 studies), dogs (7 studies), horses (8 studies), guinea pigs (1 study), and another study made use of three animals, namely a dog, a lama and a rabbit. Since the current study made use of horses, the discussion will be centre on Equine-assisted therapy (EAT).

EAT is a collective term for equine therapy, hippo therapy, equine-facilitated psychotherapy, as well as equine-assisted psychotherapy, and used to describe the role of horses in the educational, physical or psychological domains (Bizub *et al*., 2003). EAT is a physical

treatment strategy in which children with or without motor difficulties perform activities on and alongside a horse with the goal of using equine movements to improve balance,

posture, gross and fine motor skills (Snider *et al*., 2007). Snider *et al*. (2007) states that the warmth, shape and rhythmical, three-dimensional movements of the horse improve flexibility, posture, balance and mobility of the rider. In addition, EAT provides a multisensory environment that will prove beneficial to children with profound social and communication deficits (Bass *et al*., 2009).

PURPOSE OF RESEARCH

Research on AAI, specifically in children with ASD, is very limited (Stone *et al*., 1999; Baranek, 2002). Limited studies have been conducted to determine the improvement of motor functioning using EAT specifically in children with ASD. Thus, limited comparisons could be made with previous research. The aim of the current study was to explore the efficacy of an EAT intervention by means of two case studies in children diagnosed with Autism Spectrum Disorder in order to improve their motor functioning levels.

METHODOLOGY

Participants

Both the children used in this study were medically diagnosed with Autism Spectrum Disorder by their family physicians, as well as by a psychologist. The inclusion criteria for participation in this study were as follows: (1) should not be afraid of horses and (2) should not receive any other concurrent therapy with regard to the motor aspects that were tested in this study. The parents of the children involved in this study voluntarily offered to participate. The children were approached at the school. Only two children were involved. The children came from families of an average socio-economic environment and the same school.

The *female participant* (J-H) was 9 years and 4 months old at the time. She was diagnosed with Autism Spectrum Disorder, oppositional-defiant disorder and hyperactivity. She had attended the class since 2010. J-H is usually impulsive, impatient, disorganised and easily distracted. She will start an activity without waiting for the instructions. She becomes confused and forgets how to do the activity. She enjoys participating in activities, but needs a lot of encouragement in order to accomplish a task. During the intervention J-H was on medication, namely Atomoxitine to improve her concentration levels and Risperidone for impulse control.

The *male participant* (J-B) was 8 years and 7 months old. He was diagnosed with Autism Spectrum Disorder, as well as ADHD, which often is associated with Asperger's disorder. In addition, he has sensory problems and epilepsy. He had attended the class since 2010. J-B can complete tasks, but sometimes needs guidance in order to complete his homework. When he takes part in activities that he enjoys, such as building blocks or folding airplanes, he will have no trouble to complete the task. Sometimes he might be impulsive, but most of the time his behaviour is typical and he will function independently. He enjoys running around and can be very busy. Most of the time he will play alone, but occasionally he prefers to play with others even though he struggles to adapt to their ways. He is very possessive over his belongings and each week he is interested in something new, such as blocks, cars, pictures or his photo

collection. J-B loves to be funny and enjoys challenges. If his mind is set on doing something, it is difficult to change it. During the intervention J-B was on medication, namely Methylphenidate in the mornings and in the evenings, to improve his attention and concentration, Valproic Acid for epilepsy and Imipramine later in the evenings to help him sleep.

Research design

The study had a pre-post-test design. It was an empirical study and the researchers made use of quantitative data. The study involved a pre-test in order to determine the motor proficiency levels of the two children. The children were tested at their school (during the Life Orientation class period) by Kinderkineticists who were familiar with the testing procedures of the relevant instrument, Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2). The children took part in a 10-week intervention programme (EAT), comprising a 30-minute session once a week at the stables, where the horses were kept. The reason for the 10-week intervention, instead of the prescribed 12-week intervention, was due to the fact that a school term only allowed the researchers 10 consecutive weeks.

One of the Kinderkineticists was also a horse specialist and riding instructor, implying that the researcher was qualified to conduct the EAT intervention programme accordingly. The EAT intervention was conducted on the horse and combined with various fundamental movements, such as manipulation and stability skills. The intervention was conducted at the stables after school hours. A post-test using the same procedure as the pre-test took place at the school in order to observe any individual changes following their EAT treatment, thus the participants served as their own control. A summary of the EAT programme consisting of balance (programme 1), strength (programme 2) and upper-limb coordination (programme 3) that were done on the horse riding bareback is attached as an Appendix. In addition, each programme started out with grooming the horse implementing tactile stimulation which plays an integral part in the EAT treatment.

Ethical considerations

Privacy is considered to be essential, therefore, subjects were evaluated individually and their information treated confidentially. The principal of the school granted permission for the research to be conducted on the school premises during the Life Orientation class periods, thus the class learning time of the participants were not compromised. Approval had been obtained from the ethics committee of the Faculty of Health Sciences, University of the Free State (ECUFS06/2014). The parents of the participants completed an informed consent form for each child participating in this study. In addition, the two children each signed an assent form.

School context

The school where the study was conducted is a public primary school that forms part of the main stream education and is located in the city of Bloemfontein, South Africa. The class for learners with Asperger's disorder was founded in 2010. It currently is the only main stream school in the Free State province that provides for the special needs of these children. The class often organises outdoor activities for the children. The school provides four classes in Afrikaans and English, a sensory room, a computer room, a separate hygiene room and a small

garden. The children attend classes during the week and also take part in Physical Education classes (30 minutes twice a week), and have art lessons on Fridays. The class is attended by 15 children, two girls and 13 boys between the ages of 7 and 13 years. They are educated by four teachers of whom all are MA-level special education graduates who frequently attend additional courses relevant to the understanding of the special developmental disorders of primary school children. There is very good cooperation between the teachers and parents.

Measuring instruments

Diagnostic and Statistical Manual of Mental Disorders, fourth edition, text revision (DSM- IV-TR)

For the purpose of this study, the DSM-IV-TR was used by the clinicians in order to make a diagnosis of ASD. Therefore, this study will recognise Asperger's as one of the disorders on the autistic spectrum. However, it is important to note that the DSM-5 (APA, 2013:51) states that "individuals with a well-established DSM-IV diagnosis of autistic disorder, Asperger's disorder, or PDD-NOS should be given the diagnosis of ASD".

Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2)

The BOTMP is considered to be one of the most widely used measuring instruments to determine motor difficulties in children with a variety of disabilities, including cerebral palsy, developmental coordination disorder (DCD), attention deficit hyperactivity disorder (ADHD) and autism spectrum disorder (ASD) (Dewey *et al*., 2007; Gordon *et al*., 2007; Wuang & Su, 2009; Kimberly *et al*., 2010).

The BOT-2 can be administered in various ways, such as the complete test (the recommended version), the short form or by using selected subtests depending on the abilities of the child (Bruininks & Bruininks, 2005). This study made use of selected subtests, since the three selected subtests were most relevant to the efficacy of the EAT intervention. The children in this study were tested using Subtest 5, which tested their balance to enable noting postural instability; Subtest 7, which tested their upper-limb coordination in order to note improvement of motor planning and gross motor performance, and in addition, Subtest 8, which tested their strength for assessing the improvement of low muscle tone.

Balance was tested through the use of nine items, all of which evaluated the stability of the trunk in static, as well as dynamic situations. These items include: standing with feet apart on a line (eyes open and closed); walking forward on a line; standing on one leg on a line (eyes open and closed); walking forward heel-to-toe on a line; standing on one leg on a balance beam (eyes open and closed); and standing heel-to-toe on a balance beam. Upper-limb coordination was tested through the use of seven items that evaluated visual tracking along with coordinated arm and hand movements. Items, such as: dropping and catching ball (with one hand as well as both hands); catching a tossed ball (with one hand and with both hands); dribbling a ball (with one hand and alternating hands); and throwing a ball at a target were conducted. Strength was tested through the use of five items that measured: trunk, upper- and lower-body strength and included the following items, standing long jump; knee push-ups; sit-ups; wall sit; and the V-up sit.

The results (raw data converted to scale scores) of the children were converted into age-

related, sex-specific norms (Bruininks & Bruininks, 2005). The different subtest scores indicated the level of motor proficiency the child was functioning at in comparison to children in the same age group (Bruininks & Bruininks, 2005).

Analysis of data

The data were captured electronically in Microsoft Office Excel 2007. Raw data were converted to scaled scores in order to determine the age equivalent, as well as the descriptive categories (ranging from "well below average" to "well above average") as determined by Bruininks and Bruininks (2005). Therefore, each child was compared to herself/himself according to their chronological age and descriptive categories before and after the EAT intervention to determine individual changes. The reason is because children with ASD have different behaviours within each distinct diagnosis of ASD and, therefore are considered to be a heterogenic group. According to McGibbon *et al*. (1998), a small sample design, where the participants can serve as their own control is acceptable to determine individual changes following their treatment (McGibbon *et al*., 1998; Taylor *et al*., 2009).

RESULTS

Table 1 presents the criteria given by Bruininks and Bruininks (2005). This table allows the examiner to determine the cut-off scale scores for the various descriptive categories and was used to determine the applicable descriptive categories by using the measured scale scores.

Table 1. **DESCRIPTIVE CATEGORIES OF BOT-2 CORRESPONDING TO SCALE SCORES**

Descriptive category	Scale Score range
Well above average (WAA)	25 or greater
Above average (AA)	20-24
Average (A)	11-19
Below average (BA)	6-10
Well below average (WBA)	5 or less

Adapted from Bruininks and Bruininks (2005)

Table 2 displays the descriptive categories with the corresponding scale scores for the 2 participants. The female participant obtained a scale score of 11 in the pre-test, placing her in the "average" category for upper-limb coordination. Her post-test scale score was 24, which placed her in the "above average" category. Concerning balance, her performance improved from a scale score of 6 in the "below average" category to a scale score of 17 in the "average" category. The only subtests and descriptive category that remained unchanged was strength ("average"). However, there was still a change in the scale score from 11 to 14.

Regarding upper-limb coordination, the male participant was ranked "below average", with a pre-test scale score of 7 and a post-test score of 10. Although the descriptive category remained

the same, there was an increase in the scale score which can be considered as an improvement. For balance, the descriptive categories for both the pre-test and post-test were "average". An improvement was noted in the scale score which increased from 12 to 15. The only variable for which there was a change in the descriptive category was strength, which had improved from the "below average" category with a scale score of 8 to the "average" category with a scale score of 12.

Table 2. **DESCRIPTIVE CATEGORIES AND CORRESPONDING SCALE SCORES OF BOT-2: CASE STUDY 1 AND 2**

	Pre-test Scale Score		**Descriptive category**		**Post-test Scale Score**		**Descriptive category**		**Difference**	
Variables	Case 1 (♀)	Case 2 (♂)	Case 1 (♀)	Case 2 (♂)	Case 1 (♀)	Case 2 (♂)	Case 1 (♀)	Case 2 (♂)	Case 1 (♀)	Case 2 (♂)
Coordination	11	7	A	BA	24	10	AA	BA	13	3
Balance	6	12	BA	A	17	15	A	A	11	3
Strength	11	8	BA	A	14	12	A	A	AA	3

WAA=Well above average; AA=Above average; A=Average; BA=Below average; WBA=Well below average.

Table 3 is a representation of the pre- and post-test age equivalences of the participants and of the improvements made over the 10-week intervention. For both the participants, the pre- and post-test results are presented according to their age equivalents for the 3 measured subtests, namely upper-limb coordination, balance and strength, as determined by the BOT-2. An improvement was observed with regard to all 3 subtests.

Table 3. **AGE EQUIVALENCE IN YEARS AND MONTHS: CASE STUDY 1 AND 2**

Case study 1 (♀)				**Case study 2** (♂)			
Variables	Pre-Test AE	Post-test AE	Improvement AE	**Variables**	Pre-Test AE	Post-test AE	Improvement AE
Coordination	7.11	19.00	11.1	Coordination	5.11	7.2	1.3
Balance	4.11	15.11	11.0	Balance	6.80	8.5	1.9
Strength	6.11	8.50	1.6	Strength	5.90	8.2	2.5

AE=Age equivalence

The female participant was 9 years and 4 months old when the test commenced. With regard to upper-limb coordination, she showed progression from an age equivalent of 7 years and 11 months to the level of a child of 19 years, thus an improvement of 11 years and 1 month. With regard to balance there was an increase from an age equivalent of 4 years and 11 months to 15

years and 11 months, thus the improvement observed is 11 years. Finally, strength increased from being equal to that of a child of 6 years and 11 months to 8 years and 5 months, suggesting an improvement of 1 year and 6 months, although the age equivalence was still lower than her chronological age.

The male participant, who was 8 years and 7 months old when the test commenced, progressed from an age equivalent of 5 years and 11 months to 7 years and 2 months, thus an improvement of 1 year and 3 months. Regarding balance, the participant advanced from an age equivalence of 6 years and 8 months to 8 years and 5 months, suggesting an improvement of 1 year and 9 months. Lastly, there was an improvement in his age equivalence from 5 years and 9 months to 8 years and 2 months with regard to strength, thus an improvement of 2 years and 5 months. All his age equivalences were, however, still below his chronological age.

DISCUSSION OF RESULTS

The research aimed to provide a possible treatment strategy for the improvement of motor proficiency in children with Autism Spectrum Disorder. As intended, the children involved in the EAT intervention improved as far as their motor proficiency is concerned. What had not been anticipated was neither the intra-subject variability of the domains assessed nor the vast difference in benefits the two subjects appeared to have made using the same intervention. Although both participants improved with regard to their chronological age, the gains made by the female participant was greater in all three subtests that were measured. It is, therefore, clear that when adding EAT to the treatment interventions of children with Autism Spectrum Disorder universal improvements cannot be expected, nor does it appear that it is a "one-size- fits-all" scenario.

The female participant improved remarkably in both the domains of balance and upper limb co-ordination. She did not make any real improvement as far as strength was concerned. It may suggest that in these children who have a fairly normal nervous system, great strides could be made in the upper-limb co-ordination and balance domains with this therapy, although, even if strength did increase in absolute values, the gain was not really significant. Perhaps the EAT intervention does not particularly address the development of strength, or perhaps it would take a longer time of intervention to make significant improvements in strength.

The male participant on the other hand performed relatively poorer in all domains prior to EAT, and although he had some gains, he did not benefit as remarkably from the intervention. What sets him aside though is the fact that he has epilepsy. Although his epilepsy is well controlled on Valproate, it may be a marker of an altered central nervous system. Early onset is a well- known confounding factor in the development of children, and a common co-morbidity in children with ASD. In order to investigate this intervention further, it may be necessary to have a cohort of children with ASD large enough to tease out some of these confounding variables.

As stated previously, limited studies have been conducted to determine the improvement of motor proficiency using EAT specifically in children with ASD. Thus, limited comparisons could be made with previous research. Comparing the present study with the results obtained by Wuang *et al*. (2010), using a simulated developmental horse riding programme,

which is an innovative horse riding exercise machine also known as a “Joba” on children with ASD. The

researchers conducted a 20-week intervention with 30 children diagnosed with ASD between the ages of 6 years and 5 months and 8 years and 9 months, where similar gains in motor proficiency in the specific subtests measured were reported. This indicates that EAT improved balance, strength and upper-limb coordination in children with ASD.

There appeared to be other general and less specific advantages observed by the researchers that also correlate with the findings of Wuang *et al.* (2010). These advantages include that the children were able to follow instructions more easily whilst in the vicinity of the horse. The EAT, therefore, provided the opportunity for indirect learning to take place. The constant movement of the horse also required high levels of concentration, which might have had a positive influence on their cognitive ability. Furthermore, the constant movement on the horse stimulates the vestibular system that may have resulted in a calming effect in both participants and in addition, it could have improved their balance abilities and muscle tone.

Another informal observation of the current study was an improvement in the children’s confidence levels and their self-esteem. Over the period of the intervention, they became more confident in approaching the horses on their own (with supervision), mounting them with more confidence and playing a bigger role in manipulating the horse. Far less time was spent preparing the participants before the actual therapy commenced. This may possibly be due to the fact that each participant could take control over the situation he/she was placed in, and experienced a sense of authority over the horse. According to Rothe *et al.* (2005), horses can put children therapeutically in touch with their own vitality by their large and gentle presence. Children who usually avoid physical and emotional closeness are often willing to accept such closeness from horses and could transfer these skills to their daily lives by means of therapy. These researchers are of the opinion that the behaviour of a sensitive horse serves as an important instrument with which therapists can teach children different skills.

CONCLUSION

This research was aimed at determining if an EAT intervention could result in improvement of balance, upper-limb coordination and strength as aspects of motor proficiency in children with ASD. The results suggest that an EAT intervention improved all three aspects in both participants, although the range of benefits varied notably between the two participants. Possible reasons for this have been referred to already although the result is considered understandable taking into account the heterogeneous nature of underlying problems of these children.

Although positive results were obtained from both participants, it is suggested that future research should be conducted with a larger sample to determine the efficacy of EAT on the motor proficiency of children with ASD, and possibly also determine the role of concurrent co- morbidities and even medical interventions. The researchers are of the opinion that the 10 contact sessions should be increased, although the average sessions that have been reported for EAT were 12 weeks and lasted 40 minutes each (O’Haire, 2013). Finally, the study did not evaluate the sustained effects of the EAT intervention, although it is

considered important to determine if the effects of such interventions can be sustained. Further research is, therefore, recommended in this area in order to study the benefits of EAT interventions on motor proficiency of children with ASD in more depth. Although no definite conclusions can be

drawn, the results of this study suggest that an EAT intervention may be beneficial to improve the balance, upper limb coordination and possibly strength of children with ASD in a way that is acceptable but also enjoyable to these children.

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APPENDIX
EQUINNE-ASSISTED THERAPY PROGRAMMES

Intervention programmes

The intervention programme of the current study alternated between three separate programmes. The researchers had 12 weeks to conduct the study. Week 1 and Week 12 were used for the pre- and post-test and during Week 2 the children got to know the horse. During weeks 3, 6 and 9, Programme 1 was followed in order to attempt to improve balance. During weeks 4, 7 and 10, Programme 2 was followed in order to attempt to improve strength. During weeks 5, 8 and 11, Programme 3 was followed for the purpose of improving upper-limb coordination.

Week 1: Pre-test evaluation

Week 2: Getting to know the horse
Tactile stimulation through grooming of horse;
Leading the horse through different obstacles;
Riding bareback.

Programme 1: Tactile stimulation (Grooming of horse)
The following activities are all performed on the horse whilst the horse is in motion:
Ride with hands on head;
Ride with arms stretched out like an airplane;
Balance a beanbag on head;
Balance beanbag on shoulders;
Balance a beanbag on palm of hand whilst arms are stretched out like an airplane.
(Balance activities are performed while the horse is bareback in order to incorporate tactile stimulation as well as to intensify the improvement of balance.)

Programme 2: Tactile stimulation (Grooming and saddling of horse)
The following activities are all performed on the horse whilst the horse is in motion:
Hold beanbags between upper thighs against saddle; Jockey seat: Push on horse's neck whilst lifting hips; Upper-limb strength: Perform lateral arm raises;
Cross over: Bring left hand to right foot and right hand to left foot; Move arm in circular motion whilst tracking with eyes.
(Strength exercises are performed on the saddle, because these exercises cannot be performed without the use of stirrups).

Programme 3: Tactile stimulation (Grooming and saddling of horse)

The following activities are all performed on the horse whilst the horse is in motion:
Throw tiny handball from left to right hand and vice versa;
Throwing and catching:
Catch tiny handball with both hands;

Catch beanbag with one hand;
Throw beanbag into bucket;
Pass ball around the body from one hand to the other hand.

Week 12: Post-test evaluation

(0)82 979
1040 (H), Fax.: +27 (0)51 401 2323, Email: demilanderm@ufs.ac.za

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INNOVATIVE SPORT TECHNOLOGY THROUGH CROSS-DISCIPLINARY RESEARCH: FUTURE OF SPORT SCIENCE

Terry J. ELLAPEN[1] & Yvonne PAUL[2]
Department of Sport Management, Cape Peninsula University of Technology, Mowbray Campus, Cape Town, Republic of South Africa
Department of Sport, Rehabilitation and Dental Sciences, Tshwane University of Technology, Pretoria, Republic of South Africa

ABSTRACT

This paper provides an overview of the advantages and disadvantages of innovative sport technology brought about by cross-disciplinary research in sport, engineering, medical and material sciences. Sport technology has subsequently contributed greatly to the enhancement of epidemiology, prevention and management of injuries, management of non-communicable diseases, physical activity and sport performance. The debate raging between sport scientists and academics pertaining to the greater amount of attention paid to sport technology and cross-disciplinary research in sport and the diminished quality and quantity of subject matter is highlighted. The paper also raises the following ethical question: Should only affluent elite athletes have the opportunity to capitalise on this technology? Is this jeopardising the success of less affluent athletes?

***Key words*:** Sport technology; Cross-disciplinary.

INTRODUCTION

The 21st Century has seen more people than ever before participating in sport and physical activity. Koffi Annan, the UN Secretary General, has described sport as the universal language of the world that unites its entire people (Fuss *et al*., 2008). The increased interest and participation by both athletes and spectators have enabled sport to evolve into a global business, worth approximately USD 600 billion and growing (Fuss *et al*., 2008). The quest for sport supremacy has directed millions to innovative sport technological developments, particularly epidemiology, prevention and management of injuries, management of non-communicable diseases, physical activity and human performance. These sport technological developments have come about through collaborative efforts of engineers, sport, medical and material scientists resulting in cross-disciplinary, inter-disciplinary and eventually trans-disciplinary research **(**Mirollo *et al*., 2008).

Many sport scientists and academics (Costa, 2005; Rikli, 2006; Graham & Hipp, 2014) agree that there is a need for innovative sport technological developments through collaborative cross-disciplinary research. Other authors are resistant to the application of cross-disciplinary research in sport, recommending that the sport fraternity should rather improve on the quality of basic sport science research (Polak, 1977; Rink, 2007; Vertinsky,

2009). The current paper provides an overview of the advantages and disadvantages of innovative sport technological developments brought about by cross-disciplinary research in sport, engineering, medical and

material sciences. The paper also discusses the different types of cross-disciplinary research that facilitates the advancement of sport technology. Important ethical questions are presented, pertaining to general accessibility of expensive sport technology.

METHODOLOGY

The standard practices for systematic reviews (PRIMSA) was followed. The definitions were guided by the PRIMSA checklist for participants, interventions, comparisons, outcomes and study designs (PICOS). The participants or focal theoretical areas concern sport technology. The intervention was not necessarily a therapeutic intervention, but is interpreted as an exposure, namely sport technology research and the comparison in various articles were specific to sport and exercise science.

The outcomes of interest were: (i) sport technology; (ii) sport kinesiology technology; (iii) sports medicine technology; (iv) cross-disciplinary sport technology;(v) cross-disciplinary research in sport science; (vi) cross-disciplinary research in kinesiology; and (vii) cross-disciplinary research in physical education. The exclusion criterion was publications prior to 2005. A literature searches of peer-reviewed and professional journal publications were conducted, in the following search engines: PubMed, Medline; Science Direct; Ebscohost; Biomed; CINAHL; Embase; and Google Scholar. Key search words were directly related to the outcomes.

RESULTS

Thirty-three English publications were identified, but after the exclusion criterion was applied, only 13 were finally selected for this review. Table 1 reflects the opinions that either support or refute sport technological developments via the application of cross-disciplinary research. Ten papers supported the sport technological development via the cross-disciplinary sport research, while 1 refuted its application in sport science research and the other 2 presented the advantages and disadvantages of cross-disciplinary sport research.

DISCUSSION

The discussion is presented in the following categories: the relationship between innovative sport technology and cross-disciplinary research; the evolution of cross-disciplinary research; sport research; pragmatists against sport technology and cross-disciplinary sport research; and is the use of advanced sport technology unethical? Sport research is expanded further by addressing: sports medicine technology; innovative sport technology management of non- communicable diseases and physical activity; and sport technology enhancing sport performance.

Relationship between innovative sport technology and cross-disciplinary research

Innovative sport technological developments require the collaborative efforts of specialist scientists in sport, engineering, medical and material sciences. These collaborative research

efforts are known as cross-disciplinary research (OECD, 1998). The inclination towards a greater specialisation in science and the necessity to combine knowledge from different disciplines to resolve problems are the underlying reasons for cross-disciplinary research.

Table 1. **OPINIONS ON SPORT TECHNOLOGICAL DEVELOPMENTS**

Authors	Year	Type of research	Findings
Chi *et al.*	2005	Qualitative Review	The authors' intention was to encourage and highlight new cross-disciplinary research and to arouse the readers' interest in understanding how computer engineering can be applied in sport.
Costa	2005	Qualitative review	The Delphi study proposes stronger research in cross-disciplinary sport science fields, to strengthen the application of theory in practice.
Hoods	2005	Qualitative Review	A critical review of revolutionary sport technological development of prostheses that enables lower limb amputees to competitively participate in sport.
Moor	2005	Qualitative Review	The author recommends that the sport research fraternity should establish acceptable guidelines if the application of new cross-disciplinary technologies is going to become the norm.
Wallace	2005	Qualitative Review	The author presents the advances in sport technology and positive impact on sport research.
Rikli	2006	Qualitative Review	The author embraces the application of engineering in sport research.
Gill	2007	Qualitative Review	The author embraces the application of engineering in sport research.
Rink	2007	Qualitative review	The author's primary objection against cross-disciplinary sport technological research is the development of inert sport science knowledge, which adversely influences sport science curricula.
Dzewaltowski	2008	Qualitative Review	The author argues that there is an eminent need for cross-disciplinary technological development in sport to present a counter offer to the more attractive sedentary option facilitated by commercial technology.
Fuss *et al.*	2008	Qualitative editorial	The authors are of the opinion that advances in sport technology through cross-disciplinary research, deepens the understanding of the particular needs of sport. This paper embraces the application of cross-disciplinary sport research.
Vertinsky	2009	Qualitative review	The review presents the advantages and disadvantages of cross-disciplinary sport research.
Graham & Hipp	2014	Qualitative review	The authors state that additional cross-disciplinary research should be adopted for the promotion of physical activity and sport.

Goertzen *et al.*	2015	Systematic Review	The authors embrace the application of cross-disciplinary sport research.

Evolution of cross-disciplinary research

The importance of cross-disciplinary research is widely recognised because of its creativity, progress and innovation, which have led to many intellectual breakthroughs in modern times. The evolution of the concept of cross-disciplinary research began with multi-disciplinary, then progressed into inter-disciplinary and finally trans-disciplinary research (OECD, 1998). In multi-disciplinary research, the subject under study is approached from different disciplinary perspectives, but integration is not accomplished. Inter-disciplinary research leads to the creation of a theoretical, conceptual and methodological identity.

Finally, trans-disciplinary research progressed further, to a convergence of disciplines accompanied by a mutual integration of disciplinary epistemologies (Van den Besselaar & Heimeriks, 2001). The need for cross-disciplinary research has resulted in the formulation of the bibliometric methodology. Bibliometric methodology provides a general overview of all scientific disciplines, with specific attention to their interrelation (Morillo *et al*., 2002). Graham and Hipp (2014) have reported that cross-disciplinary research is considered the best way to review and analyse practical research topics. They have reported the following benefits of cross-disciplinary technological research:

- Increasing the validity of outcome measures and findings;
- Simplifying the analysing data significantly;
- Improving the on-going, systematic collection and analyses of sport and physical activity;
- Allowing researchers to cope with analyses of large data sets by using cyber infrastructure; and
- Increasing the credibility of sport and physical activity findings among other health disciplines.

The words of Graham and Hipp (2014:2) aptly describe the need for cross-disciplinary research: “Undoubtedly, additional technologies from other scientific disciplines must be adopted for physical activity and sport measurement”.

Sport research

Sport research predominantly focuses on epidemiology, prevention and management of injuries, physical activity and technological management of non-communicable diseases. There is an increasing amount of research in the field of sports technology related to human performance. Cross-disciplinary sport research provides a panoramic view to various sport dilemmas, thereby producing the most effective solution. The subsequent discussion will provide examples of innovative sport technology improving the quality of sports medicine management, management of non-communicable diseases and physical activity and performance enhancement.

Sports medicine technology

The latest cutting edge sports medicine technology allows the epidemiologist to study the pathophysiology, early signs and symptoms, pathomechanics and severity of sport injuries thereby enabling the prescription of: (1) effective preventive strategies to combat the occurrence of these injuries; and (2) effective injury management. An example of advanced

sports medicine technology is the musculoskeletal ultrasound that is being used to determine

the incidence of muscular, skeletal and other soft tissue damage incurred from sport and physical participation, without invasive surgery. The musculoskeletal ultrasound provides a detailed view of visceral organs and tissue, allowing precise diagnosis of tendon tears, muscle abnormalities (atrophy and hypertrophy), tumours that may exist in visceral soft tissue and rheumatoid arthritis and other inflammatory diseases (Lento & Primack, 2008).

Due to this innovative sports medicine technology, sports medicine practitioners are now able to confirm and aid clinical diagnoses, as well as monitor structural response to interventions. It also has therapeutic uses, such as ultrasound guided infiltrations. The use of ultrasound definitely aids clinical management of athletes, thereby improving their return to play. Another example of sports medicine technology is platelet-rich plasma therapy that helps to heal, build tissue and stop bleeding (Mishra *et al*., 2009). Platelet-rich therapy takes advantage of the natural healing process, but at a quicker rate. Blood is drawn from the injured athlete; thereafter the platelet-rich plasma is separated. This plasma is then re-injected into an injured area, which promotes faster and more effective healing. Risks of rejection and/or adverse effects of the treatment are minimal, since the platelets come from the patient's own blood. Additional benefits also include decreased inflammation and pain, increased tissue repair, increased bone density and improved development of new blood cells (Kon *et al*., 2009). Platelet-rich therapy has successfully contributed to the quick recovery of tendon and muscle strains and ligament sprains (Kon *et al*., 2009; Mishra *et al*., 2009).

A third example of innovative sport technology injury prevention is motion digital analyses. Athletes can run, swim, cycle or perform their respective sport activity, which is digitally recorded. Thereafter, the kinesiologist reviews the footage to identify the pathomechanics of the athlete's kinesiology by measuring anatomical angles and joint range of motion to determine potential risk and severity of injury (Wallace, 2005). Motion digital analyses have successfully identified abnormal pitching patterns of baseball pitchers with shoulder injuries. This information has helped sports medicine practitioners to identify abnormal force couple relationships between internal and external rotator cuff muscles of the injured pitchers. Now motion digital analyses are frequently used to identify abnormal pitching patterns among adolescent and professional baseball pitchers in an attempt to prevent injury (Brukner & Khan, 2012).

Innovative sport technological management of non-communicable diseases and physical activity

Sport technological development, such as the smartphone fit application has the potential to transform low intensity exercise into supervised controlled moderate intensity. People can now record their walking and/or running velocity, heart rate and body mass index (BMI) (Adams *et al*., 2014, Maddison *et al*., 2014). The smartphone fit application also allows the person to calculate their desired training target heart rate range and BMI. The fit application motivates people to convert slow walking and running to faster walking and/or running, in an attempt to become fitter in a supervised controlled manner. People use the heart rate and BMI applications to determine their progress (Adams *et al*., 2014; Maddison *et al*., 2014). The use of such technology has also demonstrated to be an effective injury prevention tool. Obese, hypertensive and cardiac patients when exercising alone have used the smartphone

fit application to set specific American College of Sport Medicine (ACSM) guidelines. Correlating their own heart rate ranges and associated walking velocity to the ACSM guidelines may prevent over exertion

and injury (Adams *et al*., 2014, Maddison *et al*., 2014). This technology has proven to be safe, cost effective (eliminates the cost of biokineticists) and educational (increases the patient's knowledge on how to exercise safely, in a controlled manner to reduce risk of injury).

Dzewaltowski (2008) has warned that there is an urgent need for sport technological development to present an attractive counter-offer against alluring sedentary alternatives, such as play station and video games that lead to a sedentary lifestyle and decreased quality of life. The fitness industry has incorporated computer technology into equipment displays. In the 1990s, Life Fitness integrated its Life Cycle to the game Super Nintendo. The faster you pedal, the faster your counterpart on the video game screen moves, which encouraged patrons to increase the intensity of their workouts (Chi *et al*., 2005). This innovative idea capitalised on the competitive nature of a person, motivating them to cycle faster, thereby improving their aerobic capacity, muscle strength and endurance. These studies underscore the benefits of combining sport technology, physical activity and management of non-communicable diseases.

Sport technology enhancing sport performance

Presently, engineers, medical, material and sport scientists have developed new exciting sport technology via collaborative cross-disciplinary efforts aimed at enhancing human sport performance (Fuss *et al*., 2008). An outstanding example of the benefit of advanced sport technology is the critical review of the revolutionary development of prostheses by Hoods (2005), which highlights the engineering feat that enabled double leg amputee Oscar Pistorius to run nearly as fast as able-bodied athletes. The engineering and sport performance accolades were awarded for the development of a uniquely designed prosthesis that enhanced the athlete's aerodynamics, thereby improving his biomechanics allowing him to run faster. The engineering and material science triumph was the development of a light weight, but strong prostheses. The light weight of the prostheses successfully supported the athlete but also decreased the athlete's total body mass, which facilitated greater force propulsion per unit of body mass over a given distance, resulting in a faster running velocity (Hoods, 2005).

The modern bicycle has undergone many innovative engineering and sport technological changes, as seen in the development of specialised wheels, pneumatic tyres, extra sensitive braking system and pedals, aimed at increasing stability and rigidity, all of which improve the aerodynamics of a cyclist leading to enhanced performance (Wallace, 2005). The light weight frame decreases the total body mass of the cyclist and bicycle, thereby increasing the force propulsion per body mass unit. The revolutionary bicycle design improved the aerodynamics of the cyclist, which has contributed to faster cycling velocities.

Pragmatists against sport technology and cross-disciplinary sport research

The primary objection to sport technology development derived from cross-disciplinary sport research is the concept of inert knowledge. Inert knowledge can be described using the following analogy: When someone asks you the time, you do not explain to them how a watch is made. Inert sport knowledge is information, which students can express, but is of

minimal value. It is the process of understanding sport concepts, which does not increase their knowledge for effective problem-solving (Polak, 1977). Rink (2007) has reported that inert knowledge has crept into the sport science, kinesiology and physical education content. The cause of this inert knowledge can be traced to a knowledge explosion that has led to over-

specialisation in trans-disciplinary of sport science and other health-related fields. Polak's (1977:7) remark aptly describes the situation, "We know more and more about less and less". Basic knowledge in the discipline of sport science has been replaced by cross-disciplinary content because of the great interest in innovative sport technology. Rink (2007) has suggested that many sport science students can explain Krebs cycle, but are unable to prescribe appropriate exercises to improve cardiovascular endurance. Therefore, Rink (2007) and Vertinsky (2009) have recommended that sport science should focus primarily on research in this sport performance domain to enhance the knowledge of students of this field.

Is the use of advanced sport technology unethical?

Professional sport is a competitive occupation, which mandates millions of dollars and hours invested to improve performance (Tadepali *et al*., 2011). Both recreational and elite athletes are willing to invest a great deal of their time, effort and money to improve their performance. The ideal design of sport equipment requires the amalgamation of various disciplines for enhanced sport performance and injury prevention. The combined efforts of material scientists, mechanical engineers, physicists, anatomists, sport physiologists and biomechanists produce an advanced product (Froes, 1997). A prime example of how sport technology has improved sport performance is the shorter completion times of endurance running. Spiridon Loues won the first Olympic marathon in a time of two hours and fifty-nine minutes. Almost a century later the Olympic marathon record of Samuel Wanjiru was two hours, six minutes and thirty- two seconds, which is a 30% improvement. Much of this improvement is attributed to the changes in foot-wear, clothing apparel and improved training programmes (Froes, 1997; Tadepali *et al*., 2011).

The use of sport technology has proven that performance can be enhanced, but raises important fundamental ethical questions. The first question being, where should the proverbially line be drawn? Froes (1997:18) has postulated the following pertinent question: "Are the days of strenuous conditioning and natural supplementation the ideology of a by-gone era?"

The cost of high-tech ergogenic sport equipment is exorbitant. The latest, cutting edge sport technology is capital intensive, which is naturally only available to affluent elite athletes. Prosthetic devices that enable amputee athletes to be catapulted forward more efficiently than if the person were running on their own natural limbs, cost approximately R500 000 (McGimpsey & Bradford, 2013). Although ergogenically superior, the disc wheels were initially banned from Olympic bicycle competition, because they were expensive and beyond the financial means of most cyclists (Lee & Park, 2015). Wheel-chair basketball, rugby and tennis have seen drastic revolutionary wheel-chair design modifications. The modern tennis wheel-chairs have sharply slanted back wheels so that the player is able to change direction rapidly without capsizing (Sindall *et al*., 2013). The seat height of the wheel-chairs of basketball forwards have been raised to enhance their scoring, while the guards' wheel-chairs have an inclined seat to facilitate quick change of direction (Sindall *et*

al., 2013). The cost of these special sporting wheel-chair modifications ranges from R50 000 to R70 000 per chair (Sindall *et al*., 2013). Wallace (2005) has posed the question of whether it should be allowed that competition at the highest level to be restricted to athletes who can afford high tech sport equipment. Moor (2005) recommends that the sport research fraternity needs better ethical guidelines if the application of innovative sport technologies is going to become the norm.

CONCLUSION

Innovative sport technology improves the quality and effectiveness of epidemiology, prevention and management of injuries, physical activity, management of non-communicable diseases and human performance. However, the sport governing federations should provide direction with regard to the ethical questions related to whether the sport supremacy of elite competitors is dictated by financial affluence, or not.

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Dr Terry Jeremy ELLAPEN: Department of Sports Management, Cape Peninsula University of Technology, Private Bag X8, Wellington, 7654, Republic of South Africa. Tel.: +27 (0)843205162, Email: tellapen1@yahoo.com

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EFFECT OF TEN WEEKS OF COMBINED EXERCISE ON GROWTH HORMONE, INSULIN-LIKE GROWTH FACTOR-2 AND MYOSTATIN LEVELS IN ELDERLY KOREAN WOMEN

Tae-Kyung HAN[1] & Wi-Young SO[2]
[1] *College of Art and Physical Education, Andong National University, Andong-si, Republic of Korea*
[2] *College of Humanities and Arts, Korea National University of Transportation, Chungju-si, Republic of Korea*

ABSTRACT

The purpose of the present study was to examine the effect of 10 weeks of combined exercise on growth hormone (GH), insulin-like growth factor-2 (IGF-2) and myostatin levels in elderly Korean women. Subjects were randomly assigned to the combined exercise group (CEG; n=17) or the control group (CG; n=17). The CEG performed 80 minutes of exercise, 5 days per week for 10 weeks. Each exercise session included four phases: a 10-minute warm-up; a 30-minute resistance exercises (10 to 15 repetitions maximum); a 30-minute aerobics exercise (60 to 80% of heart rate reserve); and a 20-minute cool-down. The interaction effect (time × group) on the levels of GH (F=6.934, p=0.013) and IGF-2 (F=8.592, p=0.006), increased significantly more in the CEG than in the CG, whereas the interaction effect for the myostatin levels (F=13.544, p<0.001) decreased significantly more in the CEG than in the CG. The 10 weeks of supervised combined exercise was effective for increasing GH and IGF-2 levels and decreasing myostatin levels in elderly Korean women.

Key words: Combined exercise; Elderly women; Growth hormone; Insulin-like growth factor-2; Myostatin.

INTRODUCTION

According to a statistics report on the Republic of Korea, 12.7% of the population (6.4 million people) in 2014 were aged (65 years and older), and this population has almost tripled since 1990 (Statistics Korea, 2015). The increasing senior population is becoming a serious social and public health problem. This increase in the aged population tightly correlates with drastic increases in falls, frailty and medical costs (Kim *et al*., 2013; Gelbard *et al*., 2014; Buckinx *et al*., 2015).

Rosenberg (1989) first reported that sarcopenia (muscle loss) is associated with aging. Sarcopenia is directly linked to a decrease in muscle strength and function due to physical

inactivity and increased dependency, which is associated with cardiovascular diseases (Kim & Choi, 2015; Wannamethee & Atkins, 2015). To prevent or treat sarcopenia, the most effective approach is to improve muscle mass via regular exercise (Landi *et al*., 2014). In particular, combined exercise (consisting of aerobic exercises and resistance training) has a major positive effect on muscle mass, function and strength (Landi *et al*., 2014).

Previous studies, however, have only focused on muscles and not on other related factors influencing muscle growth, such as the growth hormone (GH). In particular, GH insulin-like growth factor-2 (IGF-2) and myostatin levels are strongly associated with an increase in gene expression, morphology and function of muscles and tendons (Boesen *et al*., 2014; Livingstone & Borai, 2014; Kalinkovich & Livshits, 2015).

PURPOSE OF RESEARCH

The purpose of this study was to examine the effect of 10 weeks of combined exercise on GH, IGF-2 and myostatin levels in systemic blood from the antecubital vein in elderly Korean women.

METHODS

Ethical compliance

All study procedures were approved by the A-si Senior Welfare Centre, and all subjects provided written informed consent.

Subjects

Subjects were randomly assigned to the Combined Exercise Group (CEG; n=20) and the Control Group (CG; n=20), which included subjects older than 65 years from the A-si Senior Welfare Centre in Gyeongsangbuk-Do, Republic of Korea. These subjects did not exercise regularly and had no previous diagnosis of abnormal glucose metabolism or other health problems. Subjects were instructed to maintain their normal diet and activity pattern throughout the study, and compliance with this instruction was assessed via physical activity and food- frequency questionnaires administered at the start and end of the study.

Using repeated analysis of variance (2×2 design), an anticipated statistical power of 0.80 and a α-error probability of 0.05 with an effect size of 0.25, a sample size of 34 subjects was required for the analysis (G-power programme 3.1.3, Kiel, Germany). Thus, 40 subjects were included in the analysis after applying the exclusion criteria. In both groups, 3 subjects dropped out of the study because they did not complete the exercise programme and/or the final test. All assessments were thus completed with only 17 subjects in the CEG and 17 in the CG.

Anthropometrical measurements

The following parameters were measured 2 days before the start of the study: anthropometrical measures; including height, weight, body mass index (BMI); waist circumference; and hip circumference.

The BMI (kg/m^2) of each subject was calculated as weight divided by the square of height.

Waist circumference was measured at the part of the trunk midway between the lower costal margin (the bottom of the lower rib), and the iliac crest (the top of the pelvic bone) with the subject standing with her feet about 25 to 30cm apart. Hip circumference was measured at the part of the hip located midway. The measurement was taken by fitting the tape snugly around

the hips, without compressing any underlying soft tissues. The circumference was measured to the nearest 0.5cm at the end of a normal expiration.

Experimental procedures

The CEG participated in a 10-week supervised combined aerobic and resistance exercise programme. An exercise session consisted of a: warm-up phase (10 minutes); a resistance exercise phase (10 to15 repetitions maximum, 30 minutes); an aerobic exercise phase (60 to 80% of heart rate reserve, 30 minutes); and a cool-down phase (10 minutes). It was performed for 80 minutes, 5 times per week. The CG was asked to maintain a normal sedentary lifestyle.

Blood sampling and analyses

All subjects were prohibited from consuming anything for 8 to 10 hours prior to blood sampling in the morning after an overnight fast. Blood samples collected from the antecubital vein were centrifuged at 3,000rpm for 20 minutes, and the serum was extracted for analysis and frozen at
-80°C to analyse GH, IGF-2 and myostatin levels. The following parameters were measured 2 days before the start of the study and 2 days after the study, hormone levels, including GH, IGF-2 and myostatin.

GH analysis

GH concentrations were determined using GH Quantikine ELISA Kits (R&D Systems, Inc., Minneapolis, MN, USA). One hundred µL of Assay Diluent RD1-57 and 50µL of serum were added to each well and incubated for 2 hours at room temperature. Each well was washed with the aspirate 4 times to prevent contamination. To determine the optical density of each well, the samples were red within 30 minutes of adding 50µL of the stop solution. The colour in the well changed from blue to yellow. When the colour change was not uniform, the plate was gently tapped to ensure that it was mixed sufficiently. The optimal density of each well was determined within 30 minutes at 450nm and 540nm using a micro plate reader (Molecular Devices, Orleans, CA, USA).

IGF-2 analysis

IGF-2 concentrations were determined using IGF-2 Quantikine ELISA Kits (R&D Systems, Inc.). Serum samples were pre-treated to release IGF-2 from the binding proteins and diluted 100-fold with a pre-treatment constituent prior to the assay. One hundred and fifty (150)µL of Assay Diluent RD1-53 and a 50µL serum sample were added to each well and incubated for 2 hours at room temperature. The same methods previously described for GH analysis were used to prevent contamination and determine optical density for IGF-2 analysis.

Myostatin analysis

Myostatin concentrations were determined using Myostatin Quantikine ELISA Kits (R&D Systems, Inc.). Fifty (50)µL of Assay Diluent RD1-17 and serum samples was added to

each well and incubated for 2 hours at room temperature on a horizontal orbital micro-plate shaker. The same methods previously described for GH analysis were used to prevent contamination and determine optical density for the myostatin analysis.

Exercise programme

All subjects in the CEG performed a whole-body stretch before (10-minute warm-up) and after

(10-minute cool-down) each training session. The exercise group performed the main exercise programme for 60 minutes, which consisted of 30 minutes of resistance exercise training (3 sets of 10 to 15 repetitions maximum of the following exercises: leg press; leg curl; chest press; lat-pull-down; shoulder press; biceps curl; triceps extension; and sit-ups). This was followed by 30 minutes of aerobic exercise at an intensity of 60 to 80% of their heart rate reserve.

Statistical analysis

All descriptive data are presented as mean ± standard deviation. Independent t-tests were used to examine differences between groups at baseline. Repeated analysis of variance was used to evaluate significant changes in the dependent variables before and after combined exercise in the CEG compared to those in the CG. All analyses were performed using SPSS, version 18.0 (SPSS, Chicago, IL, USA). Statistical significance was set at $p<0.05$.

RESULTS

Characteristics of the subjects are shown in Table 1.

Table 1. **CHARACTERISTICS OF SUBJECTS INCLUDED IN THE STUDY**

Variables	Control group (n=17)	Exercise group (n=17)	t Value	p Value
Age (years)	78.41±4.84	78.82±5.02	-0.244	0.809
Height (cm)	149.31±5.90	146.72±5.19	1.361	0.183
Weight (kg)	52.38±7.14	51.62±5.97	0.333	0.741
Body mass index (kg/m^2)	23.58±2.79	24.19±2.55	-0.667	0.510
Waist circumference (cm)	86.97±9.06	89.32±8.07	-0.800	0.430
Hip circumference (cm)	92.41±6.28	93.32±5.27	-0.461	0.648

Table 2. **CHANGES IN GH, IGF-2 AND MYOSTATIN LEVELS BEFORE AND AFTER 10-WEEK INTERVENTION**

Parameters	Group	Before	After	Interaction	
				F Value	p Value
GH (ng/mL)	Control	1469.6±861.6	1138.2±767.5	6.934	0.013*
	Combined	1284.9±624.1	1678.7±768.8		

IGF-2 (ng/mL)	Control Combined	289.8±215.5 298.0±212.6	288.6±178.0 357.0±238.0	8.592	0.006**
Myostatin (ng/mL)	Control Combined	1404.4±483.5 1548.5±752.7	1489.5±556.3 987.0±620.5	13.544	<0.001***

GH=Growth hormone; IGF-2=Insulin-like growth factor-2; Interaction=(Group × Time)
* p<0.05 ** p<0.01 *** p<0.001 Analyses=Repeated analysis of variance

Changes in GH, IGF-2, and myostatin levels before and after the 10-week intervention in the CEG and CG are shown in Table 2. The interaction effect (time×group) on the levels of GH (F=6.934, p=0.013) and IGF-2 (F=8.592, p=0.006), increased significantly more in the CEG than in the CG, whereas the interaction effect for the myostatin levels (F=13.544, p<0.001) significantly decreased more in the CEG than in the CG.

DISCUSSION

The current study investigated the effectiveness of a 10-week training programme on potential changes in the levels of GH, IGF-2 and myostatin. Significant improvements were observed in all growth-related hormones in elderly women who performed the combined exercise.

Aging is associated with a decrease in muscle mass, strength, power and maximal exercise capacity. To prevent these aging-related changes, Landi *et al.* (2014) suggested that resistance exercise training is more effective for increasing muscle mass and strength, whereas endurance exercise training is superior for maintaining and improving the maximum aerobic capacity. It is, therefore, recommended that the elderly should perform a balance of both endurance and strength exercises for at least three days per week.

Both aerobic and resistance exercises improve muscle growth. Acute exercise rapidly increases growth-related hormone levels with a physiological stimulus, which induces tissue remodelling. Furthermore, small incremental changes with repeated regular exercise eventually cause hypertrophy (Wideman *et al*., 2002; Kraemer & Ratamess, 2005). GH is the major IGF carrier in the plasma of muscle and it induces hepatic synthesis. Exercise stimulates the secretion of GH within 10 to 20 minutes, causing hypertrophy (Roth *et al*., 1963). IGFs have an anabolic effect on skeletal muscles via paracrine/autocrine secretion (Velloso, 2008; Frystyk, 2010), which simultaneously cause an increase in GH levels.

Myostatin, a potent regulator of muscle development and size, is a member of the transforming growth factor β superfamily (Guo *et al*., 2009). Myostatin inhibits the proliferation and differentiation of myoblasts and is involved in the Akt/m TOR pathway that regulates protein synthesis (Hittel *et al*., 2009). Previous studies have reported that aerobic and resistance exercises reduce circulating myostatin levels in humans whether there is acute or chronic myostatin inhibition (Roth *et al*., 2003; Louis *et al*., 2007; Hulmi *et al*., 2009).

The current study showed an increase in the levels of GH and IGF-2 and a decrease in the levels of myostatin after 10 weeks of combined exercise training. These results strongly support those of previous studies that reported positive effects on hypertrophy and muscle function in the elderly, which ultimately prevent sarcopenia.

This study had limitations. The subjects were recruited from the A-si Senior Welfare Centre in Gyeongsangbuk-Do, Republic of Korea, thus the subjects do not necessarily represent the entire elderly Korean population. Furthermore, only a small sample of elderly women was included (N=34). However, this study had a strength in that it focused on elderly women who underwent a combined exercise training programme, which positively affected relevant myokine and anabolic hormone levels.

CONCLUSIONS

The 10-week supervised combined exercise programme presented in this study has the potential to be effective in increasing GH and IGF-2 levels and decreasing myostatin levels in elderly Korean women. Combined aerobic and resistance exercise benefited the anabolic hormonal state of these elderly individuals, suggesting that it does play an integral role in attenuating age- associated sarcopenia.

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Prof Wi-Young SO: College of Humanities and Arts, Sports and Health Care Major, Korea National University of Transportation, 50 Daehak-ro, Chungju-si, Chungbuk 380-702, Republic of Korea. Tel. 82- 43-841-5993, Fax.: 82-43-841-5990, Email: wowso@ut.ac.kr

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PARTICIPATION OF DIVORCED SINGLE PARENTS AND THEIR CHILDREN IN OUTDOOR ACTIVITIES TO IMPROVE ATTITUDES AND RELATIONSHIPS

Cindy KRIEL[1], Cornelia M. SCHRECK[1] & Francois WATSON[2]
[1] *Physical Activity, Sport and Recreation (PhASRec), North-West University, Potchefstroom, Republic of South Africa*
[2] *School of Nursing Science, North-West University, Potchefstroom, Republic of South Africa*

ABSTRACT

Divorce is one of the most stressful events a child or adult might ever experience. Enhancing family functioning is a key intended outcome in designing family leisure programmes aimed at developing life-enhancing attitudes and relationships. Nonetheless, the actual effects on families participating in such programmes, specifically single-parent families, have not yet been reported. Two divorced single- parent families headed by the mother with adolescent children participated in this small scale four-day adventure intervention programme including a high-ropes course, equine-assisted therapy, mountain-biking treasure hunt, hiking, abseiling and rock-climbing. Qualitative data collected from semi-structured one-on-one interviews, field notes and participant observation were analysed rendering two main themes, namely attitudes and relationships, each with its own set of subthemes: attitudes, comprising self-esteem and motivation; and relationships, comprising communication, problem solving, respect and trust. The leisure intervention programme played a positive role in improving attitudes and the relationships between the divorced single-parent mothers and their children.

Key words: Leisure; Outdoor activities; Relationships; Attitude; Divorce; Single parenting; Adolescent children.

INTRODUCTION

Rising divorce rates have resulted in numerous changes in family life. In 2011, 20 980 divorces were reported in South Africa, affecting 11 457 children under the age of 18 (Stats SA, 2011). Divorce can be one of the most stressful events experienced by a child or adult during their lifetime, with potentially serious adverse effects on parent-child attitudes and relationships (Janzen & Harris, 1997).

Quantitative studies of leisure and its effects on family functioning and satisfaction with family life indicate that families recognise the value of shared leisure time and the possible benefits of time spent together (Agate *et al*., 2007; Smith *et al*., 2009; Hornberger *et al*.,

2010). The Core and Balance model of family leisure functioning identifies two types of leisure activities in which families participate (Zabriskie & McCormick, 2001). 'Core' family leisure activities include those taking place at home regularly, for example, watching television as a family, whereas 'balance' family leisure activities are less frequent, take place away from home and

require resources including time and finances, like a family holiday. The skills developed during balance type leisure activities can be adapted and generalised to core leisure activities, although families need an appropriate mix between these two (Agate *et al*., 2007). Nonetheless, Hornberger *et al*. (2010) found that single-parent families spend less time on both core and balance leisure activities than two parent families.

Research studies on family leisure time primarily made use of quantitative research designs (Agate *et al*., 2007; Smith *et al*., 2009; Hornberger *et al*., 2010), and only a few researchers have analysed the effects of an outdoor intervention programme on family leisure (Shaw & Dawson, 2001; Huff *et al*., 2003; Wells *et al*., 2004; Sullivan *et al*., 2010). Results indicate that the use of the outdoors during interventions contributes to family cohesiveness, communication, trust and support, affection and the resolution of family conflict (Huff *et al*., 2003; Wells *et al*., 2004). The sparse published research on leisure that focuses specifically on attitudes and relationships of divorced single parents and their children is striking.

PURPOSE OF RESEARCH

The purpose of this study was, therefore, to explore the effect of an outdoor intervention programme on the attitudes and relationships of two South African divorced single parents and their children. The findings offer a starting point for further investigation of outdoor programmes specifically for single parents and their children.

CONCEPTUAL FRAMEWORK

Formulation of attitudes and relationships

Attitudes, according to Baron (2001:628), are "the lasting evaluations of various aspects of the social world that are stored in memory". Attitudes may be influenced by family members, an individual's mental health, or a current situation and accompanying emotions (Baron, 2001; Gass & Seiter, 2002). Individuals' attitudes can be influenced to be positive on condition that the individual feels competent enough to be positive and has support from other family members (Lamanna & Riedmann, 2009).

Relationships have been defined as "a reciprocal, dynamic, interpersonal connection characterised by patterns of emotional exchange, communication, and behavioural interaction" (Zastrow & Kirst-Ashman, 2010:23). Although 'healthy family relationships' are difficult to define, it is easier to identify the elements contributing to them. One of these is communication within the family unit (Mactavish & Schleien, 1998), which enhances family functioning and plays a vital role in laying the foundation for developing trust (Kerr *et al*., 1999), addressing conflict and solving problems (Zastrow & Kirst-Ashman, 2010). Another important element is respect, which not only contributes to effective communication, but also to positive attitudes including self-esteem (Frei & Shaver, 2002).

Single-parent families

Single-parent families are households where only one of the parents lives with the children (Zastrow & Kirst-Ashman, 2010), and could be the result of death, a child born to an unmarried

woman, abandonment or disappearance of one parent or divorce (Janzen & Harris, 1997), which is the focus of this study. Divorce is associated with reduced levels of well-being and poor parent-child relationships (Leman, 2000; Von Wielligh, 2003; Ahrons, 2007). Parents often do not have good relationships with each other following divorce (Kail & Cavanaugh, 2007), making it difficult for the children to envisage healthy relationships, since the relationship between parents is recognised as the foundation for that between parents and children (Leman, 2000).

Individual attitudes may also be affected by divorce, but are not as easy to observe (Gass & Seiter, 2002). When one parent is forced to head a household alone, he or she may find it difficult to compensate for the day-to-day absence of the other parent (Leman, 2000; Anderson, 2003; Arnold *et al*., 2008). It is important to note that not all single-parent families need improvement in parent-child relationships and that some children are capable in adapting to the new situation (Von Wielligh, 2003).

Leisure of single-parent families

Divorced single parents often experience financial difficulties and time constraints, since there were always two parents running the household and earning an income and one parent is responsible for all this after a divorce (Leman, 2000; Anderson, 2003). Time and financial constraints may prevent divorced single-parent families from participating in leisure activities (Arnold *et al*., 2008; Hornberger *et al*., 2010), particularly balance activities, because free time is limited and enjoyment often depends on financial inputs and resources (Kelly, 1999 cited by Hornberger *et al*., 2010). These constraints highlight the importance of meaningful core family leisure time and affordable, well-resourced, intervention programmes based on not only family needs, but also available resources that are specifically designed to develop skills and build relationships and, thus, contribute to the families' quality of life (Compton & Hoffman, 2013).

METHODOLOGY

Research design and strategy

A descriptive qualitative research design based on a single case study intervention was adapted to investigate the role of an outdoor intervention programme in building relationships and positive attitudes between divorced single parents and their children. This design was employed to gain an in-depth understanding of each family, their way of life, and the influence of individual family members on one another. This strategy was adopted as it allowed the researchers to best describe the experiences of the participants during their day-to-day activities during the intervention (Sandelowski, 2000). Data were collected by means of semi-structured one-on-one interviews, observation of participants and field notes.

Participants and context

Non-probability purposive procedures were used to select participants by means of a snowball sample. The researchers used a social network and initially contacted a single parent. For inclusion, families had to be divorced for longer than 4 years, include a child/children between the ages of 12 and 15 years, with the single parent having full parental responsibilities and

rights as defined by the Children's Act 38 of 2005 (South Africa, 2005:25). The participants (N=5) were 2 divorced single-parent Caucasian families, each headed by a mother, and included her natural adolescent child/children.

Data collection methods

Data were collected by means of semi-structured one-on-one interviews, participant observations and field notes, which provided the researchers with in-depth descriptions of the lived experiences of the families during the course of the intervention. The interview schedule developed was based on Greenaway's (1992) process of reviewing leisure experiences around the factional aspects of the activities done, feelings experienced while engaging in these activities, findings and conclusion made due to participation, and the future of how these experiences can translate to other day-to-day activities in the participants' lives as the focus of the open-ended questions.

Ethical approval

Ethical approval was obtained from the North-West University Health Science Ethics Committee. The researcher explained the purpose of the study and allowed the families a 2-week period to confirm their participation in the study. The researcher had a follow-up meeting with each family to inform them about the procedures of the research. Each parent had to sign an informed consent form for herself, as well as for her minor child/children, where after the children signed assent to take part in this study on a voluntary basis. Families agreed to participate without any compensation and all were free to withdraw at any time without consequences.

Research procedures

Although not considered as data in this study, all participants completed the Leisure Interest Measure (LIM) questionnaire (Ragheb & Beard, 1992), with no external influences from other family members. The LIM was used to measure the participants' leisure interests, which provided information about their leisure preferences. The questionnaire covered 8 leisure activities: physical; outdoor; mechanical; artistic; service; social; cultural; and reading. The results, however, indicated a high preference for outdoor and physical activities for all the participants. An outdoor intervention programme was designed, tailored to the needs of the participants as determined by the results of the LIM questionnaire. The Therapeutic Recreation Specific Program Design (Stumbo & Peterson, 2009), was used as a framework for the intervention to ensure that the outcomes were met.

The 2 families participated in a 4-day intervention programme based on the LIM assessment on separate occasions. It included a high-ropes course, equine-assisted therapy, a mountain- biking treasure hunt, hiking, abseiling and rock-climbing, with an additional day at the start that was used for mountain-bike training. During the intervention the

researcher made use of an independent outdoor leader to present the activities and to ensure the safety of the families. Participant observations and field notes were recorded by the researchers throughout the duration of these activities.

The audio-recorded semi-structured interviews were held 2 weeks after the intervention with the intention of giving the families time to apply their newly acquired skills to their daily activities. The purpose and duration of the interviews were discussed beforehand and participants had the right to withdraw from the interview at any time or refuse to answer any questions. The site where the interviews were conducted varied, as the location and times were chosen by the participants for their convenience.

Data analysis

The participant observations, field notes and recorded semi-structured one-on-one interviews were transcribed verbatim and the content was qualitatively analysed to derive themes and sub- themes (Sandelowski, 2000; Henderson, 2006). Codes were systematically derived by the researchers and a co-coder who worked independently. Once themes and sub-themes were deduced from the codes, the researcher and the co-coder met to confirm the findings based on the experiences of the participants.

Trustworthiness

A systematic audible analytical process was used to confirm the trustworthiness of the themes and sub-themes (Henderson, 2006). The interviews took place in the settings preferred by the participants according to their schedules and the interviews were conducted in their first language. The data, which included the transcribed transcripts, were analysed by an experienced independent co-coder. Thereafter, the data was triangulated by multiple data sources. This included triangulation of the semi-structured one-on-one interviews, participant observations, field notes and literature.

The transferability of the data was enhanced through the purposive sampling method and the detailed explanation of the research procedures. Although the interventions were conducted on 2 separate occasions, it was presented in the exact same manner for both the families, which contributed to the consistency of the research. Other strategies followed to ensure the consistency included the interview schedule that was followed during the interviewing of each participant and making use of a co-coder.

RESULTS AND DISCUSSION

The available literature on the development of relationships and attitudes was used to code the data collected from the interviews, resulting in the identification of 2 main themes, each with its own set of categories. The letters and numbers represent the participants in the following discussion (parents=P1 & P2 and children=C1, C2, C3).

Theme 1: Attitudes

The literature identified 2 important aspects of attitude (*self-esteem and motivation)* that need to change before the overall attitude of an individual can change.

Self-esteem

The development of good relationships depends on the way in which participants see

themselves (Strong *et al*., 2011). An important part of the intervention programme was to assist participants in improving their self-esteem. On the first day of the programme the families participated in a 5m superficial abseiling exercise (abseiling off a climbing wall). Participants reported being anxious to climb on the structure because they "were afraid of heights" (P1), but they completed the exercise and "overcame their fear" (C3). During the hike on day 4, families were required to do a 25m abseil down a cliff face and participants were not as anxious as they had been on the 5m exercise. This experience drew the following comment "I decide what I can and cannot do and it all depends on me" (C3).

The increase of self-esteem was evident in Parent 1 who said "I felt a little bit more self-confident and got the feeling of … , you can do it" during the 25m abseil. This statement is in line with the findings of Behnke *et al*. (2011), who have found that participants with high self- esteem perceive challenging life events as manageable, which in turn lowers the possibility of depression.

Also contributing to self-esteem were the kind words of the family members to each other during one of the facilitation sessions. Individual family members had to give each other a gift that they found in nature, and elaborate on the individual strengths they observed during the intervention programme. Specifically, participants talked about the meanings of the gifts they received and were asked during the interviews how it made them feel. They explained receiving the gifts as follows, "it shows me that my child sees the things I do" (P2); "it made me feel special" (C2); "happy and emotional" (C1).

Motivation

According to the Oxford Dictionary (Hornby, 1998), 'motivation' refers to "a reason or reasons for acting or behaving in a particular way". An individual's motivation to complete a task will improve when they are encouraged by other members. Encouragement is a major factor contributing to individual self-esteem (Zastrow & Kirst-Ashman, 2010), and is defined as "the action of giving someone support, confidence, or hope" (Hornby, 1998:758). As stated previously, participants feared heights and required support and motivation from their families throughout the high-ropes course and during the abseiling activities. They described the high- ropes course as physically demanding and believed that "motivation was needed to walk on the cables" (C1). While one member was participating, the others gave their full attention and talked them all the way through the activity, supporting them and motivating them to carry on.

The support from other family members was important for the members to feel motivated to complete the abseiling activity. The participants felt that "there was someone there for me" (C2); "I heard that they were there the whole time and they supported me, that gave me the courage to go on" (C3); and "it meant a lot to me when I heard the voices saying 'come on' ..." (P1). Based on the positive feedback in the current study, it appears that families expressed support by looking after each other during the activities. These findings are similar to those reported by Huff *et al*. (2003). The current findings support those of other studies that found that motivation and support can be improved through participation in leisure activities (Huff *et al*., 2003; Voruganti *et al*., 2006).

It could be concluded from this study that self-esteem and motivation were indeed influenced by the leisure-based programme. This was established when families confirmed

its value in developing attitudes: “I definitely realised a change in attitudes, especially the attitude towards

me” (P1); and “yes” attitudes changed (C2); and “I have ... I understand them (my family members) better now” (C3). These responses indicate that leisure could have a positive effect on family attitudes.

Theme 2: Relationships

The literature identified several important aspects that have an influence on the relationship itself. The sub-themes discussed during the interviews were communication, problem-solving, trust and respect.

Communication

Effective communication characterises good relationships and forms a vital part of the relationship-building process (Huff *et al*., 2003; Zastrow & Kirst-Ashman, 2010; Compton & Hoffman, 2013). According to Shaw and Dawson (2001), families participate in leisure activities to help children establish important things in life, such as good communication skills. Participants recognised its importance and described communication skills as “important” (C2); and included “to listen and to say” (P2) what you mean and “to look at each other” (P2) while doing so. The communication skills needed during the intervention programme assisted the families with their everyday communication and participants “learned to listen and try to see things from their point of view” (C3).

These findings support the findings of Bandoroff and Scherer (1994) that leisure participation contributes to the development of good communication skills within a family. One participant highlighted the improvement of their communication during daily activities, specifically at dinner time: “we talk more around the table and laugh more” (C1). The opportunity families were afforded to spend quality time together indicated that the time they spent together every day was not enough: “it is when you spend the whole day in their company that you learn to know them as a person and not when you organise them” (P2). This statement reinforced the notion that communication improved as a result of the programme, in line with other studies (Huff *et al*., 2003).

Problem-solving

Single-parent families, like all families, are frequently faced with decisions to be made and problems to be solved. Therefore, the aim of problem-solving during the intervention was to teach divorced single parents and their children the skills to solve their daily problems. The activities required that the single-parent families communicate with each other, to brainstorm ideas, to make decisions and to plan. When asked during the intervention how the families solved the problems, participants answered: “to listen and to plan better and yes ... to test everyone’s plans to see which one worked” (C3); “we got impatient, but at the end it was teamwork” (C1) that led to problem-solving “through communication” (C2) and “"deciding on things together”.

The results of the current study are consistent with those of Sullivan *et al*. (2010) who revealed that families brainstormed possible solutions to problems and looked at the positive and negative consequences of each option. Problem-solving skills did improve during the current intervention programme. Research has indicated that working together and solving problems can lead to building trust within the individual and in others (Huff *et*

al., 2003). In the current

study, this was confirmed when C3 stated "I think I have more trust in my family and in myself".

Trust

To trust is to rely on the integrity, strength and adaptability of another person (Poole *et al*., 2007). Trust between parents and children are seen as an important part of relationships (Kerr *et al*., 1999). Improving trust formed part of the intervention as a means to improve relationships. Participants had to accompany and support each other down a rock-face and they described their day in the mountains as the highlight of the programme. When asked about this activity and what they had learned, they replied: "our lives were literally in their hands" (P1) and "it was a huge responsibility" (P2). P2 said there was "unconditional trust" and learned that "you can rely on your family; they are your anchor in life" (P2). The high levels of trust and support in the current study echoed the results of Huff *et al*. (2003) where children and adults indicated the positive change in their ability to trust and the role of this factor in improving their communication skills. The intervention programme improved trust as all the participants revealed that the main lesson learned was that they could put their trust in their parents and children, no matter what.

Respect

Children respecting parents and parents respecting children are important for building strong relationships, since it denotes willingness to show consideration and appreciation (Hornby, 1998). The theme of respect received attention through the use of a metaphor of nature during the mountain hike. The participants were informed about the natural environment and the responsibility to protect and conserve it.

Enhancing respect and care for nature through outdoor experiences enhances respect and care for the people around us (Mitchell & McCall, 2007). During the facilitation session that followed after the hike, parents and children showed understanding of the meaning of respect in their relationships. The reactions were: "I have learned how they think" (P1) and "they are able to do more than I thought" (C3), which contributed to development of respect (P2). Similar to the study of Schreck (2010), this study also found a lack of literature regarding respect and leisure or recreation. However, respect emerged as a benefit of leisure participation in Schreck's study. The current participants agreed that respect was enhanced through their participation in the leisure-based programme by saying "yes, I experience it so" (P2).

When both families were asked whether the programme had played a role in changing their family relationships, the answer was "yes" from all the participants. The results of this study and the explanations provided by the families gave strong support for the view that attitudes can be improved through the enhancement of individual self-esteem and motivation. In addition, relationships can be improved through participation in an appropriately designed leisure-based programme that focuses on communication, problem-solving, trust and respect.

CONCLUSIONS

The results of this study indicate that outdoor activities do have a positive impact on the

improvement of the attitudes and relationships between divorced single-parents and their children. Perspectives from both parents and their children in this small-scale intervention

programme opened the door to further research, especially qualitative research to establish the value of leisure-based programmes for families headed by single mothers and single fathers. It would also be insightful to further investigate the influences of the father on the child/children's leisure time. Additional qualitative research could fruitfully explore the influence of other programme areas in achieving the same results, such as arts and aquatics.

The study had certain limitations, such as that it consisted of a small sample, and as a result the findings cannot be generalised to the entire divorced single-parent family population. The researchers recommend that this study should be repeated with a larger sample of families participating in similar intervention programmes with the aim of confirming these findings.

PRACTICAL APPLICATION

This research shows that the current changes in the family structures of South Africans should encourage leisure specialists to focus more evidence-based practices on family-orientated leisure programmes. Families who have quality relationships experience improved quality of life (Compton & Hoffman, 2013). Consequently, intervention programmes such as this one, which includes 'balanced'-type leisure activities could lead to the improvement of attitudes and relationships between divorced single parents and their children and would improve their quality of life. In addition, the skills gained from participation in the intervention can be applied during the 'core' family leisure activities that take place on a daily basis. It is imperative and also vital to consider the leisure specialists as part of the interdisciplinary health team in building critical skills for healthy relationships, especially with a focus on doing so while enjoying leisure time together.

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Ms Cindy KRIEL: Physical Activity, Sport and Recreation (PhASRec), North-West University, Potchefstroom Campus, Private Bag X6001, Potchefstroom 2520, Republic of South Africa. Tel.: 018 299 4206, Fax.: 018 299 1808, Email: cindy.gresse@nwu.ac.za

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INTENTION OF MOUNTAIN BIKERS TO RETURN

Martinette KRUGER[1], Kirstin HALLMANN[2] & Melville SAAYMAN[1]
[1] *Department of Tourism Research in Economic Environs and Society, North-West University, Potchefstroom, Republic of South Africa*
[2] *Institut für Sportökonomie und Sportmanagement, Deutsche Sporthochschule, Köln, Germany*

ABSTRACT

Mountain biking forms part of cycle tourism and is a growing segment in sport tourism. Yet, information about the underlying motives of those who participate in mountain bike events, while a tourist at the same time, appears to be scant. The purpose of this research was to determine the motives of mountain bikers and what drives their intentions based on samples from German (n=205) and South African (n=205) cycling events. Five motives were identified using exploratory factor analysis. These were enjoyment, health and fitness, event status and team, social interaction, relaxation, and dedication. Participants in the two events significantly differed based on the importance of the motives. The motives dedication, enjoyment, and health and fitness were identified as drivers of intention for return participation. While the motive dedication and the variable, country, significantly influenced intention to return visits. Marketers should target their promotional activities based on the different motives in relation to behavioural outcomes.

Key words: Return intentions; Motivation; Mass participation events; Mountain biking.

INTRODUCTION

The phenomenal growth in sport tourism is not surprising considering the broad range of benefits that accrue to both the host country and the host city from staging sports events (Gratton *et al*., 2005). Potential benefits of sport tourism include, amongst others, attracting high-yield visitors, especially repeaters; generating a favourable image of the destination; improving the organisation of sports events; and increasing community support for sport and sports events (Getz, 1998; Saayman *et al*., 2005; Scott & Turco, 2007). Mountain biking, which forms part of cycle tourism, continues to grow as a recreational activity. In recent years, cycle tourism has become a competitive sport placing demands on resource managers to provide facilities and unrestricted access to favoured cycling destinations (Newsome, 2010).

Mountain biking comprises a complex demographic profile that needs to be understood in terms of its impact as a leisure and sporting activity (Newsome, 2010). Simonsen and Jorgenson (1996) believe that all cycling participants fall into one homogeneous group. However, Faulks *et al*. (2006) differ from this opinion and explain that most participants are motivated by the common variable, the 'bicycle', but participants include a wide variety of individuals, which could lead to different market segments.

According to Kruger and Saayman (2012), sport event organisers should not only attempt to achieve a balance between first time and repeat participants, but should also be aware of the attributes that differentiate these participants. Marketers should firstly attract new participants through highlighting the attributes of the event to potential participants. Secondly, they need to continue the existing participant base by keeping them content with all aspects of the event in an efficient and effective manner (Harrison-Hill & Chalip, 2005). Hence, marketers should follow a two-pronged market segmentation approach, where both groups of participants are considered to ensure the sustainability of the sport event (Kruger *et al.*, 2011).

Despite calls for research, limited studies have been carried out on how first time participants differ from repeat participants at sport events (Filo *et al*., 2008; Wood *et al*., 2010; Myburgh *et al*., 2014). In this regard, to date, limited research has also focused on mountain bikers in particular. However, since international mountain biking events cannot necessarily grow in terms of participant numbers, the challenge for organisers now is to attract and retain the most lucrative markets and to achieve a balance between, for example, national and international, novice and professional cyclists. Understanding the reasons why participants return is, therefore, vital for organisers to manage these participants.

PURPOSE OF RESEARCH

The goal of this research is twofold: firstly, to identify the main motives of mountain bikers to compete; and secondly, to determine which factors (socio-demographic, behavioural and motives), influence the intentions of mountain bikers to repeatedly participate in an event and undertake travel.

THEORETICAL FRAMEWORK

This research relies on motivation theory. In sport, a distinction is commonly made between intrinsic and extrinsic motivation. In general, intrinsic motivation refers to engaging in an activity purely for pleasure, fun and satisfaction derived from doing the activity (Deci, 1975; Vallerand & Losier, 1999; Ryan & Deci, 2000). These motives are consistent with the self- determination theory which states that people are pushed to achieve goals through intrinsic pressures, which lead to more positive experiences (Vallerand & Losier, 1999). When intrinsically motivated, a person is moved to act for fun, for experiencing feelings of competence, achievement and self-determination and for the challenge, rather than for external motivations or rewards (Pelletier *et al.*, 1995; Ryan & Deci, 2000). Extrinsic motivation, on the other hand, pertains to the participation in sport to derive tangible benefits, such as material (trophies) or social (prestige) rewards (Deci, 1975; Vallerand & Losier, 1999; Ryan & Deci, 2000).

Another model, the trans-theoretical model (TTM) by Prochaska *et al*. (1992), has also traditionally been the most widely adopted model for examining engagement in sport and physical activity. The TMM suggests that mediation of behaviour involves progression through five stages - pre-contemplation (not ready, no intention of becoming active), contemplation (getting ready, thinking about becoming physically active), preparation (ready, making small changes in physical activity behaviour), action (meeting a criterion of activity, but only recently) and maintenance (meeting a criterion of activity for a sustained period). The current

research specifically focuses on the aspects that influence the last stage of the intentions of mountain bikers to continue their participation. Therefore, this model seems to be very suitable in this research context instead of looking solely at different types of motivations, such as intrinsic and extrinsic as used in the self-determination theory (Deci, 1975; Ryan & Deci, 2000)
- which is also important - or the progression towards self-actualisation following the hierarchy of needs of Maslow (1943).

It is important for every sport event and other tourism product to determine the motives of participants (intrinsic and extrinsic), because it is the starting-point of marketing, which helps professionals make the most suitable travel and event arrangements that meet the requirements of each individual traveller and/or participant (Mohammad & Som, 2010). In addition, a better understanding of what motivates participants to compete in different sporting events will lead to more effective marketing communication, enhance the event experience and identify the key components on which participants base their decisions (Kruger *et al*., 2011; Kruger *et al*., 2012; Kruger & Saayman, 2013).

LITERATURE REVIEW

Profiles of mountain bikers and their motivation

Mountain biking is defined as a type of cycling undertaken primarily on "off-paved roads, purpose-built single track trails, fire roads, access roads and multipurpose trails" (FCS, 2005:6). Although road cycling and mountain biking both use a bicycle, they are two very different sports (Milton, 2010; Rauter & Topič, 2010). These differences are evident in the size of the events, the length (time to complete and duration), type of bicycle, distance and the terrain on which the bicycles are ridden (Lopes & McCormack, 2005).

The research on mountain bikers by Cessford (1995) and Getz and McConnell (2011) revealed that mountain bikers tend to be younger male participants. Getz and McConnell (2011) also found mountain bikers to be in their late thirties, with 'active' types of interests and professional backgrounds. These cyclists also have a high level of education, a high degree of club involvement and high level of experience in the sport. Research has further indicated that the majority of professional mountain bikers participate in the activity frequently (Koepke, 2005). Koepke (2005) found that bikers ride an average of four to six times per week during the season. Most of the riders are also involved in other sports like running, walking and tramping. The more experienced cyclist spends much more money on their bikes, as well as improvements on them. Mountain bikers also demonstrate a diverse need for a variety of activity preferences based upon challenging riding, natural forested settings, single-track, speed and excitement experiences, scenery and general variety in riding conditions (Cessford, 1995).

With regard to motivational differences, LaChausse (2006) identified nine motives of competitive and non-competitive cyclists. These were health orientation, weight concern, goal achievement, competition, recognition, affiliation, coping, life-meaning and self-esteem. It was found that mountain bikers were mainly motivated by life-meaning while road cyclists were motivated more by competition and goal achievement. These results correspond with the results found by Streicher and Saayman (2010). Gadja (2008) identified eight motives for mountain bikers in the United Kingdom. These were, in order of

importance, stimulation/excitement/

experiencing flow, riding/socialising with friends, escapism and separation, scenery and contact with nature, exercise/fitness workout, exploration and discovery of new areas, developing and improving skills and speed, and risk. In their study of the motives of mountain bikers and road cyclists, Rauter and Topič (2010) found that the main reason for the performance of mountain bikers is the love of the sport itself (intrinsic motivation) while the road cyclists are driven by a wish for sport results, reputation (prestige) and money. Mountain bikers appreciate risk, the search for new adventure and getting to know more people. King (2010) explored the experience of mountain biking of young people (between the ages of 13 and 25 years), and found that young females were motivated more by self enhancement and health and fitness reasons, while young men were motivated more by group identity, lifestyle, the challenge of mountain biking and being outdoors.

Getz and McConnell (2011) identified four motivation dimensions for mountain bikers. These were athleticism, social, prestige and excitement of which athleticism and excitement were the most important motives to compete - especially motives such as "to challenge myself", "have fun" and "for the thrill of it". These results confirmed the notion that active sport tourists need to compete and improve their skills. However, mountain bikers did not appear to value winning compared with other active cycling tourists. Previous research also indicates that the reasons for participation may vary by gender (Masters *et al.*, 1993; King & Burke, 2000), level of participation and type of activity (Ogles & Masters, 2003).

Return intentions in a travel and sport context

Revisit intention refers to the willingness or plans of tourists to revisit the same destination again (Cole & Scott, 2004). In the context of this research, revisit intention also refers to the plans of participants to take part in the same event again in the future. Destination and event organisations are concerned with the reasons underlying tourist revisit intention, since the cost of retaining repeat visitors is much less than that of attracting new visitors (Um *et al*., 2006). Other reasons for aiming to attract repeat visitors include the notion that repeat visitors signal that they are satisfied visitors/participants, they are generally loyal to the event or attraction, they become ambassadors of the event, and satisfied participants promote the event by word of mouth (Shoemaker & Lewis, 1999; Oppermann, 2000; Tang & Turco, 2001; Caneen, 2004; Li *et al*., 2008). In particular, the host destinations of sport events are concerned with long-term economic benefits and local development and, therefore, need to persuade event participants to stay beyond the period of the event or to attract them to return to visit the destination as a non- sport tourist (Chalip & McGuirty, 2004).

Previous research has examined determinants, such as socio-demographics, group size, motivations and past behaviour of return intention in the leisure travel and sport context. Various studies have also focused on retaining the youth to continue their participation in sport (Ullrich-French & Smith, 2009; Poobalan *et al*., 2012; Guzman & Kingston, 2012; Atkins *et al*., 2015), as well as the influence of a coach-created motivational climate (Alvarez *et al*., 2012; Ntoumanis *et al*., 2012). In addition, differences have been identified between first time and repeat visitors (participants), indicating that previous experience matters and those groups might have distinct perceptions about future intentions.
With regard to socio-demographics, Gitelson and Crompton (1984), Lau and McKercher (2004) and Li *et al*. (2008) found first timers to be younger than repeaters. Moreover,

and Saayman (2014) revealed that among males, first time and repeater numbers are similar, but among women fewer women undertake repeat participation. Sport event participants in general tend to be male and well educated (Turco *et al*., 2003; Chalip & McGuirty, 2004; Funk *et al*., 2007). Surprisingly, it appears that very few studies have included socio-demographics to explain intentions, even though general consumer behaviour theory suggests this relationship (Solomon *et al*., 2013).

With regard to group size, a study among triathletes participating in Ironman South Africa found that repeat participants travel in larger groups than first time participants (Myburgh *et al.*, 2014). Regan *et al*. (2012) found that effective destination image, and enduring involvement in the event category influence group-oriented travel behaviour to major events; however, no distinction between first-time and repeat athletes was drawn.

Concerning motivations, diverse findings have been reported. The motives intrinsic achievement and escape and relaxation were the most important motives to participate for both first-time and repeat athletes (Kruger & Saayman, 2015). In contrast, first timers are more curious (Fakeye & Crompton, 1991), and are more motivated by external factors (Alegre & Juaneda, 2006), when compared with repeaters. First time participants were mostly motivated by challenge, inner vie and intrinsic achievement and control, whereas repeat participants viewed event novelty, challenge, inner vie, and health and fitness as the most important motives to participate (Myburgh *et al*., 2014). Based on all these findings, it is no surprise that first timers participate in more activities compared to repeaters (Kemperman *et al*., 2004; Lau & McKercher, 2004). Atkins *et al*. (2015) found that enjoyment and self-esteem contributed the most to young sport participants.

Finally, pertaining to past behaviour as a potential determinant of intentions, it has been shown that previous experience of the event is an important driver of behavioural intentions of tourists (Petrick *et al*., 2001; Um *et al*., 2006), and active sport tourists (Hallmann & Breuer, 2010). It was also shown that for active sport event tourists, first timers were unsure that they would return, and concerning travel to other tourist attractions, it is noteworthy that the results confirmed that repeaters do visit attractions in the area (Kruger & Saayman, 2015).

Despite this research, a consensus on the determinants of return intentions of tourists and the correlations between influential factors and repeat travel remains underdeveloped (Chen & Funk, 2010). Weed (2005) pointed out that studies have acknowledged that sport event participants, who enjoy their sport tourism experience, would like to repeat the experience in the future; however, exploratory studies focusing on why the experience is enjoyable and why participants would like to repeat it are lacking.

METHODOLOGY

A quantitative paradigm was followed to address the research questions. Data for this research were collected at the SKS Mountain bike Marathon in Sundern, Germany on 27 April and 28 April 2012, and at the ABSA Cape Epic Race in South Africa on 24 March 2012.

The SKS Mountain bike Marathon is held annually in the last weekend (two days) in April

with over 1600 participants taking part in the 2012 event. The event consists of three races (100km, 50km and 30km), and the route is along very rural and hilly terrain. The ABSA Cape Epic, on

the other hand, is one of the biggest endurance mountain bike events in South Africa, attracting over 1200 participants. The race is held over an 8-day period and includes a trail prologue. The route is approximately 800 kilometres and mostly consists of gravel paths, rocky uphill's, river crossings, technical downhills and routes in the forest (Cape Epic, 2012). At both events, a self- administered questionnaire was distributed to the participants using non-random sampling, namely a convenience sampling approach. This was due to ease of accessibility.

Measures

Twenty (20) motivational items were measured on a 5-point Likert scale, with respondents being asked to indicate the importance of each item on the scale (1=not at all important; 2=less important; 3=neither important nor less important; 4=very important and 5=extremely important). The motivation items were based on the research conducted by LaChausse (2006), Gadja (2008), King (2010), Rauter and Topič (2010), as well as Getz and McConnell (2011). They were selected after checking for their adequateness for the mountain bike context based on discussions with mountain bikers and faculty staff. The items included in the motivation section included self-actualisation, prestige and competitive related motives. In addition, socio- demographic information was requested relating to gender, age, education, behavioural variables concerning experience with the event, the sizes of the party travelling with the participant to the event, their intentions for return participation in the event, and return visits to the destination (Table 1).

Sampling procedures

The questionnaire was distributed to the participants of the races on the day before the race took place in the area where they could pick up their bib numbers, on the race day in the same area, and in the finish area. In Germany, 263 questionnaires were returned, of which 41 were excluded from the analysis due to incomplete answers and 17 respondents were excluded because they did not qualify as sport tourists, being from the hosting destination. Thus, the final sample size for the German sample amounted to n=205. A total of 205 completed participant questionnaires were administered for the Cape Epic in South Africa. An onsite intercept survey was conducted, with field workers handing out questionnaires during registration at the Forum, Victoria and Alfred Waterfront. Participants were approached while they were queuing for registration. Respondents were briefed about the purpose of the research beforehand to ensure that they participated willingly and fieldworkers were also trained to ensure a representative sample at both events in terms of gender, race and nationality.

Participant characteristics

Considering the sample from South Africa, the majority of participants was male (89%), well- educated (87% have at least A-levels), and with a mean age of 39 years (39.22±8.558). They travelled with 3 persons on average and had participated at least once before in the event. Similar characteristics apply to the German sample: 75% were male, 1 third (38%) were well- educated, the mean age was 38 years (37.96±9.787), and they

travelled with 3 other persons. However, on average, they had already taken part in the event 3 times. Table 2 presents an overview of these results.

Table 1. **OVERVIEW AND OPERATIONALISATION OF VARIABLES**

Variable	**Description**	**Scale**
Gender	Female=1, Male=0	Dummy
EDU	Higher education (at least A-levels)	Dummy
Age	Age of respondent in years	Metric
Party size	Size of group party travelling	Metric
Experience	Number of times participated in the event	Metric
Country	Country of the event (Germany=0; South Africa=1)	Dummy
Re-participate	Intention to re-participate in the event (Yes=1, else=0)	Dummy
Revisit	Intention to revisit the destination/attractions (Yes=1, else=0)	Dummy
Motives#	**Description**	**Scale**
Get away	To get away from my routine.	Ordinal
Relax	To relax.	Ordinal
Family/friends	To spend time with family and friends.	Ordinal
Meet people	To meet new people.	Ordinal
Sociable	It is a sociable event.	Ordinal
Enjoy	Because I enjoy cycling.	Ordinal
Well organised	Because the event is well organised.	Ordinal
Endurance	The event tests my level of fitness and endurance.	Ordinal
International	It is an international event.	Ordinal
Team	I am participating as part of a team.	Ordinal
Challenge	The event is a huge challenge.	Ordinal
Pride	To feel proud of myself and to feel a sense of achievement.	Ordinal
Must do	It is a "must do" event.	Ordinal
Identity	To share group identity with other cyclists.	Ordinal
Health	To improve my health.	Ordinal
Goal	I am pursuing a personal goal of participating in a predetermined number of cycling events.	Ordinal
Club	Because I am participating as part of a club.	Ordinal
Professional	Because I am a professional cyclist.	Ordinal
Addicted	I am addicted to training and this event sets training targets for me.	Ordinal
Preparation	Because this race allows me to train, qualify or prepare for other events, such as the Ironman, etc.	Ordinal

Measured on a five-point Likert scale (1=*not important at all* to 5=*extremely important*)

Data analysis

Data analysis included several steps. Initially, mean values were analysed indicating sample proportions for binary variables (Table 2). The summary statistics include an overview of the mean values of each sample (South African and German), and the total sample. In addition, motives were tested for differences using independent t-Tests. To reduce the data considering the motives, exploratory factor analysis was carried out using all 21 motives. Principal component analysis with varimax rotation was employed. In a first round of analysis, the single motives *challenge* and *pride* had factor loadings smaller than 0.4 and

were loading

on 2 factors. The motive *goal* was also loading on 2 factors. Thus, these were excluded from further analysis (all analyses going beyond the summary statistics). Consequently, the motive *identity* had a factor loading smaller than 0.4 and was also excluded from the subsequent analyses. Following the screen test and the Kaiser criterion, a 5-factor solution was suggested. Finally, all factor loadings were higher than 0.5 and could, therefore, be considered significant (Hair *et al.*, 2010). In addition, all communalities were higher than 0.4.

Thereafter, logistic regression analyses using (a) intention for return participation, and (b) intention for return visits to the destination were employed. Socio-demographic indicators (gender, education, age), behavioural components (party size, experience, country), and the 5 motive factors retrieved from the factor analysis served as independent variables.

RESULTS

Table 2. **SUMMARY STATISTICS AND RESULTS OF INDEPENDENT t-TEST FOR MOTIVES BETWEEN SOUTH AFRICAN AND GERMAN SAMPLES**

Variable	**Total sample** Mean±SD	**South African sample** Mean±SD	**German sample** Mean±SD	**t-Score for motives**
Gender	0.184±0.388	0.113±0.318	0.251±0.435	
EDU	0.627±0.484	0.873±0.334	0.381±0.487	
Age	38.55±9.237	39.22±8.558	37.96±9.787	
Party size	3.403±2.550	3.345±2.216	3.643±2.863	
Experience	2.186±2.106	1.516±1.618	2.821±2.313	
Commitment	0.212±0.501	0.068±0.253	0.356±0.480	
Motives				
Get away	3.073±0.409	3.017±1.314	0.312±1.111	0.855
Relax	2.997±1.210	2.92±11.333	3.066±1.072	1.153
Family/friends	2.935±1.204	2.667±1.288	3.167±1.089	3.992*
Meet people	2.889±1.210	2.976±1.288	2.814±0.938	-1.410
Sociable	3.177±1.082	3.195±1.231	3.162±0.965	-0.292
Enjoy	4.468±1.096	4.449±0.833	4.485±0.599	0.482
Well organised	4.033±0.717	3.952±0.927	4.101±0.839	1.612
Endurance	3.968±1.493	3.998±1.105	3.951±0.894	-0.360
International	3.215±0.995	3.573±1.260	2.904±1.264	-5.076*
Team	3.303±1.304	3.720±1.147	2.938±1.439	-5.737*
Challenge	4.032±1.366	4.438±0.768	3.681±0.899	-8.801*
Pride	3.997±0.915	4.351±0.831	3.696±0.960	-7.022*
Must do	3.190±0.959	4.012±1.089	2.480±1.311	-12.160*
Identity	3.148±1.433	3.173±1.248	3.126±0.984	-0.382
Health	3.284±1.110	3.173±1.234	3.376±1.026	1.705
Goal	2.908±1.128	2.781±1.449	3.010±1.263	1.597

(Continued)

Table 2. (continued)

Variable	**Total sample** Mean±SD	**South African sample** Mean±SD	**German sample** Mean±SD	**t-Score for motives**
Club	2.238±1.352	1.853±1.182	2.556±1.405	5.161*
Professional	1.949±1.354	1.727±1.245	2.133±1.224	3.096*
Addicted	3.419±1.248	2.976±1.414	3.787±0.846	6.525*
Prepare	2.659±1.208	2.422±1.415	2.857±1.337	3.024*

SD=Standard deviation * $p<0.05$

The single motives were rated differently by the 2 samples. The 3 most important motives (based on the mean values) for the South Africans were *enjoy* (4.449±0.833), *challenge* (4.438±0.768) and *pride* (4.351±0.831), while for the Germans *enjoy* (4.485±0.599), *well organised* (4.101±0.839) and *addicted* (3.787±0.846) were rated the highest. The motives were tested for differences between the 2 groups and the t-Test statistic revealed significant ($p<0.05$) differences for the motives *family and friends, international, team, challenge, pride, must do, club, professional, addicted* and *prepare*. Consequently, the 2 groups differed significantly on 50% of the motives. Notwithstanding these differences, the data were reduced to find common factors among the motives.

Table 3. **EXPLORATORY FACTOR ANALYSIS: PRINCIPAL COMPONENTS WITH VARIMAX ROTATION**

Variable	**Factor 1** Dedication	**Factor 2** Social interaction & relaxation	**Factor 3** Event status and team	**Factor 4** Enjoyment	**Factor 5** Health & fitness
Get away		0.627			
Relax		0.723			
Family & friends		0.683			
Meet people		0.754			
Sociable		0.705			
Enjoy				0.826	
Well organised				0.787	
Endurance					0.711
International			0.702		
Team			0.789		
Must do			0.738		
Health					0.715
Club	0.755				
Professional	0.778				
Addicted	0.668				
Prepare	0.701				

(Continued)

Table 3. (continued)

Variable	Factor 1 Dedication	Factor 2 Social interaction & relaxation	Factor 3 Event status and team	Factor 4 Enjoyment	Factor 5 Health & fitness
Eigen value	3.974	1.961	1.684	1.234	1.034
% Variance explained (61.80)	24.838	12.254	10.527	7.712	6.464
Mean value	2.550	2.990	3.230	4.260	3.630
Cronbach's Alpha	0.771	0.754	0.620	0.560	0.452
KMO			0.755		
Bartlett's Test for sphericity			1201.827*		

* p<0.001

The results of the exploratory factor analysis are summarised in Table 3. The eigenvalues of all factors were greater than 1.0 and the overall variance explained amounted to 61.80%. Bartlett's Test for sphericity exposed a significant χ^2 of 1201.827. The analysis revealed a 5- factor solution. The 1st factor comprised the variables *Club* (β=0.755), *Professional* (β=0.778), *Addicted* (β=0.668) and *Prepare* (β=0.701), and was, therefore, labelled ***dedication***. This factor had the lowest mean value of 2.55. The 2nd factor entailed the variables *Get away* (β=0.627), *Relax* (β=0.723), *Family & friends* (β=0.683), *Meet people* (β=0.754), and *Sociable* (β=0.705), and was named ***social interaction and relaxation*** and has a mean value of 2.99. The 3rd factor included 3 variables, *International* (β=0.702), *Team* (β=0.789) and *Must do* (β=0.738), and was labelled ***event status and team***. This factor had a mean value of 3.23. The 4th factor, ***enjoyment***, comprised the variables *Enjoy* (β=0.826), and *Well organised* (β=0.787) and, based on the mean value (M=4.26), was regarded as the most important motive to participate in the events. The 5th factor referred to the variables *Endurance* (β=0.711) and *Health* (β=0.715), and was labelled ***health and fitness*** and obtained the 2nd highest mean value of 3.63.

The results of the logistic regression (Table 4) suggested that the estimated model for ***intention for return participation*** is significantly predictive (χ^2=47.098; -2LL=302.354; p=0.000), with R^2 McFadden amounting to 13.47%. Three variables contributed significantly to the overall model. These included 3 factors, namely *dedication, enjoyment* and *health and fitness*. The analysis of the odds reveals that the odds for intention to revisit increase significantly by 1.479 per additional unit in *dedication* under control of all other variables. A positive effect was also attributed to *enjoyment* (Odds=1.706) and *health and fitness* (Odds=1.465). The 2nd estimated model using ***intention for return visits*** to the destination as a dependent variable was also significant (χ^2=85.395; -2LL=217.472; *p*=0.000). R^2 McFadden was 23.93%. In total, 2 variables exerted a significant influence on intention to revisit: *country* and *dedication*. Taking part in the South African event led to an increase in odds by 6.509 to revisit the destination. There was a significant negative effect of the factor *dedication* (Odds=0.599) on revisit intention.

Table 4. **LOGISTIC REGRESSION ANALYSIS: INTENTION TO PARTICIPATE AGAIN AND TO REVISIT AS DEPENDENT VARIABLES**

Variable	Intention to re-participate Coefficient (Odds)	Intention to revisit Coefficient (Odds)

Female	-0.457 (0.633)	-0.936 (0.392)
EDU	-0.219 (0.803)	0.474 (1.607)
Age	-0.025 (0.976)	-0.005 (0.995)
Party size	0.040 (1.041)	-0.152 (0.859)
Experience	-0.016 (0.984)	0.018 (1.019)
Country	-0.705 (0.494)	1.873 (6.509)***
Dedication	0.392 (1.479)*	-0.512 (0.599)**
Social interaction & relaxation	-0.146 (0.864)	-0.038 (0.962)
Event status & team	0.279 (1.321)	0.214 (1.239)
Enjoyment	0.534 (1.706)***	-0.047 (0.954)
Health and fitness	0.382 (1.465)**	0.089 (1.093)
Constant	1.081 (2.949)	-1.650 (0.192)
Pseudo R^2 Mc Fadden	13.47%	23.93%
χ^2	47.098	85.395
-2LL	302.354	217.472
p	0.000	0.000

* $p \leq 0.05$ ** $p \leq 0.01$ *** $p \leq 0.001$

DISCUSSION

The results revealed that if one wants to attract the mountain bike market, their profile appears to be similar in all the studies conducted internationally. The profile of mountain bikers based on the socio-demographic variables, confirms that mountain bikers are male, well-educated and in their late thirties, which is congruent with previous findings (Cessford, 1995; Koepke, 2005; Getz & McConnell, 2011).

Moreover, across mountain bike events, some single motivations differ slightly. For example, 'family and friends' was significantly more important in the German sample whereas the South Africans consider their event to be a 'must do' as more significant. In general, five distinct motives (as dimensions including several motivations) were identified. The five motives identified for participating in the two mountain biking events, in order of importance are *dedication, social interaction and relaxation, event status and team, enjoyment*, and *health and fitness*. Mountain bikers are, therefore, motivated more by intrinsic than extrinsic motives, which are consistent with the self-determination theory which states that participants are pushed to achieve goals through intrinsic pressures. These motives, furthermore, support the results obtained by LaChausse (2006), Gadja (2008), Rauter and Topič (2010), King (2010)

and Getz and McConnell (2011). However, the combination and importance of the motives are unique to this research confirming once again that motives differ from one event to the next.

The logistic regression identified three variables that exert a significant influence on return participation. These are the motives *dedication*, *enjoyment* and *health and fitness*. These

motives differ substantially from the motives identified by Myburgh *et al*. (2014) and Kruger and Saayman (2015), that had an influence on repeat participation in their respective events; emphasising that the type and nature of the sport and participant influence intentions to re- participate. Hence, the type of cycling and the type of participant greatly influence the motives to participate. Kruger and Saayman (2015) identified intrinsic achievement and escape and relaxation as the most important motives for both first-time and repeat visitors, while Myburgh *et al*. (2014) identified event novelty, challenge, inner vie, and health and fitness. Thus, the results show that mountain bikers are not only devoted and loyal to their sport, but also to the respective events with intrinsic motives being the strongest drivers for repeat participation.

In support of Kruger *et al*. (2012) and Krugell and Saayman (2013), the results emphasised that the type of event can greatly influence the intentions of participants to return as visitors to a destination where the event is held. This supports the TMM highlighting the progression through the five stages and pointing in particular to action and its link to maintenance, which represents the last and final stage. This is portrayed through intention to return. With regard the aforementioned, two determinants were significant, namely *country* and the motive *dedication*. This means, that participants of the Cape Epic held in South Africa, are more likely to revisit the destination than the participants of the German event. This can be ascribed to the type of event and the greater attractiveness of the South African destination. A possible explanation for this could be the event itself, the difference in the route distances, the timing of the two events, the fact that only teams of two can participate in the Cape Epic, and there are no individual cyclists. The Cape Epic is furthermore an eight-day race compared with the SKS Mountain bike Marathon, which is only a two-day event. From the identified motivations and t-Test analysis, it is clear that challenge is a very important motive for participants in the Cape Epic, which could also explain their affinity with the race since it provides the ultimate mountain bike challenge. These results support the self-determination theory, which states that challenge is an important motive to compete in sports.

The motive *dedication* exerted a negative influence on re-visit intentions of participants to the host country. Results concerning the motive *dedication*, therefore, suggest that when one participates in an extreme endurance sport, such as mountain biking, aspects such as devotion are necessary to compete in this type of sport. Therefore, it is an important motive to participate in a particular event. It does not, however, play a significant role when choosing a destination where the events are held. For these participants, the event is more important than the destination. However, the results should be interpreted with caution, especially when the nature of the two events and the differences between them are taken into account. This also corresponds with the notion by Taylor (2010) that factors that influence participation by cyclists in mountain biking are diverse, complex and interrelated. The findings further challenge current sports motivational theories and indicate that while the motives identified are applicable to participation in sport events, they are not applicable to repeat travel to a particular destination as a result of the sport participation.

IMPLICATIONS

The profiles of mountain bikers are similar in both current studies, as well as those in other studies carried out internationally. This has the advantage that the marketing campaign used nationally will most probably be successful for the international market. Mountain biking events can, therefore, apply a universal marketing strategy to attract participants. Marketers

and organisers of cycling events should certainly take the results of this research into consideration, not only to sustain the respective events, but also to grow the sport of cycling. However, the distinct nature of each race needs to be incorporated in marketing material in order to emphasise the characteristics of the race and route. This will attract participants with different levels of experience suitable for each race. Further research is required to understand the different cyclists who participate in different mountain biking events.

Coupled with this, promotional activities of different events need to focus on different motives based on the type of event. The communication message for short and middle distance events, such as the German event, should stress the fun factor of a well-organised event and challenge dimension ('check training against the real thing'). On the other hand, the marketing campaign for longer distance events, such as the Cape Epic, should combine the characteristics of the event (time, duration, terrain and skill required), as well as emphasise team work, which is key to the event. Furthermore, it is recommended that the route for mountain biking events change periodically in order to manage the impact and give cyclists an added challenge of an unfamiliar route.

The advantage that mountain biking events offers, which was also a key finding in this research, is that the sport of mountain biking can appeal to various participants, since their motives for participating in the respective events differ. Mountain biking can thus appeal to a variety of participants in terms of fitness level, endurance and challenge. There are various mountain biking events held all over the world. These events should work together to not only promote their events, but also to create greater awareness of the sport. This in return could also increase tourism to the areas where these events are held thereby contributing toward sport tourism in the host countries. The main goal of sport organisers should be to make mountain biking events accessible to all people, irrespective of their fitness level, gender, race or geographic location.

LIMITATIONS

This research has some limitations. The first limitation concerns the sampling procedures employed at the two events: The sampling was rather non-random as a result of the accessibility of participants instead of using a systematic and random approach. In addition, the two events studied were slightly different in nature, in particular, considering the duration of the events and the length of the races offered. Nonetheless, it is evident from the results that the socio- demographics are alike, though this does not apply to all the motivations.

CONCLUSION

The aim of this research was twofold: firstly, to identify the main motives of mountain bikers at these events and the results indicated five primarily intrinsic motives. The second objective was to identify the factors that influence the intention of mountain bikers for return

participation in an event and their intentions regarding return visits to the host destination. This kind of study has not yet been undertaken in mountain biking literature to the best of our knowledge. Three variables were identified for intentions of participants to re-

participate, namely *dedication*, *health and fitness*, and *enjoyment*. With regard to the intention of participants to revisit the destination, two variables were significant, namely *country* and the motive *dedication*; however, in this case, the motive had a negative influence. In this study, the role that the event plays are noteworthy since the data from two different biking events were used and show great resemblance in terms of socio-demographic characteristics. However, motives and behaviour differed to some extent, and is an issue that requires further research. In the case of comparing events, consideration might be given to establishing what the event specific factors are, that play a role in riders returning to the event, especially in the field of endurance events.

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Prof Martinette KRUGER: Department: Tourism Research in Economic Environs and Society, North-West University, Potchefstroom Campus. Potchefstroom, 2520, Republic of South Africa. Tel.: +27 (0)18 299 1980, Fax.: +27 (0)18 299 4140, Email: 13018493@nwu.ac.za

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ANTHROPOMETRICAL, PHYSICAL, MOTOR AND SPORT PSYCHOLOGICAL PROFILE OF ADOLESCENT MALES WITH SPRINTING POTENTIAL

Ankebé KRUGER & Anita E. PIENAAR
Physical Activity, Sport and Recreation Research Focus Area, North-West University, Potchefstroom, Republic of South Africa

ABSTRACT

This study determined whether anthropometrical, physical, motor and sport psychological differences exist between a group of male adolescents who show talent for sprinting and their less talented counterparts. Grade 8 boys (N=89; mean age: 13.25±0.46 years), from a high school in Potchefstroom voluntarily participated in the study. A general talent identification (TID) protocol and a sport psychological questionnaire were completed. The 40m-sprint test was used to categorise the subjects into two groups. Those in the top 10% were assigned to the talented group (TG) (n=8, mean age=13.79), and the remaining subjects were assigned to the less talented group (LTG) (n=72, mean age=13.55). An analysis of covariance (ANCOVA) was applied with stature as the covariate to adjust for variations in growth status between the two groups. The practical significance of differences between the two groups was determined by means of effect sizes (ES). The level of significance was set at p≤0.05. Significant differences with the potentially talented sprinters, who obtained better scores in upper and lower body explosive power, acceleration, maximal speed, aerobic endurance and in goal setting were found.

***Key words*:** Sprinting; Anthropometry; Physical; Psychology; Adolescence; Boys.

INTRODUCTION

Sprinting is the fastest running event in athletics over short distances and among the oldest track and field events (Wikipedia, 2014). Currently, three sprinting events are held at the Summer Olympics and outdoor World Championships: 100m, 200m and 400m (Wikipedia, 2014). Despite the Summer Olympics and outdoor World Championships, the IAAF World Junior Championships, comprising of track and field events, for junior athletes (aged 19 years or younger) are held biannually. Therefore, children should be ready to perform at a high level at a relatively young age in this event.

Top performance in sprinting is the result of a multifaceted and unique blend of different factors (Onyewadume *et al*., 2004). Sprinting consists of a start, acceleration phase, maximal speed phase and a speed endurance phase. Each phase requires specific physical and motor characteristics to obtain optimal performance in the event (Delecluse *et al*., 1994; Young *et al*., 1995; Carr, 1999). Successful performance in competitive sprinting depends on specific attributes such as stature, anthropometry, muscle strength and flexibility (Onyewadume *et al*., 2004). According to Hadavi and Zarifi (2009), psychological, genetic, biological and

sociological factors also influence sprinting performance. In addition, Ericsson (1996) suggests that performers have to engage in 10 years or 10 000 hours of deliberate practice in order to develop talent to its full potential.

Excessive fat mass can be disadvantageous during sprinting events. Several researchers

indicate an inverse relationship between fat mass and performance in activities where vertical displacement of body mass takes place (Boileau & Lohman, 1977; Pate *et al*., 1989). Uth (2005) reports that a very low or very high body mass might be a limiting factor in sprinting performance. A higher optimal body mass will be detrimental to a sprinters' performance seeing that it takes a higher force to accelerate a larger body mass. However, performance in sprinting relies heavily on force production which depends on muscle mass. Thus, sprinters with a very low body mass would probably have less muscle mass and consequently a weaker ability for force production.

Although a too high stature might be disadvantageous for sprinters, it might be advantageous as well (Uth, 2005). From a biomechanical point of view, the most important factors influencing performance in sprinting are stride length and frequency (Paruzel-Dyja *et al*., 2006). Thus, a taller sprinter's longer limbs might contribute to increased stride length and consequently increased running speed. It, thus, seems that body mass, height and body mass index are important anthropometrical attributes for successful sprinting. In addition, successful participation in different sport events requires specific motor and physical abilities. Kruger (2006) indicates that aerobic endurance, strength and speed endurance, flexibility, maximal strength, speed, reaction time and good running technique are important motor and physical attributes that a sprinter must possess in order to be successful.

Several studies have already reported results on the relationship between certain anthropometrical, physical, physiological and motor characteristics and performance in different sporting codes such as track and field (Thomas *et al*., 1983; Mero *et al*., 1990; Onyewadume *et al*., 2004; Uth, 2005; Paruzel-Dyja *et al*., 2006; Vučetić *et al*., 2008; Abraham, 2010; Habibi *et al.*, 2010; Pilianidis & Mantzouranis, 2011), rugby league (Gabbett *et al*., 2009), football, baseball and lacrosse (Nesser *et al*., 1996), handball (Mohamed *et al*., 2009), tennis (Sánchez-Muñoz *et al*., 2007), Australian rules football (Keogh, 1999), field hockey (Keogh *et al*., 2003), rowers (Mikulić, 2008) and volleyball players (Gabbett *et al*., 2007). In addition to anthropometrical, biomechanical, physical, physiological and motor characteristics, psychological indicators may also be important in discriminating between successful and less successful athletes (Krane & Williams, 2010).

Several studies report that psychological skills can distinguish elite athletes from non-elite athletes. Grossarth-Maticek *et al*. (1990) found psychological skills as performance determinants in football and boxing. Elite rodeo riders outscored non-elite riders on psychological skills such as motivation, confidence, anxiety control and concentration (Meyers *et al*., 1996). In track and field events, Cox *et al*. (2010) found elite athletes outscored their collegiate level counterparts on confidence and anxiety control. Despite the importance of psychological skills in sport performance as reported in these studies, only one study could be traced regarding the psychological characteristics of sprinters. Thomas *et al*. (1983) found that anxiety and extraversion-introversion were important performance predictors of sprinters in

their study of national class athletes. No studies, however, could be traced on the psychological make-up of adolescent athletes with potential for sprinting.

It is clear from the literature that distinctions can be made between athletes of different levels of sport participation based on specific anthropometrical, physical, motor and sport

psychological attributes. A multidimensional sport talent profile, which includes anthropometrical, physical, technical and psychological characteristics of successful athletes in a certain sport might be useful in different ways. If specific anthropometrical, physical, technical and psychological characteristics can be determined, these characteristics might be used as a guideline in the composition of training programmes and even for selection purposes. Only one study regarding talent prediction in athletics on adolescents could be traced (Headly, 2000). Although an extensive study, it also has specific shortcomings. The talent identification determinants that were identified within the study were not specific to the different events in athletics and no psychological measurements were included in die testing protocol.

PURPOSE OF THE STUDY

The purpose of this study was to determine if anthropometrical, physical, motor and sport psychological differences exist between a group of male adolescents who show talent for sprinting and their less talented counterparts. The results can make a significant contribution to the field of Sport Science in assisting coaches, sport scientists as well as sport psychological consultants in the composition of holistic sport specific training programmes for male adolescent sprinters. The results can furthermore be used in identifying potentially talented sprinters and might contribute to the development of well-rounded sprinters in the learning to train phase of the Long-Term Athlete Development program (LTAD) (Vardhan *et al*., 2012).

METHODOLOGY

Research design

A cross-sectional research design was used on a selected group of school children. The data was collected by means of anthropometrical, physical and motor tests, as well as a sport psychological questionnaire. This project was part of a larger three-year longitudinal study. Only the data of the baseline measurements were used for the purpose of this study. Ethical approval (NWU-00142-11-A1) for the study was obtained from the Ethics Committee of the North-West University (NWU).

Subjects

Grade 8 boys (N=89), with a mean age of 13.25 (SD±0.46) years, from a high school in Potchefstroom in the North-West Province, who consented to participate in the study, were recruited to participate in the study. They were subjected to a general talent identification (TID) protocol and they completed a sport psychological questionnaire. Although only 1 school was part of the study, the learners represent children who came from 46 different primary schools in the surrounding area. The result of the 40m sprint test, which is normally used by coaches to predict sprinting time in the 100m, was used to categorize the subjects into 2 groups. The subjects whose performance was in the top 10% were assigned to the talented group (TG) (N=8,

mean age=13.79), and the remaining subjects were assigned to the less talented group (LTG) (N=72, mean age=13.55). According to Australian norms for 13-year-old boys, 5.87 seconds on a 40m sprint test placed the talented group above the 95th percentile for the

speed test. Nine boys did not complete the speed test and, therefore, their results had been omitted from further analysis.

Test procedure

Administration of testing

The testing was done over 2 consecutive days during school hours. Because the learners were under age, informed consent forms had to be completed by their parents. All the learners were informed of the purpose and nature of the research study. They were ensured of the confidentiality of their results and were told that the data would only be used for the research project. Any participant had the right to withdraw from the research project at any time.

Demographic and general information questionnaire

A questionnaire in which learners had to provide information with regard to the following was administered during the testing period:

- Name of the learner, date of birth, gender and ethnic group;
- General level of physical activity over the past three months;
- How does his physical activity compare with those of his friends;
- Involvement in organised sport and/or training programme during the past six months;
- Involvement in general physical activities during the past six months;
- Opinion on whether he was as physically active as he should have been;
- What did he do during the past month;
- If he was not active enough, what might the possible reasons be;
- What type of transport he uses to get to school;
- What type of sport/s is he currently participating in;
- His best performance in sport in the year of testing (2010); and
- His three favourite sports.

Measuring instruments

The protocol used for the purpose of this study was based on an existing Australian Talent Search for the identification of sport talent among children 12 years and older (Australian Sports Commission, 1995). This protocol consists of 11 tests consisting of 4 anthropometrical and 7 physical and motor abilities. Cricket ball throw was added to the existing talent search protocol. The anthropometrical measurements included stature, body mass, relative sitting height and arm span and were measured using standard measuring procedures as described in the Australian manual (Australian Sports Commission, 1995). All measurements were taken by International Society for the Advancement of Kinanthropometry (ISAK) Level 2 accredited anthropometrists. The physical and motor tests that were used included the basketball throw, throw and catch test, cricket ball throw, vertical jump test, 40m sprint, 5m agility and the bleep test (Australian Sports Commission, 1995). Following a brief description of the tests:

Basketball throw: The subject had to sit with the buttocks, back and head against a wall with their legs on the floor in front of the body. A 2-handed chest pass is used to push the ball in a

horizontal direction as far as possible, while the back stays against the wall. The better of 2 attempts were recorded.

Throw and catch test: This test consists of a total of 20 underhand throws with a tennis ball which have to hit a round target with a diameter of 30cm against a wall, which is placed 2.5m from the starting line. The first 10 throws are executed with the dominant hand, while catching the ball with the dominant hand where after the second 10 throws is executed with the dominant hand, while catching with the non-dominant hand.

Cricket ball throw: The subject threw the cricket ball over arm with the preferred hand as far as possible. A 20m run up was allowed and the subject had to throw the ball without running over the line. The better of 2 attempts were recorded.

Vertical jump test: The subject stands with the preferred side nearest to the wall and reaches upwards with the inside arm as high as possible while the feet stay flat on the ground. After recording the distance of the reach height, the subject is instructed to jump as high as possible, touching the wall with the inside arm. Performance in the vertical jump test is determined by subtracting the jumping height from the reaching height. The better of 2 attempts were recorded in centimetres.

40m-Sprint test: Speed lights (Brower Timing Systems, Utah, USA) were set up on the 0, 10 and 40m marks. The subject had to be in a stationary position before the start. The subject should have to run as fast as possible through the last gate. The better of 2 attempts were recorded.

5m-Agility test: The test consists of 2 markers that are placed 5m apart. The subject had to complete 5 consecutive runs between the 2 markers as fast as possible. The best time of 2 attempts were recorded in seconds.

Bleep test: This test is an aerobic endurance test measured over a distance of 20m. It is a multi- stage shuttle run with a progressive increase in pace. Performance in the bleep test is expressed as the number of shuttles and levels completed.

Sport psychological skills profile

The Athletic Copings Skills Inventory (ACSI-28), developed by Smith *et al*. (1995) was used to determine the learners' sport psychological skills profile. The ACSI-28 questionnaire is divided into 7 subscales and has a total of 28 questions. This questionnaire determines a person's ability to cope with adversity, peaking under pressure, goal setting/mental preparation, concentration, freedom from worry, confidence and achievement motivation and the person's coachability. Each of the 7 subscales consists of 4 items measured on a 4-point Likert scale ranging from 0 (almost never) to 3 (almost always). In some cases, reverse scoring applies. The test-retest reliability of the ACSI-28 yielded a mean stability of r=0.84 (Smith *et al*., 1995). A sport psychological consultant was present for the duration of completing the questionnaire to answer any questions or to explain unfamiliar terminology to the pupils.

Data analysis

The Statistical Consultation Services of the NWU determined the statistical procedures for this study, which were performed using SPSS for Windows (version 17). The validity and reliability of the psychological scales for the specific sample was determined by means of factor analysis and the Cronbach alpha's coefficient. An analysis of covariance (ANCOVA)

test was applied with stature as the covariate to adjust for variations in growth status between the 2 groups. Boys were in an accelerated growth phase between 12 and 14 years. Therefore, stature was used as a covariate. The practical significance of differences between the 2 groups was determined by means of effect sizes (ES) (0.3 is seen as small, 0.5 as medium and 0.8 as large). The level of significance was set at $p \leq 0.05$.

RESULTS

Table 1 serves as a descriptive table for the talented and less talented potential sprinters regarding their age, 40m sprinting time, mean physical activity, participation in organized sports, as well as their best performance in their main sport.

Table 1. **DESCRIPTIVE INFORMATION OF TALENTED AND LESS TALENTED GROUPS**

Variables	**Talented group** (n=8)	**Less talented group** (n=72)
Age (years)	13.79	13.55
40m sprinting time (seconds)	5.87	6.73
Mean physical activity	4.58	3.84
Participated in organised sport for last 6 months	1.15	1.00

Activity level: 1=Inactive 2=Not very active 3=Moderately active 4=Active 5=Very active

The adjusted mean with stature as covariate, MSE, statistical and practical significance for both groups of the anthropometrical, physical and motor test variables are presented in Table 2.

Table 2. **ANCOVA RESULTS WITH STATURE AS COVARIATE: DIFFERENCES BETWEEN TALENTED AND LESS-TALENTED SPRINTERS FOR ANTHROPOMETRICAL, PHYSICAL AND MOTOR VARIABLES**

Test variables	**Adjusted mean**		**MSE**	**p-Value**	**Effect size (ES)**
	TG	**LTG**			
Body mass (kg)	55.22	55.98	104.36	0.846	0.07
(n)	(8)	(72)			
Sitting height (cm)	123.49	121.87	4.25	0.143	0.27
(n)	(8)	(72)			
Arm span (cm)	165.81	165.98	17.97	0.914	0.04
(n)	(8)	(72)			
Basketball throw (m)	6.83	6.04	0.39	0.003*	1.27***
(n)	(7)	(72)			

*Table 2. **(continued)***

Test variables	**Adjusted mean**		**MSE**	**p-Value**	**Effect size (ES)**
	TG	**LTG**			
Cricket ball throw (m)	52.79	40.43	67.16	0.723	0.42
(n)	(8)	(71)			
Throw and catch	10.67	8.68	12.20	0.138	0.57
(n)	(8)	(72)			

Vertical jump (cm)	42.70	33.10	42.69	0.000*	1.47***
(n)	(8)	(72)			
Agility (sec)	18.38	19.63	1.87	0.019*	0.91***
(n)	(8)	(72)			
Speed (0-10m) (sec)	1.89	2.09	0.02	0.000*	1.41***
(n)	(8)	(72)			
Beep (level)	8.71	6.70	3.72	0.008*	1.04***
(n)	(8)	(66)			

LTG=less talented group; TG=talented group ∗ p≤0.05 *=small ES **=medium ES ***=large ES

The results of the ANCOVA revealed that the potentially talented sprinters outperformed the less talented sprinters statistically and practically significantly in the basketball throw, vertical jump, 0-10m speed, agility and aerobic endurance. However, no differences were found between the groups regarding the anthropometric characteristics. The adjusted mean and MSE for both groups for the sport psychological variables are displayed in Table 3.

Table 3. **ANCOVA WITH STATURE AS COVARIATE: DIFFERENCES BETWEEN TALENTED AND LESS TALENTED SPRINTERS FOR PSYCHOLOGICAL VARIABLES**

Test variable	**Adjusted mean (%)** TG (n=8)	LTG (n=72)	**MSE**	**p-Value**	**Effect size (ES)**
Coping with adversity	72.56	63.00	331.21	0.172	0.53
Peaking under pressure	58.61	56.68	594.01	0.836	0.08
Goal setting/Mental prep.	70.66	54.88	448.61	0.054*	0.75***
Concentration	69.70	66.21	290.07	0.593	0.20
Freedom from worry	48.74	53.84	365.77	0.485	0.27
Confidence & motivation	85.33	74.32	301.75	0.100	0.63
Coachability	76.18	71.74	187.62	0.398	0.32
Average coping ability	68.83	62.96	131.42	0.183	0.51

LTG=less talented group; TG=talented group ∗ p≤0.05 *=small ES **=medium ES ***=large ES

The ANCOVA revealed that the potentially talented sprinters significantly outperformed the less talented sprinters in goal setting. Although not statistically significant, a trend was apparent that the potentially talented sprinters had higher mean percentages in all the other subscales of the ACSI-28 (coping with adversity, peaking under pressure, concentration, self-confidence,

coachability and the overall score for coping ability). They also showed a lower percentage in the freedom from worry subscale.

DISCUSSION

The purpose of this study was to determine if possible motor, physical and sport psychological differences exist between male adolescents who show talent for sprinting and their less talented counterparts. The study indicated significant differences with the potentially talented sprinters, which obtained statistical significantly better scores in upper

and lower body explosive power (basketball throw and vertical jump), acceleration (0-10m speed), maximal speed (0-40m speed), aerobic endurance (beep test) and in goal setting.

Various researchers reported that a powerful angular drive of the arms would assist forward drive during the starting phase of the sprint (Cherry, 1982; Schnier, 1982; Embling, 1984; Korchemny, 1992). The talented group in this study significantly outscored the less talented group in explosive upper body power (as determined by the basketball throw), and in arm speed (as determined by the cricket ball throw). It is assumed that this higher explosive upper body power will contribute to a more vigorous arm drive during the sprint start and subsequently enhance performance in the 100m sprinting.

Sprinting further requires high anaerobic capacity (Amusa & Toriola, 2003). The ability of an athlete to cover a distance in the shortest possible time is dependent on explosive power of the muscles (Amusa & Toriola, 2003). The potentially talented sprinters outscored their less talented counterparts significantly with regards to explosive leg power as measured by the vertical jump test. These results agree with other researchers who also regard explosive leg power as an important factor in sprinting (Meckel *et al*., 1995; Young *et al*., 1995; Morin & Belli, 2003).

Furthermore, potentially talented sprinters significantly outscored their less talented counterparts in the agility test. According to Kukolj *et al*. (1999:121), "sprinting is generally considered as a dynamic movement requiring high muscle power". Seeing that agility is also regarded as a dynamic movement requiring high muscle power, it can be assumed that sprinting and agility performance could be closely related (Sporiš *et al*., 2010). Few studies, however, examined the relationship between sprinting ability and agility performance (Paoule *et al*., 2002; Little & Williams, 2005). Paoule *et al*. (2002) reported a high correlation between agility and sprinting performance (r=0.73) in a group of college-aged women. Vescovi and McGuigan (2008) concur that a moderate correlation (r=0.55) exists between agility and sprinting among a group of high school soccer players. In addition, Jarvis *et al*. (2009) also found significant correlations between 40m linear sprint running and the Illinois agility run among forwards (r=0.68) and backs (r=0.81) in sub-elite rugby union players. From the results of the current study and the abovementioned literature, it could be assumed that implementing agility training into a sprinters' training program design would be advantageous in improving linear sprint performance.

Rapid acceleration is important in the starting phase of the sprint (Mero *et al*., 1990). Nesser *et al*. (1996) found that the faster an athlete can accelerate, the faster that athlete will be able to reach maximal speed. Their findings substantiate the importance of rapid acceleration needed

for better sprint performance, which is in agreement with the results of the current study. Agility depends on speed, balance and coordination and will consequently also contribute to a better controlled acceleration phase.

The current results further indicate that the potentially talented sprinters achieved a significantly better score in the bleep test, which is an indirect test of aerobic capacity, in comparison to their less talented counterparts. The relative aerobic-anaerobic energy system contribution for 100m track events is determined as 21-79% respectively (Duffield *et al*., 2004). Therefore, it can be assumed that the better the aerobic energy system, the better

the performance in the 100m sprint.

Only one sport psychological skill, namely goal setting, made a distinction between the potentially talented and less talented sprinters. Goal setting is regarded as an important sport psychological skill that influence the performance of participants with a positive effect on confidence, motivation and anxiety control independent of the participants' age and skill level (Cox, 2007; Leuens, 2008; Gould, 2010). Various previous studies reported that successful athletes are significantly better in goal setting than their less successful counterparts, which support the results of the current study (Katsikas *et al*., 2009; Cox *et al*., 2010; Weinberg & Gould, 2015). Although not statistically significant, trends were, however, also observed in all the other sport psychological variables of higher mean values among the talented group.

CONCLUSION AND RECOMMENDATIONS

A comparison of motor, physical and sport psychological attributes of potentially talented adolescent sprinters and their less talented counterparts revealed that upper and lower body explosive power, acceleration, maximal speed, aerobic endurance and goal setting showed significant distinction ability between the two groups. These differences suggest that various motor, physical and sport psychological variables can be used to identify potentially talented sprinters during adolescence.

These results are potentially useful in the identification of young talented adolescents who show promise to become a possible sprinter, and to develop their talent by means of development programmes. The variables of the general TID model can be used in this regard (excluding the throw and catch test). Although the psychological variables showed less distinction ability at this young age, clear trends were observed of distinct ability. The distinct ability of psychological variables might become stronger over time. However, more research is needed and especially longitudinal studies to determine the possible growing importance of these variables in TID programmes. It is recommended that psychological variables should be part of the development programmes of talented adolescents in order to prepare their minds to be ready for the different challenges that sport on a high level pose to an athlete.

However, the results of the present study must be interpreted with caution since the participants were a selected group of learners from one geographical area in Potchefstroom, South Africa. Hence generalisations of the results to other potentially talented sprinters might not be accurate.

Further studies in this area of talent identification on potentially talented sprinters are needed to identify the motor, physical and sport psychological variables, which can be used in a holistic

talent identification program. Inclusion of a much larger sample size of athletes from different geographical areas is also an important aspect to keep in mind for future research.

The results of this study can make a significant contribution to the field of Sport Science in assisting coaches, sport scientists, as well as sport psychological consultants in the composition of a holistic sport specific training programmes for adolescent sprinters. The

results can also be used in identifying potentially talented adolescent sprinters and might contribute to the development of well-rounded sprinters in the learn-to-train phase of the LTAD (Vardhan *et al*., 2012).

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Dr Ankebé KRUGER: Physical Activity, Sport and Recreation Research Focus Area, North-West University, Private Bag X6001, Potchefstroom 2520, Republic of South Africa. Tel.: +27 (0)18 299 1793, Fax.: +27 (0)18 299 2022, Email: Ankebe.Kruger@nwu.ac.za

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EXPLORING DIRECTION BETWEEN COHESION AND COLLECTIVE EFFICACY AND RELATIONSHIPS WITH PERFORMANCE OF FOOTBALL TEAMS

Francisco M. LEO[1], Inmaculada GONZÁLEZ-PONCE[2], David SÁNCHEZ- OLIVA[2], Diana AMADO[2] & Tomás GARCÍA-CALVO[2]
[1] *Department of Didactics of Musical, Plastic and Corporal Expression, Faculty of Teacher Training, University of Extremadura, Caceres, Spain*
[2] *Department of Didactics of Musical, Plastic and Corporal Expression, Faculty of Sport Sciences, University of Extremadura, Caceres, Spain*

ABSTRACT

The direction between cohesion and collective efficacy measured at the beginning and the end of a season and their association with team performance as measured by final classification was examined. The sample comprised 146 soccer players, aged between 15 and 18 years (mean=16.96±0.76). The Spanish version of the Group Environment Questionnaire (GEQ) and the Football Collective Efficacy Questionnaire (FCEQ) were used to assess cohesion and collective efficacy. Performance was evaluated by the average between final position in the classification table and satisfaction with team performance perceived by the players. Results showed that in the first six months of competition, team cohesion had greater power to predict collective efficacy at the end of the league. However, collective efficacy did not predict team cohesion significantly. Collective efficacy was more closely related to team performance than group cohesion by the end of the season. It was concluded that during pre-season and at the start of the season, team sport coaches should focus on social and task aspects, both individually and at a group level. This would improve the perception of collective team efficacy and lead to better team performance.

Key words: Cohesion; Collective efficacy; Direction; Performance; Football teams.

INTRODUCTION

One of the main objectives in team sport is to optimise the resources of the group and to maximise the performance of the team. In this area, several studies have been carried out in the field of Social Psychology, where group processes, such as cohesion or collective efficacy play an important role due to the close relationship with performance (Carron *et al*., 2002b; Myers *et al*., 2004; Heuzé *et al*., 2006; Leo *et al*., 2010b).

With respect to group processes, Carron and Eys (2012) suggested that there is a reciprocal relationship which helps the functioning of the team. It is not known exactly when during the season, teams deal with cohesion and efficacy, but research has indicated that both variables do play a role in performance. Thus, it is necessary to investigate the role of both these variables, especially since little is known about the interaction between them (Heuzé *et al*., 2007). When a literature review was conducted, only studies which examined the relationship

between both variables or the predictive capacity in one direction, were found (Spink, 1990; Paskevich *et al*., 1999; Heuzé *et al*., 2006; Leo *et al*., 2010a). Thus, the directionality of the relationship between these variables might help to provide relevant information to develop practical interventions in professional sport.

Team cohesion has been defined as "a dynamic process that is reflected in the tendency for a group to stick together and remain united in the pursuit of its instrumental objectives and/or for the satisfaction of member affective needs" (Carron *et al*., 1998:213). This definition aligns with Carron's model (Carron *et al*., 1985; Carron & Eys, 2012), which proposes that team members hold (a) collective beliefs about the group as a unit in terms of its closeness, resemblance and affinity (GI - group integration), and (b) individual beliefs regarding the degree to which the group attracts them, thereby satisfying their needs and personal goals (ATG

- individual attraction to the group).

Each of these classes of beliefs is further divided into two categories, depending on whether they revolve around task-related (T) or social (S) issues (Carron & Brawley, 2000; Carron & Eys, 2012). Thus, four aspects of team cohesion have been identified: *Group Integration-Task* (GI-T) and *Group Integration-Social* (GI-S) which reflect, respectively, members' beliefs about the degree to which the group is united to reach its objectives and to have its members socialising; and *Individual Attraction to the Group-Task* (ATG-T) and *Individual Attraction to the Group-Social* (ATG-S), which reflect members' judgments about the degree to which the group is attractive for its objectives and social relationships, respectively.

Collective efficacy, understood as "a group's shared beliefs in its capacities to organise and execute actions to produce a desired goal" (Bandura, 1997:476), is conditioned by a series of antecedents that strongly affect the perception of the players, among which is group cohesion (Spink, 1990; Paskevich *et al*., 1999; Heuzé *et al*., 2006; Leo *et al*., 2010a). Likewise, these antecedents will create a specific perception of collective efficacy in the team, which will lead to a series of cognitive, affective and behavioural consequences, among which is performance (Bandura, 1997; Feltz & Lirgg, 1998; Beauchamp, 2007; Leo *et al*., 2010a).

Regarding the relationship between cohesion and collective efficacy, cohesion has been considered as an antecedent of collective efficacy (Bandura, 1997; Kozub & McDonnell, 2000; Leo *et al*., 2010a). In fact, investigations have reported that players who perceive greater team cohesion develop stronger perceptions of collective efficacy (Heuzé *et al*., 2006; Leo *et al*., 2010a). Specifically, several studies found that some aspects of task cohesion are more closely related to the perception of collective efficacy (Paskevich *et al*., 1999; Kozub & McDonnell, 2000; Ramzaninezhad *et al*., 2009; Leo *et al*., 2014), whereas other studies established no differences between social cohesion and task cohesion in the relationship between cohesion and collective efficacy (Spink, 1990; Heuzé *et al*., 2006; Leo *et al*., 2010a). One reason for this disparity may be that the diverse studies used different participants because either the research was carried out with professional or young teams, or they used different types of sport, such as volleyball, handball, basketball or rugby.

Some authors argued that cohesion is both an antecedent and a consequence of collective efficacy (Zaccaro *et al*., 1995; Heuzé *et al*., 2007). Zaccaro *et al*. (1995) suggested that the relationship between cohesion and collective efficacy is reciprocal, and that in order to

understand the relationships between these variables, it may be necessary to differentiate between the types of cohesion considered antecedents or consequences of perceived efficacy. When cohesion is an antecedent, certain associated positive changes should enhance group performance and promote higher levels of collective efficacy (Bandura, 1997; Kozub & McDonnell, 2000; Leo *et al*., 2010a). When it is a consequence, stronger perceptions of collective efficacy should increase the desire to stick together, thereby increasing group cohesion (Zaccaro *et al*., 1995; Heuzé *et al*., 2007).

In this regard, Heuzé *et al*. (2007) hypothesised, taking into account the suggestions of Zaccaro *et al*. (1995), that depending on the type of cohesion could be an antecedent or a

consequence, that Individual Attraction to the Group-Task might be an antecedent of collective efficacy, whereas Group Integration (both Task and Social) would be considered a consequence of efficacy. In their design, they controlled group performance because it may affect players' perceptions of cohesion and collective efficacy (Feltz & Lirgg, 1998; Watson *et al*., 2001; Myers *et al*., 2004; Heuzé *et al*., 2006). They found that collective efficacy measured at the beginning of the season predicted changes in Individual Attraction to the Group-Task throughout the league. Despite this fact, as was indicated by authors (Heuzé *et al*., 2007), the research had some limitations (low number of participants, deleting the ATG-S factor and measurement of the performance only by table classification) which suggested proposing new studies that attempt to reaffirm the relationship between both variables.

With respect to the relationship between psychological variables and performance in team sport, one of the first difficulties that researchers found when examining it, was the way to assess performance itself. Normally, objective criteria of the sport, such as statistics, victories and defeats, or a classification table (Heuzé *et al*., 2006; Dithurbide *et al*., 2009) have been used. Overall, most of the studies have found a positive association (Heuzé *et al*., 2006; Ramzaninezhad *et al*., 2009; Leo *et al*., 2010a). This aspect may be the key discriminator when examining the causality direction between these variables. A positive relationship between team cohesion and performance has been found previously (Carron *et al*., 2002a; Carron *et al*., 2002b; Beal *et al*., 2003), as well as between collective efficacy and performance (Feltz & Lirgg, 1998; Myers *et al*., 2004; Myers *et al*., 2007; Leo *et al*., 2014).

When performance is measured objectively, as is the case in some closer sports, such as basketball, handball, volleyball or hockey (Kozub & McDonnell, 2000; Heuzé *et al*., 2006), the measurement can be effective. On the other hand, in more open sports, such as football, performance measurement is more complex and wrong results might be obtained (Myers *et al*., 2004). To reduce these limitations, it would be interesting to use objective (classification table) and subjective assessments (satisfaction with team performance), together (Carron *et al*., 2002b; Dithurbide *et al*., 2009), to ensure that the measured performance is the real performance (Dithurbide *et al*., 2009). In this sense, satisfaction with team performance could be a subjective measure of team performance over the season. If players perceive high satisfaction with team performance, it will mean that this performance has been high and vice versa (Balaguer *et al*., 2002).

PURPOSE OF THE STUDY

In view of the prior comments, the aim of this study was to determine the direction of the relationship between cohesion and collective efficacy, and their effect on team performance, through a structural equation modelling. This allows for using more than one dependent variable, and the same variable can be dependent or independent at the same time. In this study, these variables are cohesion, collective efficacy and performance. Thus, the chief aim of this study was to determine the direction between cohesion and collective efficacy, measured at the beginning and at the end of the season, and their relationship with team performance. Thus, two longitudinal models will be generated to examine the relationships between cohesion and collective efficacy and their influence on performance in team sports.

METHOD

Participants

The sample comprised 146 male soccer players. Players belonged to 15 federative teams that played in the XI group of the National League in the sub-18 category, aged between 15 and 18 years (mean=16.96±0.76). With the selection of participants, intentional sampling was used in which all the teams of the competition participated in the study. With regard to playing position, the recruited players were 15 goalkeepers, 50 defenders, 50 midfielders, and 31 strikers. The players had a mean previous soccer experience of 9.79±2.64 years.

Instruments

Group Environment Questionnaire (GEQ)

The Spanish version of the GEQ developed by Iturbide *et al*. (2010) was used to assess team cohesion. This inventory of 18-items comprises 4 factors: Group Integration-Task (team members are united in their efforts to reach their performance goals in training sessions and matches); Group Integration-Social (team members would like to spend time together in situations other than training and games); Individual Attraction to the Group-Task ("on this team, I can do my best"); and Individual Attraction to the Group-Social ("the team is one of the most important social groups I belong to"). Responses were rated on a 5-point scale ranging from *strongly disagree* (1) to *strongly agree* (5). A confirmatory factor analysis (CFA), with the data being collected at the beginning of the season, showed acceptable model fit (χ^2/df=1.70; CFI=0.93; IFI=0.93; RMSEA=0.06; SRMR=0.05). The CFA with data from the
end of the season revealed similar values to those obtained at the beginning of the season in all instruments (χ^2/df=3.40; CFI=0.94; IFI=0.94; RMSEA=0.06; SRMR=0.04). This study examined internal consistency through Cronbach's alpha, obtaining values at both measurements (at the start and the end of the season) of 0.73 and 0.76 for Group Integration- Task, 0.77 and 0.74 for Individual Attraction to the Group-Task, 0.71 and 0.73 for Group Integration-Social, and 0.74 and 0.75 for Individual Attraction to the Group-Social.

Collective efficacy

To assess collective efficacy, the "Cuestionario de Eficacia Colectiva en Fútbol" (CECF; in English, The Football Collective Efficacy Questionnaire [FCEQ]), developed by Leo *et al.* (2011) was used. This instrument starts with a stem phrase ("Our team's confidence in our

capability to…") and has a total of 26 items that refer to some offensive (13 items, such as keeping ball possession in the face of rival pressure), and defensive soccer situations (13 items, such as …to defend set piece ball situations). Responses were rated on a 5-point scale ranging from *bad* (1) to *excellent* (5). The CFA results with data taken at the beginning of the season confirmed an acceptable model fit (χ^2/df=2.73; CFI=0.90; IFI=0.91; RMSEA=0.06; SRMR=0.05), where all 26 items were grouped into a single factor. The CFA with data of the end of the season revealed similar values to those obtained at the beginning of the season in all instruments (χ^2/df=4.53; CFI=0.90; IFI=0.91; RMSEA=0.06; SRMR=0.04). Internal consistency values in both measurements were acceptable (0.73 and 0.82, respectively).

Performance

There is a general awareness about the difficulty of measuring team performance in collective sports. To date, there is no standardised performance measurement in sport, such as football. Most of the studies have used table classification or statistics (Carron *et al*., 2002b; Heuzé *et al*., 2006), without taking into account subjective measures. For example, teams may finish the season at the mid-point of the classification, but if their objectives were higher at the beginning of the season, the final classification would be very poor and the satisfaction low. However, if their objectives were lower at the beginning of the season, the final classification would be very good and satisfaction with the team is high.

With the aim to measure team performance in this study, an approach to the real team performance through satisfaction with team performance was attempted. The average was calculated between the final classification and satisfaction with team performance obtained in the league. To assess each team's final classification, the final position in the classification table at the end of the regular season was used. The data was reversed so that higher classification values (1, 2, 3, etc.) would correspond to higher scores (16, 15, 14, etc.). To assess satisfaction with team performance, a single item was used that asked the players whether they were satisfied with the team classification at the end of the season. Responses were rated on a 5-point scale ranging *not at all* (1) to *very much* (5). In this sense, the average between final position and satisfaction with team performance can reflect their real performance.

Procedure

This study received ethical approval from the University of Extremadura. The study followed the American Psychological Association ethics guidelines regarding consent, confidentiality and anonymity of responses. A correlation methodology with a longitudinal design to study the evolution of group processes was used. Two assessments at 2 different times were developed, analysing a sub-sample or specific group over a long time interval. Measurements were taken at the beginning and at the end of the season, with a difference of 20 to 22 weeks to ensure that enough time had passed, as the levels of cohesion and collective efficacy could vary.

The first set of data was collected during the first third of the competition over a 3-week period to ensure that the teams played in several official games and that team members would have had sufficient opportunities to interact and to develop both cohesion and collective efficacy beliefs. The second set of data was collected in the last third of the season over a 3-week period, following the same guidelines as in the first data collection. For the second assessment, the last third of the season was chosen, because team participation in a study is more problematic at

the end of the season. If a measurement is made just at the end of season, head coaches would not want to participate, because, in the last weeks of competition, game results are increasingly important for teams' goals, and teams often refuse to participate.

Only the players who completed the questionnaires at both the assessment times comprised the study sample. Players who either did not complete both measurements, due to injuries, illness, or studies, or who played on different teams due to a possible change during the season, were excluded. Of the 235 players who completed the first measurement, only 146

completed the second measurement. The latter comprised the final sample.

The main investigator contacted all the coaches from the juvenile teams of the National Team of Extremadura (Spain) to request permission to include their teams in the study. They were informed about the goals and procedures of the study. The XI group of the National Juvenile League was made up of 16 teams, and 15 of them agreed to collaborate. Participants were requested to answer the questions as truthfully as possible and were reassured that their responses would be strictly confidential.

A protocol was developed to ensure the similarity of data collection at both assessments with the participants in the research. Participants completed the questionnaires in the changing room before the training session. This procedure took approximately 15 to 20 minutes. They completed the questionnaires individually, in the absence of their coach, in a calm atmosphere that ensured that they would not be distracted. A researcher was always present and encouraged the participants to ask questions if they had any doubts that needed to be clarified.

Data analysis

The PASW Statistics 18.0 program was used to analyse the data, establishing sequential stages to examine the relationships among the variables. Statistical techniques employed were factor analysis and reliability analysis to verify the adequacy of the factor structure and the reliability of the instruments, as well as descriptive analyses to observe the levels in the diverse variables at both measurements. AMOS 18.0 software was also used to test the structural equation models.

Data normality was examined, obtaining skewness values between -0.7 and 0.9, kurtosis values between -0.8 and 0.7, as well as normal scores in the Kolmogorov-Smirnov statistic ($d<0.70$, $p>0.05$). The tolerance index of the variables was between 0.81 and 1.00, and the variance inflation factor (VIF) index had values between 1.00 and 1.23, which indicated that the probability of an error due to co-linearity could be discarded.

RESULTS

Descriptive analysis

Table 1 presents the descriptive results of all the variables of the research. The means of the cohesion factors were higher both at the beginning and at the end of the season, because they were above the average values of the measurement scale. However, it is important to note that the cohesion factors with the highest scores at the first assessment (Group Integration-Social,

Individual Attraction to the Group-Task and Individual Attraction to the Group-Social), decreased at the second measurement, especially Group Integration-Social, which showed the greatest decrease. In contrast, Group Integration-Task, which had the lowest score of the cohesion factors at the first assessment, showed a slight increase at the second measurement. Regarding collective efficacy, the means at the beginning and at the end of the season were high. However, at the end of the season collective efficacy decreased moderately.

Table 1. **DESCRIPTIVE RESULTS**

Variables	**Measurement 1** Mean±SD	**Measurement 2** Mean±SD
Group Integration-Social [GI-S]	4.107±0.787	3.441±0.921
Group Integration-Task [GI-T]	3.614±0.813	3.936 ±0.731
Individual Attraction to Group-Social [ATG-S]	3.888±0.746	3.724±0.739
Individual Attraction to Group-Social [ATG-T]	3.902±0.837	3.868±0.772
Collective Efficacy [CE]	3.734±0.778	3.695±0.706

Structural Equation Model

In order to determine the prediction capacity of the variables of this study, structural equation modelling was used. This statistical programme has the advantage of including all the variables in the same regression model, similar to multiple regression, with the peculiarity that this model allows the use of more than one dependent variable, and the same variable can be dependent or independent at the same time. Hence, through this technique, a theoretical model could be tested and the direction of the relationships established between the diverse variables, as well as their predictive capacity at both measurements.

In order to accept or reject a model, the most appropriate method is to use a combination of various fit indexes, as there is not consensus among researchers about which is the best index for this kind of analysis (Hoyle & Panter, 1995). Taking into account the contributions of some authors (Bentler, 1990; Bollen & Long, 1993), in this study, the following fit indexes were used: chi-square divided by degrees of freedom; the Comparative Fit Index (CFI); the Incremental Fit Index (IFI); the Tucker Lewis Index (TLI); the Root Mean Square Error of Approximation (RMSEA); and Akaike's Information Criterion (AIC). As chi-square is very sensitive to sample size (Jöreskog & Sörbom, 1996), the ratio between chi-square and the degrees of freedom (χ^2/df), which is considered acceptable when it is lower than 5 (Bentler, 1989). According to Schumacker and Lomax (1996), the incremental indexes (CFI and TLI) indicate acceptable fit when they obtain values of 0.90 or higher. Regarding the RMSEA, 0.06 has been established as an acceptable cut-off point (Hu & Bentler, 1999). AIC is one of the more popular methods to compare multiple models, taking both descriptive accuracy and parsimony into account. With lower scores indicating the best fit of the model, AIC is often

used as a measure of model adequacy in structural equation modelling (Jöreskog & Sörbom, 1996).

In the structural equation model, two of the most important psychological constructs related to group dynamics were integrated: group cohesion; and collective efficacy. Thus, to analyse the effect of the direction of causality of these variables on each other, two models were tested, using one of the variables in each model as a dependent variable. One of the variables measured at the beginning of the league as the predictor variable was entered, and

the other variable assessed at the end of the season as the dependent variable. Thus, two models were used to determine which variable had more impact on the other variable at the end of the league. In Model 1, cohesion measured at the first assessment was computed as the predictor and collective efficacy at the second measurement as a dependent variable. In Model 2, collective efficacy at the first assessment was used as the predictor and cohesion at the end of the season as a dependent variable. In addition, in both models, final performance was also entered as a dependent variable of these factors, in order to verify which one of them – cohesion or collective efficacy – better predicted performance.

It is important to note that different cohesion factors are formed by latent variables through items or random group of items that make up each factor, and collective efficacy is a latent variable comprised of two groups of items, referring to attack and defence aspects. The use of these parcels or group of items gives advantages by obtaining of a parsimony model through the reduction of the parameters, the decrease of the probability of the correlation between residuals and the increase of reliability of indicators (Coffman & MacCallum, 2005). Lastly, performance is a latent variable made up of the table classification and satisfaction with the team performance.

As seen in Table 2, after analysing the structural equation models, the fit indexes of Model 1 were adequate, because they fell between the values considered acceptable for the goodness of fit of a structural equation model. The values of Model 2 were very poor. Therefore, Model 1, where cohesion at the beginning of the season was the predictor and collective efficacy at the end of the league was a dependent variable, was the only model that presented appropriate fit indexes.

Table 2. **FIT INDEXES OF STRUCTURAL EQUATION MODELS**

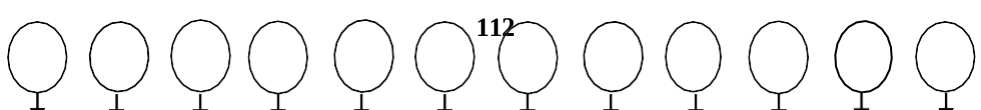
	Variables					
Models	χ^2	χ^2/df	CFI	TLI	AIC	RMSEA
Model 1	126.952	1.365	0.934	0.914	212.952	0.050
Model 2	186.041	1.938	0.796	0.745	266.041	0.080

CFI=Comparative Fit Index TLI=Tucker Lewis Index AIC=Akaike's Information Criterion RMSEA=Root Mean Square Error of Approximation

Model 1 had a higher prediction index for the dependent variables (collective efficacy and performance) than Model 2. Thus, Figure 1 shows that group cohesion at the beginning of the

league positively predicted collective efficacy at the end of the season, and this latter variable, in turn, predicted final performance at the end of the league.

More specifically, Group Integration-Social and Individual Attraction to the Group-Task emerged as the strongest predictors of collective efficacy, explaining 16% of the variance. The other two cohesion factors, Group Integration-Task and Individual Attraction to the Group- Social showed no significant predictive capacity. Furthermore, collective efficacy measured at the end of the league positively predicted the players' performance in the final classification.



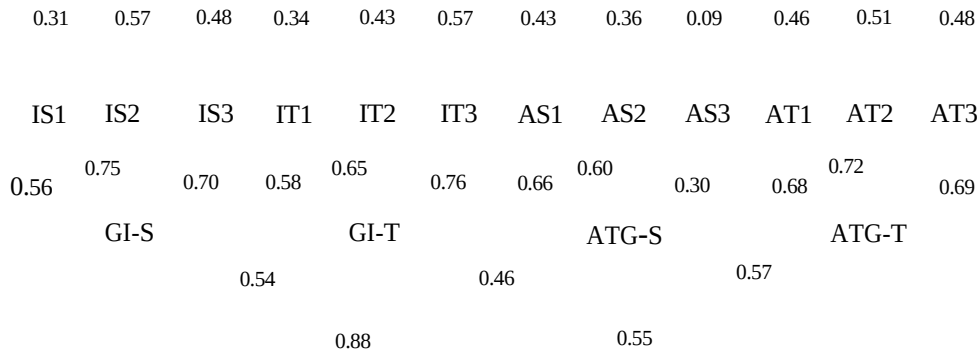


Figure 1. **STRUCTURAL EQUATION MODEL: RELATIONSHIPS AMONG COHESION FACTORS, COLLECTIVE EFFICACY AND PERFORMANCE**

GI-S=Group Integration-Social; GI-T=Group Integration-Task; ATG-S=Individual Attraction to Group-Social; ATG-T=Individual Attraction to the Group-Task; CEA=Collective Efficacy in Attack; CED=Collective Efficacy in Defence; CL=Classification; STP=Satisfaction with Team Performance.

DISCUSSION

The chief aim of this study was to determine the direction of causality between cohesion and collective efficacy measured at the beginning and at the end of the season and their relationship with team performance. Firstly, according to the results, the close relationship between cohesion and collective efficacy can be reaffirmed (Spink, 1990; Paskevich *et al*., 1999; Heuzé *et al*., 2006; Ramzaninezhad *et al*., 2009), although, in this case, team cohesion emerged as a better predictor of collective efficacy than vice versa. These outcomes are consistent with those of authors who consider group cohesion as an antecedent of collective efficacy. For example, in a study with professional rugby teams, Kozub and McDonnel (2000) postulated that players who perceived high task cohesion in their teams tended to show greater collective efficacy. Furthermore, Leo *et al*. (2010a) and

Leo *et al*. (2014) found in basketball players and football players that team cohesion was the strongest predictor of the perception of collective efficacy.

In this sense, after analysing the structural equation models, both task cohesion components (mainly Individual Attraction to the Group-Task) and, to a lesser extent, Group Integration-Task and the social cohesion component (only Group Integration-Social) significantly predicted collective efficacy at the end of the season. Previously, discrepant results have been found about the strength of the relation of cohesion dimensions with the perception of players of collective efficacy. Some investigations reported that task aspects were the most relevant (Paskevich *et al*., 1999; Kozub & McDonnell, 2000; Ramzaninezhad *et al*., 2009; Leo *et al*., 2014), and other authors (Spink, 1990; Heuzé *et al*., 2006; Leo *et al*., 2010a) found no differences between task and social aspects in this relationship.

The type of participants used in the study might be one of the reasons for these differences, because the use of semi-professionals or professional male players (Paskevich *et al*., 1999; Kozub & McDonnell, 2000; Ramzaninezhad *et al*., 2009; Leo *et al*., 2014), or male and female players together (Spink, 1990), can be a motive that influences in the variety in the results. It is probable that male participants orientated to performance give more importance to task cohesion, whereas other collectives, such as young and female participants give great relevance to social aspects. Moreover, the type of sport can be a distinguishing element, because despite of being a team sport (volleyball, handball, basketball or rugby), each of them has particular characteristics that might influence the results, such as number of team players, specialisation of the different positions, number of substitutions in games, and so forth.

In contrast, despite the fact that collective efficacy predicted team cohesion, the prediction indexes were very low and, therefore, the proposals of Zaccaro *et al*. (1995) and Heuzé *et al*. (2007) of cohesion as both an antecedent and a consequence of collective efficacy, do not support these outcomes. In the current study, both Group Integration-Social and Group Integration-Task, as well as Individual Attraction to the Group-Task had a high capacity to predict perceived collective efficacy at the end of the season (Leo *et al*., 2010a). According to the results, players who perceived higher team cohesion, both in group integration and individual attraction, at the beginning of the season also perceived greater collective efficacy in their teams at the end of the league (Heuzé *et al*., 2006; Leo *et al*., 2010a; Leo *et al*., 2014). The bi-directionality of the relationship between these constructs can promote a mutual prediction (Zaccaro *et al*., 1995; Paskevich *et al*., 1999; Carron & Eys, 2012), although most

of the studies suggest a prediction of the cohesion on collective efficacy. Further research is needed to investigate the relationship between both variables.

In the analysis of the relationship between cohesion and collective efficacy, the association of these variables with performance could also influence the direction of causality between both variables, as mentioned in the introduction. In this study, collective efficacy predicted final performance; a fact that had already been reported in several previous studies (Feltz & Lirgg, 1998; Myers *et al*., 2004; Myers *et al*., 2007). As mentioned in the results section, the capacity of collective efficacy to predict performance was greater than team cohesion, which suggests that it is more relevant to achieve higher collective efficacy levels at the end of the season because this might guarantee better performance. In contrast, the relationship

among performance and cohesion was lower, which is consistent with different works that showed an unstable relationship (Carron *et al*., 2002a; Carron *et al*., 2002b; Beal *et al*., 2003). This disparity in the results between both variables seems to be stronger when collective efficacy is showed (Leo *et al*., 2014). Further studies analysing the mediator effects to explain performance can be relevant to enhance the knowledge in this field of research.

A limitation of the current study was that the findings, although longitudinal with two measurements across the sport season, were correlational, and no causal inferences can be drawn as to the relationships between cohesion, collective efficacy and performance. Nevertheless, the results are consistent with theoretical predictions and previous empirical research concerning the association between these variables (Heuzé *et al*., 2006; Heuzé *et al*., 2007; Leo *et al*., 2010a). Furthermore, the scale used to assess performance has not been previously validated, however, this type of measuring performance was supported by previous studies (Dithurbide *et al*., 2009; Carron & Eys, 2012).

Another limitation of this study was that it relied exclusively on self-reports, and thus to some extent the findings are subject to potential influences of shared method variance. Future longitudinal research in this area will do well to assess objective markers of cohesion and collective efficacy (observation instruments). Finally, generalisability of the findings to other population samples and sports should be made with caution as the current sample comprised only males, from a particular sport (soccer) and from a particular country (Spain).

Despite the aforementioned limitations, this work makes a unique contribution to the literature by examining the direction of causality between cohesion and collective efficacy in football teams over an eight-month period. In this sense, it might be interesting to investigate how cohesion can modify collective efficacy and vice versa with male and female players and in different sports. Also, longitudinal and experimental studies will be necessary to improve the knowledge about the direction of the relationship between cohesion and collective efficacy. Future research can build upon this work by incorporating different levels of analysis (individual, team, sport, time, gender) to create relevant information for coaches and sports psychologists.

CONCLUSION AND PRACTICAL APPLICATION

The present study indicates that team cohesion during the first months of competition had a greater impact on their perception of collective efficacy at the end of the league. In addition, both group integration and individual attraction to the group were antecedents of collective efficacy, with high predictive capacity. Collective efficacy was more relevant than team cohesion for team performance at the end of the season. Thus, one of the main practical implications of this study is that, during pre-season and at the beginning of the season, team sport coaches should focus on social and task aspects, both individually and at a group level, because this would improve the perception of collective team efficacy at the end of the season and lead to better team performance.

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Prof Francisco M. LEO: Faculty of Teacher Training. University of Extremadura. C/ Avenida de la Universidad, S/N, C.P.: 10003, Cáceres, Spain. Tel.: +34 927 257049, Fax.: +34 927257051, Email: franmilema@unex.es

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MORPHOLOGICAL AND SKILL-RELATED FITNESS COMPONENTS AS POTENTIAL PREDICTORS OF INJURIES IN ELITE FEMALE FIELD HOCKEY PLAYERS

Marlene NAICKER[1], Derik COETZEE[1] & Robert SCHALL[2]
[1] *Department of Exercise and Sport Sciences, Faculty of Health Sciences, University of the Free State, Bloemfontein, Republic of South Africa*
[2] *Department of Mathematical Statistics and Actuarial Science, University of the Free State, Bloemfontein, Republic of South Africa*

ABSTRACT

This study investigated whether morphological or skill-related factors measured pre- season can predict injuries sustained in-season by field hockey players. In this cohort- analytical study, 30 female South African national field hockey players

underwent pre-season testing including anthropometry, balance, flexibility, explosive power, upper and lower body strength, core strength, speed, agility and isokinetic testing of the ankle. A questionnaire was used to collect demographic data, elite-level experience, playing surface, footwear and injury history. Injuries in training and matches were recorded during the subsequent season using an injury profile sheet completed by injured players. Eighty-seven injuries, mostly involving ligaments and muscles of the ankles, hamstrings and lower back, were recorded. Univariate analyses showed that ankle dorsiflexion strength was a strong predictor of ankle injuries (p=0.0002), while ankle dorsiflexion deficit (p=0.0267) and eversion deficit (p=0.0035) were significant predictors. Balance indices (anterior/posterior, p=0.0465; medial/lateral, p<0.0001; and overall, p<0.0001) were pre-season performance measures significantly predicting potential ankle injury. For lower leg injuries, univariate associations were found with ankle inversion deficit (p=0.0253), eversion deficit (p=0.0379), and anterior/posterior balance index (p=0.0441).

***Key words*:** Elite female field hockey players; Morphology; Skill-related fitness components; Predictors of injuries.

INTRODUCTION

In South Africa, field hockey is commonly played at primary and high schools, sport clubs and universities. Once an amateur game, it has developed into a professional sport undergoing radical changes. According to Reilly and Borrie (1992), some of these changes have increased the incidence of injuries. Compared to grass pitches, the modern synthetic surface, Astro Turf, is a more consistent playing surface leading to better ball control, higher passing accuracy and higher speed across the turf (Hughes, 1988). These factors contribute to the game being played at a faster pace, which places greater physiological stress on the player, specifically the musculoskeletal system and the lower limb joints, and ultimately increases the risk of injury.

Despite the popularity of this Olympic sport, recent data on the incidence of injuries among female field hockey players are limited, although the head/face (Theilen *et al*., 2016) and ankle (Petrick *et al*., 1992; Murtaugh, 2001; Dick *et al*., 2007; Naicker *et al*., 2007), have been identified as frequently injured sites among female field hockey players. Other common areas of injury among female hockey players are the lower back (Rishiraj *et al*., 2009), knees (Petrick *et al*., 1992; Dick *et al*., 2007), upper leg muscles (strains) (Dick *et al*., 2007), and hands (Murtaugh, 2001; Dick *et al*., 2007). Some of these injuries could be explained by players running and playing the ball in a stooped body position with their sharp sprints and sideways movements placing considerable strain on the musculoskeletal structures of the lower leg and lower back (Verow, 1989). Oro-facial injuries among female field hockey players have also raised concern and highlight the use of protective equipment (Hendrick *et al*., 2008; Hendrickson *et al*., 2008; Theilen *et al*., 2016). Theilen *et al*. (2016) argue that although the head or face injuries reported in their study were minor, these injuries need to be addressed because they may reflect the liberalisation to play high balls all over the pitch, especially within the circle.

In terms of playing position on field hockey, goalkeepers have the greatest potential to be injured by direct trauma from sticks and balls (Verow, 1989). This finding was confirmed

by Murtaugh (2001) who reported goalkeepers to have the highest rate of injury (0.58 injuries/athlete-year) among Canadian high school, university and national-level female field hockey players (N=158). Conversely, midfielders were the most frequently injured field players (0.36 injuries/athlete-year) (Murtaugh, 2001).

Dick *et al.* (2007) found in a 15-year-long (1988–2003) surveillance of injuries among collegiate female field hockey players that different types of injuries occurred during games as compared to practices. Similarly, in a five-year-long study of 75 under-21 aged female field hockey players, Rishiraj *et al*. (2009) observed a significantly higher risk of injury during the second half of a game or practice.

Neither of these studies (Dick *et al.*, 2007; Rishiraj *et al*., 2009), however, investigated the possible aetiology of injuries or their risk factors. The high incidence of injury reported in field hockey calls for preventative action based on the results of epidemiological research. Preventative strategies and activities are justified on medical, as well as economic grounds. Risk factors that predispose female field hockey players to injury should be understood before implementing an intervention to reduce the incidence of injuries. Identification of risk factors for injuries not only contributes to reduce the risk of injuries, but in a game that is becoming increasingly popular, professional and demanding, knowledge about risk factors will ensure that professionals consistently perform at their peak. Furthermore, a reduction in the incidence of injuries decreases healthcare costs.

PURPOSE OF RESEARCH

The purpose of this study was to identify risk factors for injury in female field hockey players. More specifically, this study investigated the question whether a range of pre-season assessments of morphological and skill-related components can predict injuries sustained in- season.

METHODOLOGY

Ethical clearance and consent

Before the research commenced and the subjects were recruited, the study was approved by the Ethics Committee of the University of Stellenbosch, South Africa (Ethics No. 497/2011). Informed consent forms approved by the Ethics Committee were handed out and signed by all participating players. The study included all players of the South African senior women's field hockey team. The national women's hockey team is selected from the 9 provincial teams in South Africa based on the performance of the players in the inter-provincial tournaments. This group of players, therefore, comprised the elite female field hockey population in South Africa. The group of 30 national-level female hockey players were tested over a 2-day period.

Survey and laboratory testing

A cohort-analytical study where all participants completed a survey and underwent a battery of pre-season fitness tests was conducted. Injury data were obtained using a self-administered injury report survey. After scrutiny of various injury surveillance questionnaires and definitions of injuries, the questionnaire was based on a document drafted by the Rugby Injury Consensus Group to monitor the epidemiology of rugby

injuries (Fuller *et al*., 2006; Fuller *et al*., 2007; Pluim *et al*., 2009). The questionnaire was adapted by the researchers to address the aims of this study and to standardise definitions of injury. The study included all players of the South African senior women's field hockey team during the 2011/12 season. All measurements took place under laboratory conditions. Players were instructed to refrain from eating or drinking within 2 hours of the appointment and to empty the bladder before measurements were taken. Fitness tests were conducted according to accepted protocols and were administered in the same order for all athletes to control for the effects of accumulating fatigue on a subsequent performance test. All fitness tests used in this study have been shown to be adequately reliable (Jackson *et al*., 1980; Wisbey-Roth, 2000; Boddington *et al*., 2001; Cachupe *et al*., 2001; ISAK, 2001; Baltaci *et al*., 2003; Durandt *et al*., 2007; Ostojić *et al*., 2010; Evans, 2011; Seo *et al*., 2012; Váczi *et al*., 2013).

Morphological measures

Height, mass, body fat percentage (ISAK 2001) were measured. Body weight and height were measured using a calibrated mechanical scale with height rod (Seca 700; Seca GmbH & Co. Kg., Hamburg Germany). Weight graduation was 50g, and measurement rod graduation was 1mm. Players were weighed wearing shorts and a T-shirt with bare feet. Body fat percentage was then calculated using the Jackson and Pollock method (Jackson *et al*., 1980).

Skill-related fitness

All players performed a 3-minute warm-up and static stretch routine, emphasising the lower body before starting with the flexibility test. Flexibility (sit and reach test) (Baltaci *et al*., 2003), balance (Biodex Balance system single leg test) (Cachupe *et al*., 2001), strength (1 RM leg press, 1 RM bench press) (Seo *et al*., 2012), core strength (Wisbey-Roth, 2000), isokinetic testing of the ankle joint (Biodex System 3) (Evans, 2011), and explosive power (vertical jump test) (Ostojić *et al*., 2010), were measured on the first day of testing. On the second day of testing, on-field tests were performed, namely speed (10m and 40m linear sprints) (Durandt *et al*., 2007), agility (Illinois Agility Test) (Váczi *et al*., 2013), and anaerobic capacity (5m-multi-

shuttle run test) (Boddington *et al*., 2001). Speed and agility tests were run once without the player holding a hockey stick and a second time with the player holding a hockey stick.

Injury report survey

At the end of the season, the self-administered injury report survey was handed out to players to establish incidence, mechanism and severity of the injury/injuries sustained during competition. The principal researcher explained the procedure for the completion of the self- administered injury report to each of the players.

Statistical analyses

Every binary dependent variable (specific injury occurred or did not occur) was analysed using 1-way logistic regression, fitting (1 at a time) the potential predictors of injury. For each independent variable, a point estimate and associated 95% confidence interval (CI) for the odds ratio of injury, as well as the corresponding likelihood ratio chi-square test statistic and P-value were reported. Furthermore, a multivariate analysis was conducted where each binary dependent variable was analysed using multiple logistic regression fitting all potential predictors of injury, followed by stepwise variable selection (P-value for entry and

P-value to stay were both set to 0.1). The statistical analysis was done using the SAS statistical software package (version 9.22).

RESULTS

Demographic characteristics of study sample

Thirty (N=30) national female field hockey players completed the general questionnaire, which constituted a 100% response rate. The mean age of the players was 23.8±3.16 years (range=20 to 31yrs). Their mean height was 164.5±5.24cm (range=156 to 175cm), and their mean body mass 62.6±8.45kg (range=46.9 to 86.7kg). All participants reported in this this study were right hand dominant, playing the game at provincial level for more than 6 years, with 6.7% (n=2) of the players having less than 5 caps, 23.3% (n=7) having between 11 and 20 caps, and 70.0% (n=21) having more than 20 caps for South Africa. Ten of the players were strikers, 9 midfielders, 7 defenders and 4 goalkeepers.

Injury profile

In total, 87 injuries were reported by the 30 players during the 2011/12 field hockey season, giving an incidence of 2.9 injuries per player per season. The number of injuries during this season, classified by anatomical region injured, is presented in Figure 1. Most injuries (n=14; 16.1%) involved the ankle, followed by the back of the thigh (n=11; 12.6%), and the lower back (n=9; 10.3%). Besides injuries to the anatomical regions specified in Figure 2, 3 facial injuries (2 of the nose and 1 of the eye) were also reported. No concussion injuries were reported. The incidence of injuries by body site and playing position was also calculated. Overall, the midfielders had the highest incidence of injury (3.4 injuries/athlete/year), including the highest percentage (45%) of back thigh (hamstring) injuries, and the second highest percentage (36%) of ankle injuries. The strikers experienced the second highest incidence of injuries (2.8 injuries/athlete/year), including the highest percentage (50%) of ankle injuries,

and the highest percentage (57%) of front thigh (quadriceps) injuries. This was followed by the defenders who had an injury incidence rate of 2.4 injuries/athlete/year and, finally, the goalkeepers with 1.3 injuries/athlete/year.

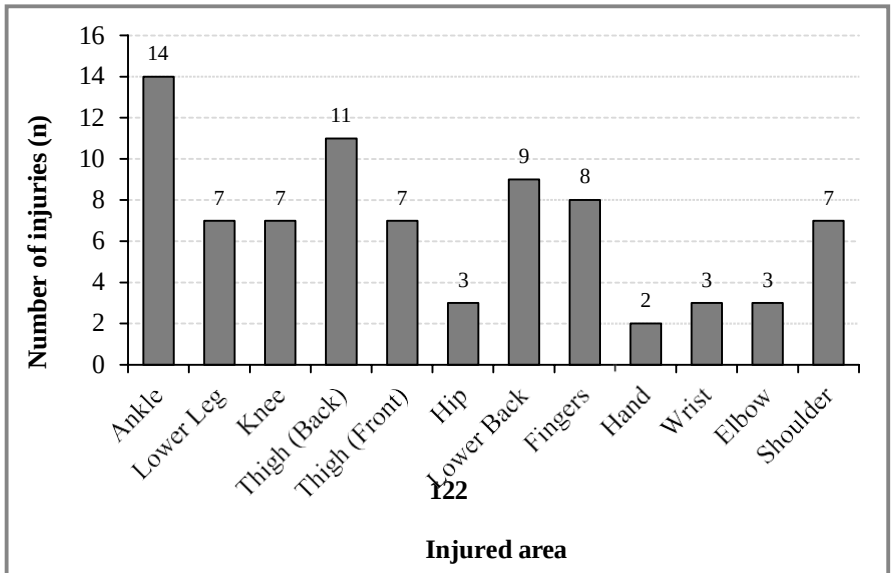

Figure 1. **ANATOMICAL REGION: NUMBER OF INJURIES DURING 2011/12 SEASON**

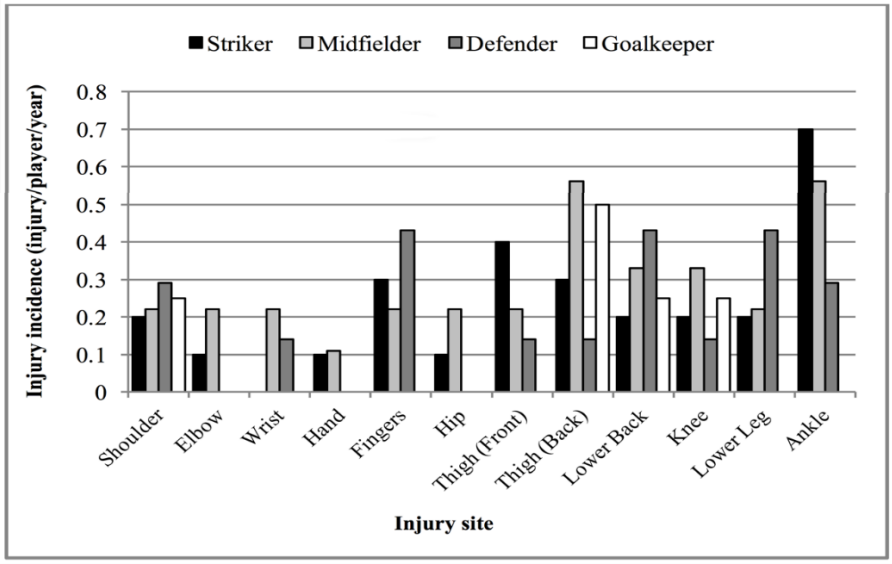

Figure 2. **INCIDENCE OF INJURIES IN ANATOMICAL REGIONS CLASSIFIED BY PLAYER POSITION**

The time of injury occurrence was captured, showing that 33.3% (n=29) of all injuries occurred during a training session, while the remainder (66.7%; n=58) occurred during a match. Among injuries occurring during a match, 34.5% (n=20) occurred in the first half of the match, while the remainder (65.5%; n=38) occurred in the second half.

The mechanisms of injury, as described by the players, were classified into falls, being struck by the ball or a stick, player contact and overuse injuries. The highest percentage of injuries (29.9%) was due to falls, while overuse injuries were reported by 7 players (8.1% of all injuries). Severity of the injury was related to time lost from playing the game. Mild injuries [return to play (RTP) within 7 days of injury] accounted for 45% (n=39) of the injuries, while transient injuries (RTP within 3 days of injury) accounted for 35% (n=31) of the injuries, moderate injuries (RTP within 10 days of injury) for 13% (n=11), and 7% (n=6) sustained severe injuries (RTP within longer than 10 days). The most common type of injury was a ligament sprain, accounting for 40% (n=35) of total injuries, followed by strains at 32% (n=28) and lacerations at 20% (n=18). Most sprains occurred to the ankle and knees, while most strains involved the hamstring, quadriceps and lower back muscles. Most lacerations were to the face, hand and fingers. Of the remaining injuries, 2% (n=2) were fractures, 1% (n=1) were dislocations, 1% (n=1) were subluxations and 2% (n=2) were ruptures. Most of the injuries required some attention from the medical personnel, of which 64% required physiotherapy treatment, 23% needed medical attention from a doctor, 11%

needed rehabilitation for their injuries and 2% required surgical intervention.

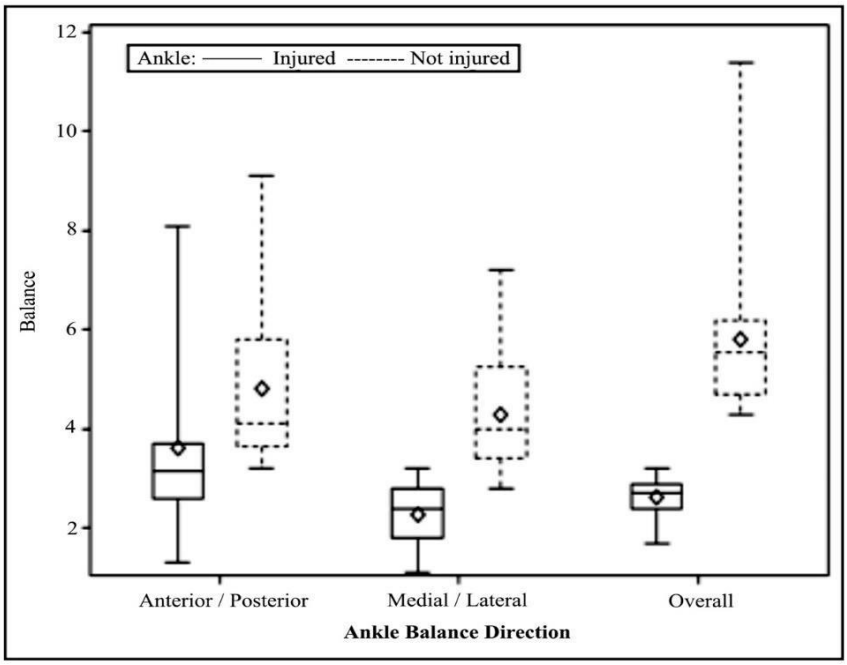

Figure 3. **BALANCE SCORES OF PLAYERS WITH AND WITHOUT ANKLE INJURIES**

Figure 3 shows boxplots of the balance scores for the players that sustained ankle injuries and those not sustaining ankle injuries. The players that sustained ankle injuries were weaker on balance scores for both anterior/posterior movements, as well as medial/lateral movements, and had a lower overall balance score when compared to those that did not have ankle injuries.

Predictors of injury

One of the main aims of the study was to investigate if variables measured in the pre-season could predict injuries during the playing in-season. Both univariate and multivariate (stepwise) logistic regression were used to identify potential predictors of injury. The results of the univariate logistic analyses are summarised in Table 1, where, for the various types of injury, all predictors significant at the $\alpha=0.1$ significance level, are listed. Similarly, Table 2 summarises the results of the multivariate analysis by listing the best set of predictors for the various types of injury, determined through stepwise logistic regression.

Note that in both Table 1 and Table 2, odds ratios larger than 1 imply that the injury risk increased as the value of the predictor variable in question increased; *vice versa*, odds ratios smaller than 1 imply that the injury risk decreased as the value of the predictor variable in question increased.

Table 1. **UNIVARIATE LOGISTIC REGRESSION: SIGNIFICANT (p<0.1) PREDICTORS OF INJURY**

Injury site	Predictor (independent variable)	Likelihood ratio (df=1)	p-Value	Odds ratio	95% CI
Ankle	Dorsiflexion L (Nm)	13.9506	0.0002	0.663	0.465–0.848
	Dorsiflexion deficit (%)	4.9087	0.0267	1.124	1.012–1.316
	Eversion deficit (%)	8.5153	0.0035	1.133	1.035–1.291
	Ant/Post balance (n)	3.9644	0.0465	0.611	0.322–0.993
	Med/Lat balance (n)	29.3391	<0.0001	0.004	<0.001–0.114
	Overall balance (n)		<0.0001[a]		
Lower leg	Ankle inversion L (Nm)	2.7583	0.0967	1.095	0.985–1.249
	Inversion deficit (%)	5.0035	0.0253	1.152	1.016–1.357
	Eversion deficit (Nm)	4.3105	0.0379	1.078	1.004–1.185
	Ant/Post balance (n)	4.0524	0.0441	0.590	0.292–0.988
Hand	Inversion deficit (%)	5.1350	0.0234	0.856	0.706–0.981
Upper arm	Plantar flexion R (Nm)	3.4352	0.0638	1.041	0.998–1.096
	Plantar flexion L (Nm)	4.8263	0.0280	1.046	1.005–1.102
	Ankle inversion R (Nm)	4.2730	0.0387	1.123	1.006–1.302
	Inversion deficit (%)	3.5157	0.0608	0.878	0.731–1.005
	Ant/Post balance (n)	4.6441	0.0312	1.696	1.046–3.134

[a] p-Value from exact test for effect of overall balance on ankle injuries. CI= Confidence Interval Odds ratio could not be calculated because of complete data separation (see text).

Table 2. **STEPWISE LOGISTIC REGRESSION: SELECTED SETS OF PREDICTORS OF INJURY**

Injury site	Predictor (independent variable)	Odds ratio	95% CI
Ankle[a]	Strength bench (%)	<0.001	<0.001–0.024
	Dorsi L (Nm)	0.398	0.108–0.735
	Eversion deficit (%)	1.177	1.032–1.500
Lower leg	Eversion deficit (%)	1.072	0.993–1.174
	Inversion deficit (%)	1.148	1.001–1.361
Thigh	Plantar deficit (%)	1.273	1.058–1.833
	Eversion L (Nm)	0.673	0.435–0.882
	Eversion deficit (%)	0.803	0.651–0.923
	Ant/Post balance (n)	0.501	0.189–0.997
Hand	Inversion deficit (%)	0.856	0.706–0.981
Lower back	Plantar deficit (%)	1.090	0.998–1.241

Upper arm	Sit/Reach (cm)	0.855	0.689–0.991
	Inversion R (Nm)	1.478	1.158–2.252
	Inversion deficit (%)	0.711	0.502–0.893

[a] Regarding ankle injuries, the variable overall balance was not fitted in the model for stepwise selection because of complete data separation (see text).

Ankle injuries

Of ankle muscle strength that was tested, dorsiflexion of the left foot was a significant univariate predictor of injury, together with dorsiflexion deficit and ankle eversion deficit (relevant p-values are listed in Table 1). All movements of balance, namely anterior/posterior, medial/lateral and overall, were also highly significant predictors of injury (Table 1; Figure 3). Overall balance was the best observed predictor of ankle injury. All 14 players with overall balance less than or equal to 3.2n had an ankle injury, while all 16 players with overall balance greater than or equal to 4.3n did not have an ankle injury (Figure 3, this is an instance of complete data separation in logistic regression). These results suggest that players with balance scores smaller than 3n are almost certain to sustain an ankle injury.

Lower leg injuries

Lower leg injuries comprise all injuries to the knee and lower leg areas. Table 1 shows that ankle inversion deficit, ankle eversion deficit and anterior/posterior balance were significant univariate predictors of lower leg injuries. Inversion of the left ankle was found to be a borderline predictor of lower leg injuries. Since the odds ratios for inversion deficit, ankle

eversion deficit and ankle inversion were larger than 1, increasing values of these variables were associated with increased odds (or risk) of injury. In contrast, the odds ratio for anterior/posterior balance was smaller than 1, implying that decreasing values of this variable were associated with increased odds of injury.

Hand injuries

Hand injuries comprise all injuries to the wrist, hand and fingers. Only ankle inversion deficit was found to be a univariate significant predictor of hand injuries.

Upper arm injuries

Upper arm injuries comprise all injuries to both the elbow and shoulder areas. Plantar flexion of the left ankle, inversion of the right ankle, and anterior/posterior balance were significant univariate predictors of upper arm injuries. Ankle plantar flexion of the right ankle and ankle inversion deficit were borderline predictors of upper arm injuries.

Multivariate analysis

The selected variables listed in Table 2 can form part of a predictive model for the respective injuries. Note that the sets of variables selected in the multivariate analyses do not necessarily comprise those variables which in the univariate analysis were found to be

the most significant predictors of injury. Furthermore, there is not necessarily a causal relationship between the selected variables and the injury in question. Rather, the selected variables represent a subset of the independent variables which, within the context of stepwise logistic variable selection, emerged as the best subset of variables to include in a prediction model for the injury in question.

DISCUSSION

The overall mean incidence of injury reported by this sample of field hockey players (2.8 per player in the 2011/12 season), was much higher than the incidences previously reported respectively by Eggers-Ströder and Hermann (1994) (0.6 per player per season), Murtaugh (2001) (0.36 to 0.37 per player per season), and Petrick *et al*. (1992) (0.48 per player per year). In addition to the fact that the present study focused on elite hockey players exposed to a competitive playing milieu, the relatively high incidence observed in the current sample could possibly be attributed to the greater use of synthetic playing surfaces (Reilly & Borrie, 1992), recent rule changes (Ostenberg & Roos, 2000), and advances in stick construction (Murtaugh, 2001), which have increased the pace of the game and potential for injury.

Regarding anatomical site of injury, the results were similar to the findings of other authors, namely that the ankle joint is the most frequently injured joint in field hockey players (Reilly & Borrie, 1992; Dick *et al*., 2007; Rishiraj *et al*., 2009). The incidence of ankle injuries in the current study was 0.47 injuries per player-year (14 injuries), which is higher than reported in the above cited studies. The higher incidence of ankle injuries in the current study might again be related to the more demanding level of play. After ankle injuries, the hamstring muscle at
0.37 per player-year (11 injuries) and the lower back at 0.30 injuries per player-year (9 injuries), respectively, had the highest incidence.

In contrast to the findings of Ostenberg and Roos (2000), Murtaugh (2001) and Le Gall *et al*. (2006), age did not appear to be a predisposing factor in the present study. The moderately significant association (p=0.0809) between mass and incidence of lower back injuries found in this study, is supported by the findings of Heuch *et al*. (2013). The current results show that decreased ankle dorsiflexion strength is a very strong predictor of ankle injuries. It is similar to findings by Willems *et al*. (2005), who reported that decreased dorsiflexion muscle strength in male physical education students was a risk factor for ankle sprains.

Wang *et al*. (2006) found no association between isokinetic ankle strength and ankle injuries when they examined players in the pre-season in order to predict ankle injuries in men's high school basketball. In this study, the univariate associations suggest that the weaker dorsiflexion strength of the left ankle, as demonstrated by the majority of players who sustained ankle injuries to the left ankle (79%), is a significant risk factor for ankle injury (p=0.0002). It is noteworthy that players sustaining injuries to the right ankle (21%) displayed weaker dorsiflexion strength of their right ankles. In a previous study (Naicker *et al*., 2007), an association between ankle injury and weak dorsiflexion torque was observed, but due to the retrospective nature of this study, it was not possible to decide whether the poor dorsiflexor torque was the cause of the injury, the result of the injury or perhaps the result of inadequate rehabilitation of the injured ankles (Naicker *et al*., 2007).

The most common ankle injury is a lateral ankle sprain and is sustained in the inverted and plantar-flexed ankle. A possible explanation for these findings is that during these movements, the evertor and dorsiflexor muscles of the ankle are lengthened and act eccentrically. Weak dorsiflexors in the ankle joint that cannot act with sufficient eccentric strength will, therefore, allow for excessive plantar flexion and inversion, placing additional stress on the lateral ligaments of the ankle joint, thereby predisposing the ankle to injury. These findings not only confirm the association between poor dorsiflexion torque and ankle injury, but also that poor dorsiflexion torque can in fact predict new ankle injuries. It highlights the possibility that strong dorsiflexors assist the ankle in preventing excessive plantar flexion and inversion injury responsible for most lateral ankle sprains.

Evertor muscle weakness and decreased evertor to invertor torque have been implicated as a risk factor to ankle injury in previous studies (Willems *et al*., 2002; De Noronha & Borges, 2004). However, less is known about the relationship between the incidence of ankle injury and the peak dorsiflexion to plantar flexion torque of the injured ankle and that of the uninjured ankle. Baumhauer *et al*. (1995) were the first to show that the plantar flexion strength and the ratio of dorsiflexion to plantar flexion strength was significantly different for the injured ankle, compared with the contralateral uninjured ankles when they studied 145 college-aged athletes before the athletic season.

In a systematic review and meta-analysis of journal articles from selected electronic databases for ankle injury prediction (Witchalls *et al*., 2012), it was found that higher concentric plantar flexion strength at faster speeds and lower eccentric eversion strength at slower speeds posed increased risk of ankle injury. In a sport, such as field hockey, the constant intermittent changes in speed could be associated with the high incidence of ankle injuries. In another systematic review (De Noronha *et al*., 2006), however, found that ankle muscle strength was not associated

with an increase in ankle injuries, but instead dorsiflexion range was reported to strongly predict risk of ankle sprain. Although the current study did not observe an association between flexibility and ankle injury incidence, perhaps an isolated test of range for dorsiflexion of the ankle is required to compare results instead of the generalised sit-and-reach test of flexibility used in the current study. Due to the lack of consistency in these findings, particularly when applied to sportspersons, this lack of clarity may give constructive direction for future research. From the results, it is concluded that muscle imbalance around the ankle joint is indeed a consideration when developing conditioning programmes of field hockey players.

All balance indices, namely anterior/posterior ($p=0.0465$), medial/lateral ($p<0001$) and overall ($p<0001$), showed significant potential to predict ankle injury, confirming the findings of other researchers (Tropp *et al*., 1984; Watson, 1999; McGuine *et al*., 2000), who showed that reduced ability to balance is associated with increased risk of ankle injuries (Tropp *et al*., 1984). Tropp *et al*. (1984) measured the change in the athlete's centre of gravity (postural sway) as an indicator of proprioceptive ability during pre-season in soccer players. They were then monitored for a complete season and it was found that an elevated postural sway value identified the athletes at increased risk of ankle sprain (Tropp *et al*., 1984). McGuine *et al*. (2000) confirmed this when they assessed the balance or postural sway of 210 basketball players from five high schools during the pre-season, to determine

if balance was a predictor of ankle injury. Higher postural sway scores corresponded to increased ankle sprain rates and subjects who demonstrated poor balance (high sway scores) had nearly seven times as many ankle sprains as subjects who had good balance reported. They, therefore, concluded that pre- season balance measurement served as a predictor of ankle injury susceptibility (McGuine *et al*., 2000). Likewise, Wang *et al*. (2006) found that high variation of postural sway in both anteroposterior and mediolateral directions corresponded to the occurrence of ankle injuries.

While Tropp *et al*. (1984) studied soccer players and McGuine *et al*. (2000) and Wang *et al*. (2006) basketball players, this study has identified balance as an ankle injury risk factor in female field hockey players. The players' reduced ability to balance on the Biodex Balance might be indicative of poor sensory input from joint mechanoreceptors (Naicker *et al*., 2007) and proprioceptive ability (Tropp *et al*., 1984), and might also reduce dynamic balance or active position sense (De Noronha & Borges, 2004) during the game of hockey.

Extremely high forces pass through the ankle joint especially during a game, such as hockey, with changes in running speed and direction. If the ability to efficiently accelerate and decelerate in multiple directions is lost, there is the likelihood that when trying to change direction during game play, the body will be unable to control the movement, thus allowing unnatural forces to pass through the ankle joint and place the foot in abnormal positions. This dynamic balance is required in a fast game of field hockey where players need to transfer their body weight rapidly, move and control their low centre of gravity during squatting and lunging, while co-ordinating speed and power. An impairment in this ability may, therefore, have predisposed these athletes to ankle injury. Several studies have suggested that proprioceptive or balance training should be an important component of rehabilitation (Mattacola & Dwyer, 2002; Verhagen *et al*., 2004; Fu & Hui-Chan, 2005). Perhaps this should in fact be incorporated into pre-season conditioning programmes in an attempt to decrease the incidence of ankle injury.

CONCLUSION AND PRACTICAL IMPLICATIONS

A comprehensive rehabilitation or injury prevention programme is only possible if a thorough understanding of the physical demands and biomechanics, specifically as it is applied to field hockey, is established. However, more research is needed to identify and treat the injured structures involved.

Based on the results of this study, the following conclusions and recommendations seem warranted:

- Injury prevention should be an important goal for sport medicine professionals. While most teams rely on medical support for curative and rehabilitative services once injury has occurred, the best approach is to prevent injuries from occurring. An injury prevention model based on the predictive factors highlighted in this study needs to be formulated. However, future research is required to validate this injury prevention model.

- This study has highlighted injury risk factors in elite female field hockey players, which, if known by the medical and coaching team, may prevent injuries from occurring.

- Ankle injuries have been identified as a common injury in female field hockey players

and had the highest incidence of injury in this study. Although ankle injuries in this study involved the lateral ankle complex, it will be beneficial for future research to report a standardised classification of ankle injury. While poor dorsiflexion and balance were associated with ankle injury after the ankle injury occurred (Naicker *et al*., 2007), the current study has confirmed that these weaknesses are in fact good predictors of ankle injury, with all balance indices being good predictors of ankle injury.

- Ankle inversion deficit, eversion deficit and anterior/posterior balance were associated with lower leg injuries in elite female field hockey players.

- Conditioning programmes and team preparation need to be adjusted to address these factors which can help prevent serious injuries that keep players out of matches.

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Conflict of interest

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Prof Derik COETZEE: Department of Exercise and Sport Sciences, Faculty of Health Sciences, University of the Free State, 205 Nelson Mandela Drive, Bloemfontein 9300, Republic of South Africa. Tel.: +27 (0)51 401 2944, Fax.: +27 (0)51 401 7989, Email: coetzeef@ufs.ac.za

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AN ANALYSIS OF BATTING BACKLIFT TECHNIQUES AMONG COACHED AND UNCOACHED CRICKET BATSMEN

Habib NOORBHAI[1,2] & Timothy D. NOAKES[2]
[1] Department *of Sport Management, Faculty of Business and Management Sciences, Cape Peninsula University of Technology, Cape Town, Republic of South Africa*
[2] *Division for Exercise Science and Sports Medicine, Department of Human Biology, Faculty of Health Sciences, University of Cape Town, Cape Town, Republic of South Africa*

ABSTRACT

One of the first principles of cricket batsmanship for batting coaches is to teach junior cricketers to play using a straight bat. This requires the bat to be lifted directly towards the stumps with the bat face facing downwards. No study has yet examined whether there are differences in the batting back lift techniques (BTT) of coached cricketers (CC) and uncoached cricketers (UC). With the study sample, CC comprised of both adolescent (n=30) and amateur (n=10) cricketers, whereas the UC comprised of only young cricketers (n=40). Various types of deliveries were bowled to the participants utilising a bowling machine. Biomechanical and video analyses were performed on both participant groups. Classifiers were utilised to identify the type of BTT employed by all batsmen. More than 70% of uncoached cricketers adopted a lateral BTT, whereas more than 70% of CC adopted the straight BTT. Coaching implications from this study suggest that if players are not coached, they automatically hit the ball using a lateral BTT, which indirectly

suggests that coaching emphasising traditional techniques could be disadvantageous to the young cricketer.

***Key words*:** Video analysis; Batting back lift techniques; Cricket; Coached and uncoached batsmen.

INTRODUCTION

One of the first principles of cricket batsmanship as seem by batting coaches is to teach junior cricketers to play using a straight bat; although the most natural way is to play with a bat at a slight angle (Ranjitsinjhi, 1897; Fry *et al*., 1903). In order for this to happen, batsmen are taught to lift the bat directly backwards in the direction of the stumps on the initiation of the batting stroke (Beldam *et al*., 1905).

This straight back lift coaching philosophy was finally entrenched for all cricket playing nations in the first edition of the Marlybone Cricket Club (MCC) coaching manual published in 1954. This included the following statement: "A correct back lift is not natural but can easily be obtained and too much attention cannot be given to getting it right, the bat should be taken back directly over the middle stump" (The MCC, 1954:77).

Forty years later, the 1994 edition of the MCC coaching manual (Lewis, 1992) continued the same interpretation by teaching that the back lift should be directed towards the stumps to ensure that the bat will come down straight, in line with the stumps. However, the same

coaching manual also includes the contrasting statement of former English opening batsman, Sir Geoffrey Boycott: "If your stance is correct, it is a natural movement to pick up your bat in the direction of the slips, as the great batsmen do, such as Sir Donald Bradman" (The MCC, 1962:108). Then, at the top of the back lift, loop the bat and bring it down the line of the stumps. Many tutors teach more traditionally that, if you pick the bat up straight it will come down straight, so they suggest you take the bat back directly over middle-stump. The author feels that the best players have never done that. It simply is not a natural movement and it will let a batsman down under pressure.

If a person searched any search engine with 'how to coach cricket batting', he/she would find over one million results on how to coach batting techniques. If the search is then simplified to 'how to coach batting back lift techniques', the results would reveal approximately six thousand results. Therefore, there is no real consensus of what coaching needs to be advocated with the batting back lift techniques in cricket across all age groups. Most of the coaching literature between 1954 and 2015 have advocated for the bat to be directed towards the wicket-keeper or first slip (The MCC, 1954; Bradman, 1958; The MCC, 1962; Dellor, 1990; Palmer, 1999; Australian Cricket Board, 2000; Woolmer *et al*., 2009). Only since 2007 it became common practice for coaches to coach the back lift in the direction of first or second slip. However, there still remains a paucity of coaches who teach the lateral batting back lift technique.

It is of special interest that Sir Donald Bradman (the most successful batsman of all time with a test batting average of 99.94, at least 30% better than the second best such average), agrees with Boycott's opinion: "If videos were taken of all the greats of cricket then we

would see that not one of them take their bats back directly towards the stumps" (Bradman, 1958:36). Bradman's opinion also suggested that "playing with a straight bat was great for defence but not for offence, and that a straight back lift will let you down under pressure" (Bradman, 1958:37). In his coaching video first produced in 1934, Bradman voiced the opinion that "In batting there are many competent players but for some reason, maybe coaching, the emphasis seems now to be on forward play. There are fewer batsmen who are predominantly back foot players. Hence we don't see as many cut shots and pull shots. One cause seems to be the tendency to use heavier bats. These are fine for the pendulum-type shot but militate against strokes across the line of flight".

Bradman's interpretation is that the straight back lift encourages players to play forward and to use heavier bats to generate power (Noorbhai & Noakes, 2015) (Figure 1). According to Bradman, this would reduce their ability to play shots with a cross-bat or off the back foot. As a result, they would have a more restricted range of scoring strokes, they would be more passive in their defensive strokes and they would be unable to score as rapidly as did Bradman (Shillinglaw, 2009).

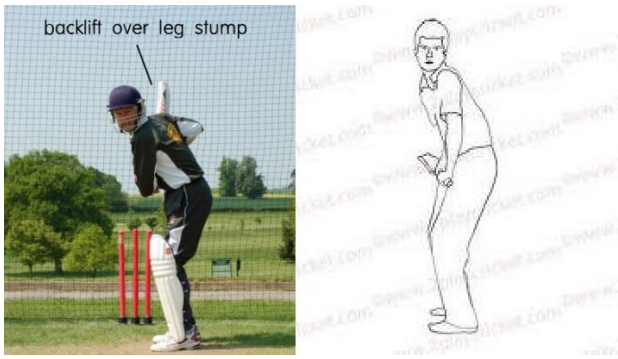


Figure 1. **BACKLIFT TOWARDS THE STUMPS**
(Adapted from Pitchvision and www.2playcricket.com)

The mechanics of the back lift in cricket batting are poorly understood (Davis, 1983; Gibson & Adams, 1989). Qualitative biomechanical analyses of movement in sport are key to its investigation (Kreighbaum & Barthels, 1996). Such a mode of investigation can provide important insights in the biomechanics of technique in sport, especially with those skills that have to satisfy parallel performance outcomes by choosing from a kinematically redundant set of joint angle time-histories (Gelinas & Hoshizaki, 1988; Handford *et al*., 1997; Mullineaux *et al*., 2001).

Cricket batting is complex in this way with different variables, such as the grip, stance, initial movement, back lift, downswing and follow through (Stretch *et al*., 2000). An important component of the overall batting technique is the back lift, a technical component of batting that has defied the traditional attempt to constrain its motion to the linear plane (McLean & Reeder, 2000; Stretch *et al*., 2000). The most proficient run-scorers of the game lift the bat from the region of the slips, often causing the downswing path of the bat to deviate from its upswing. Devising a qualitative biomechanics model of the back lift could, therefore, do much to probe its underlying mechanics.

Research conducted in Australia by Stuelcken *et al*. (2005) on international batsmen (n=9) was one of very few studies that demonstrated findings of the back lift in cricket batting. The study showed that path tracings of the bat indicated a distinctive loop, which was unexpected. No clear evidence was provided by the authors to explain why this occurred, aside from the fact that increasing the number of strokes would be a likely outcome. In addition, it was found that the path of the bat deviated well outside the mean alignment of the shoulders to reach an average maximum angle in the transverse plane of 47°. Furthermore, this angle was reduced by a mean of 23° at the top of the back lift, the position of the bat was still well away from an alignment that would enable the required bat plane for a drive to the off-side (Stuelcken *et al*., 2005).

Later, Penn and Spratford (2012) investigated whether current coaching recommendations for cricket batting techniques are supported by findings from biomechanical research. The research indicated that coaching manuals are valuable tools for coaches and that it is common practice for such coaching manuals to be written by former players and coaches of the game (Penn &

Spratford, 2012). These manuals are based on their views and/or experiences and, thus, lack the scientific rigour of a peer-reviewed journal. Therefore, this area of batting back lift techniques of cricketers requires further research. A previous research study (Noorbhai & Noakes, 2016) has shown that a vast majority of successful batsmen (77%) in the last century had used a lateral batting back lift technique. It was also found that the lateral batting back lift technique is a key contributing factor of the overall cricket batting technique.

For the purpose of this study, the 'lateral' batting back lift technique described by Bradman and Boycott is one in which the bat is lifted laterally in the direction of second slip or gully. Using this technique, the face of the bat is directed towards point. In the straight MCC batting back lift technique, the bat is lifted towards the stumps or first slip and the face of the bat points towards the wicket-keeper or the ground.

RESEARCH AIMS AND OBJECTIVES

To the researcher's knowledge, no study has yet examined whether there are differences in the back lift and batting techniques of coached and uncoached cricket players. Therefore, the aim of this research study was to investigate the batting back lift techniques of coached and uncoached cricket players. It was hypothesised that uncoached cricketers would adopt the lateral batting back lift technique (a looped back lift with an open face of the bat), whereas coached cricketers would adopt the straight batting back lift technique (straight back lift and closed face of the bat).

METHODOLOGY

This is a cross-sectional research study in which both observational and analytical research methods were employed.

Participants

All participants were young, adolescent or amateur cricketers residing in the Western Cape

Province, South Africa. The young cricketers (both male and female) were between the ages of 7 and 11 years who participated in the Calypso cricket programme in the Atlantis and Khayelitsha areas in the Western Cape, whereas the adolescent cricketers were between 12 and 18 years of age and belonged to the Western Province Cricket Club. The number of cricketers among both the young and adolescent groups were equally represented in their respective age groups. Amateur cricketers between 19 and 29 years of age were players of the Western Cape amateur provincial team. The average age of the amateur cricketers was 23±2.73 years (Table 3). For the purpose of this research study, adolescent and amateur cricketers were grouped as coached cricketers (CC), whereas young cricketers were grouped as uncoached cricketers (UC).

Calypso cricket is a unique and enjoyable adaptation of the conventional game of cricket (Burton, 1985). Utilising most of the rules of cricket, the game is usually played on the beaches with 2 teams of 10 players each. This competitive sport that originated in the West Indian islands, is played between different villages that gather in their hundreds for the event (Midgett, 2003). It has proven to be an exciting way of introducing young children to the game of cricket

and usually encompasses children being taught how to play cricket instead of being coached for certain ways of playing (Burton, 1985; Midgett, 2003).

Study procedure

Various types of deliveries (n=12; 3 short deliveries, 3 good-length deliveries, 3 full deliveries and 3 full-toss deliveries, either pitched on middle, leg or outside off-stump), were bowled to the participants utilising a bowling machine in indoor or outdoor nets. Participants were required to bat using their usual batting technique.

Biomechanical analysis

Biomechanical and video analyses were performed on both participant groups. This analysis included the measurement of a photo sequence with drawing tools and a static angle calculation of the batsman's technique utilising the Kinovea™ (Version 0.8.15) software package. The analysis was done similar to other studies (Stuelcken *et al*., 2005) whereby the initial movement of the batsman was determined from the first frame before the initiation of the back lift, while initial movement patterns were assessed qualitatively by viewing the footage. The back lift represented the period from the initiation of the back lift to the maximum vertical displacement of the toe of the bat and selected the video frame immediately before the bowler released the ball. These frames were then used to determine the type of batting back lift technique for each type of delivery bowled. Variables of interest included the direction of the back lift and where the face of the bat is directed during the back lift from a Canon LEGRIA HF R506 HD Camcorder™ video camera attached to a laptop computer. An external hard drive from the video camera was inserted into a laptop for further usage of the software. All of the above was performed on both participant groups.

Classifiers

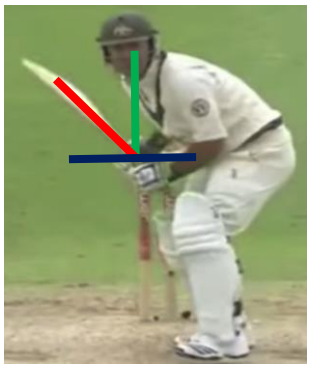
Classifiers were utilised to identify the type of batting back lift technique employed by all batsmen. These classifiers were coded as "1" (bat face facing straight back and towards the

wicket-keeper or the ground), “2” (bat face facing first or second slip) and “3” (bat face towards gully or point). If the bat is directed fairly straight back or towards the slips/gully regions but has an open face of the bat, it is classified as classifier “4”. Angle ranges were conceptualised to determine these classifiers (1=between 0 and 25^{o}; 2=between 25 and 45^{o}; 3=between 45 and 80^{o}; 4=same as 3, but with an open face of the bat).

For the purpose of this study, the toe of the bat is defined as the vector orthogonal to the toe being the pointer (Glazier *et al*., 2003). This strengthens the validity and reliability of the analysis as the back lift can be readily detected and analysed at different positions and time points in the lift (Hopkins, 2000).

Drawing a vector is a common approach in defining the toe of the bat and how it will point in a particular direction (Kreighbaum & Barthels, 1996). Lines and vectors were drawn (1) vertically from the head to the hands (green line); (2) a line drawn horizontally to show where the hands rest (blue line); and (3) a line drawn obliquely to show the direction of the bat during the back lift (red line). The still photo (which was captured from the video footage, namely the last frame just before the bowler had released the ball) was analysed while the ball had just

been released from the bowler. These lines create an angle to show how far away the bat is from the body in the frontal plane and how much rotation is made before making impact with the ball. The researchers accounted for perspective error by limiting the type of videos observed, as well as including horizontal lines in the background.



Right-handed batsman

Left-handed batsman

Figure 2. **LINES AND VECTORS DEPICT ANGLE OF BATTING BACKLIFT TECHNIQUE**

Analysis of data

STATISTICA 11 analysis software was used for all statistical analyses. Descriptive statistics were performed and results were represented as means and standard deviations for continuous variables.

Ethical considerations

Child assent, as well as informed consent forms were obtained from parents and players

prior to each child's and adult's participation. Ethical approval for the study was granted by the Human Research Ethics Committee of the University of Cape Town (HREC: 586/2014). This research study conforms to the World Medical Association Declaration of Helsinki on Ethical Principles for Research Involving Human Subjects.

RESULTS AND DISCUSSION

The CC comprised of both the adolescent (n=30) and amateur (n=10) cricketers, whereas the UC comprised of only the young Calypso cricketers (n=40) (Table 1, 2 & 3). Of the UC, 75% adopted the lateral batting back lift technique and 25% were classified in the most lateral group (Classifier 4) (Table 1 & Figure 3). Of the coached adolescent cricketers, 27% adopted the lateral batting back lift technique and only one batsman was classified under the most lateral group (Table 2 & Figure 4). Between the age groups of under-9 and the amateur side, there is a slight decline of players utilising the lateral batting back lift technique. Therefore, as players increase in age, the use of the lateral batting back lift technique decreases due to traditional coaching. With regard to the amateur cricketers, only 2 out of the 10 players adopted the lateral batting back lift technique and was classified under classifier 4 (Table 3 & Figure 5).

Interestingly, both these batsmen achieved the highest averages in both 3-day and 1-day formats of the game respectively (Player 5.2=41.3 and 48.9%; Player 5.4=51.8 and 34.3%). Although player 5.8 had an average of 46% in 1-day cricket, this figure was not relevant as the player had played only one game (Table 3).

Table 1. **DEMOGRAPHIC AND BATTING CHARACTERISTICS OF YOUNG UC**

Young age groups	N	Lateral BBT	Straight BBT	Class 1	Class 2	Class 3	Class4
Under-9	20	16	4	4	5	4	7
Under-11	20	14	6	6	1	3	10
Total (%)	40	30 (75)	10 (25)	10 (25)	6 (15)	7 (17)	17 (43)

BBT=Backlift Batting Technique Class=Classifier

Table 2. **DEMOGRAPHICAL AND BATTING CHARACTERISTICS OF ADOLESCENT CC**

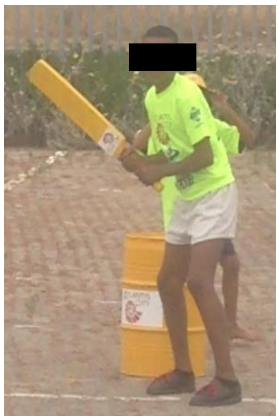
Adolescent age groups	N	Lateral BBT	Straight BBT	Class 1	Class 2	Class 3	Class4
Under-13	10	3	7	5	2	2	1
Under-15	10	3	7	5	2	3	0
Under-19	10	2	8	6	2	2	0
Total (%)	30	8 (27)	22 (73)	16 (54)	6 (20)	7 (23)	1 (3)

BBT=Backlift Batting Technique Class=Classifier

Table 3. **DEMOGRAPHIC BATTING AND PERFORMANCE CHARACTERISTICS OF AMATEUR CC IN 3-DAY AND 1-DAY CRICKET**

Amateur players	**Age** (yrs)	**BTT**	**Class**	**Three-day** Runs	Average	**One-day** Runs	Average
Player 4.1	28	Straight	1	76	7.60	15	15.00
Player 4.2	25	**Lateral**	4	5873	**41.35**	2152	**48.90**
Player 4.3	21	Straight	2	1927	27.52	487	18.73
Player 4.4	19	**Lateral**	4	570	**51.81**	103	**34.33**
Player 4.5	25	Straight	2	3000	34.09	376	17.09
Player 4.6	26	Straight	1	802	22.91	171	11.40
Player 4.7	20	Straight	2	117	23.40	6	3.00
Player 4.8	20	Straight	1	73	7.30	46	46.00
Player 4.9	24	Straight	2	90	12.85	13	13.00
Player 4.10	22	Straight	2	167	12.84	114	16.28
Total Gr. Mean±SD	23±2.73	—	2.1±1.04	1269.5	24.17	348.3	22.40

BBT=Backlift Batting Technique Class=Classifier Age by 18 February 2015



3.1

3.2

3.3

3.4

3.6 **3.7** **3.8** **3.9**

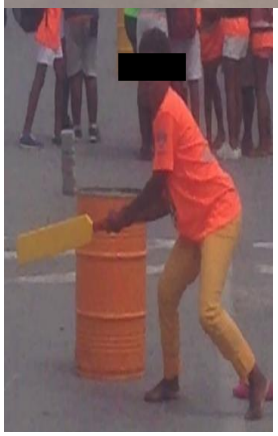



3.11 **3.12** **3.13**




3.14 **3.15**

3.16 **3.17** **3.18**
3.19 **3.20**



3.21 **3.22** **3.23**

3.24 **3.25**

3.26 **3.27** **3.28**
3.29 **3.30**



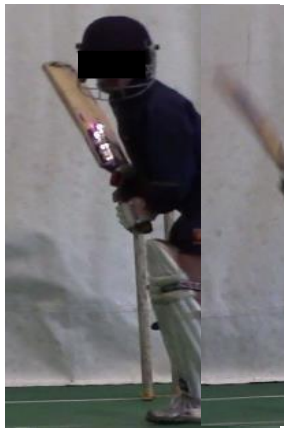

3.31 **3.32** **3.33** **3.34**




3.36 **3.37** **3.38** **3.39**

Figure 3. **UNCOACHED CRICKETERS PLAYING CALYPSO (STREET) CRICKET** (n=40)

4.1 **4.2** **4.3** **4.4**



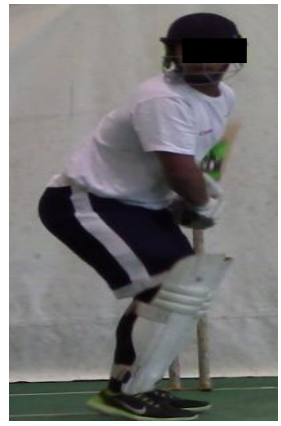
4.6 **4.7** **4.8** **4.9**

4.11 **4.12** **4.13**

4.14 **4.15**

4.16 **4.17** **4.18**

4.19 **4.20**

4.21 **4.22** **4.23** **4.24**

estelle.watson@wits.ac.za


4.26 **4.27** **4.28** **4.29**

Figure 4. **COACHED CRICKETERS PLAYING CRICKET AT ADOLESCENT LEVEL** (n = 30)

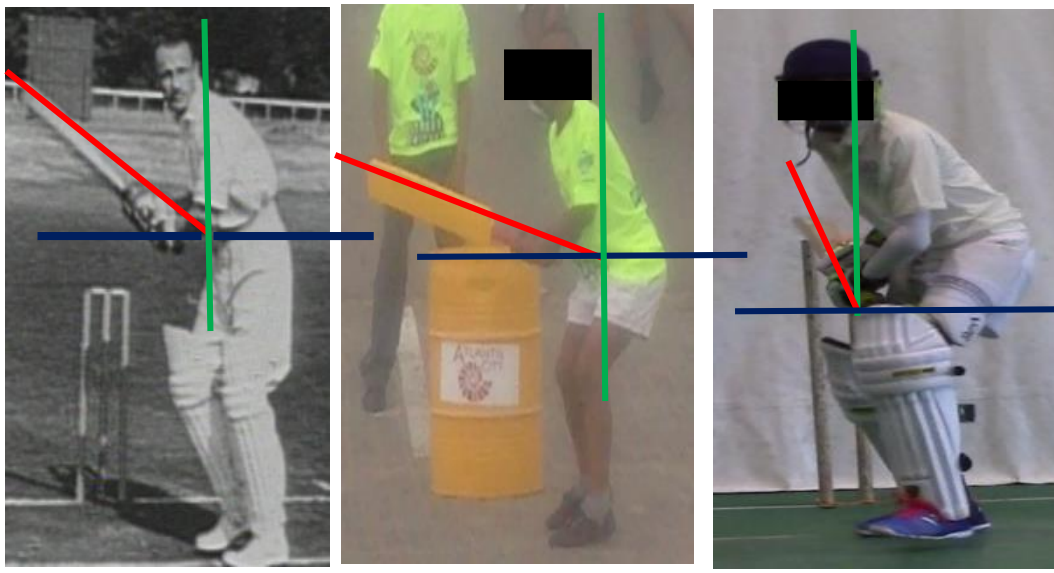



5.1 **5.2** **5.3** **5.4**




5.6 **5.7** **5.8** **5.9**

Figure 5. **COACHED CRICKETERS PLAYING CRICKET AT AMATEUR LEVEL** (n=10)



6.1 Sir Donald Bradman Angle of 60^{o}

6.2 Young UC Angle of 75^{o}

6.3 CC Angle of 35^{o}

6.4 Amateur CC Angle of 35^{o}

Figure 6. **FOUR-WAY COMPARISON OF BACKLIFT BATTING TECHNIQUES**

The main finding of this research study showed that more than 70% of previously uncoached cricketers adopted the *lateral* batting back lift technique, whereas more than 70% of coached cricketers adopted the *straight* batting back lift technique. This result showed that the natural movement of uncoached cricketers was to pick up the bat in a rotary angle or laterally. Similar sports, such as baseball, golf and tennis, also have their bat pointed away from their bodies before impact and in an angular direction instead of being taken straight back (Welch *et al*., 1995). The technique of baseball hitting shows that higher rotational velocities facilitate successful timing. If the rotational component is emphasised then the centre of pressure aligns itself with the centre of mass between both feet (Welch *et al*., 1995). A wider arc of swing also produces a wide range of shot selection instead of just predominantly forward defensive play (Borooah & Mangan, 2010). Similarly, in cricket this would ensure more effective timing and power when hitting the ball.

To further elaborate on the angular direction of the bat, Figure 6 shows a comparison of batting back lift techniques among CC, UC and Sir Donald Bradman. Both images 6.1 of Sir Donald Bradman and 6.2 of the typical uncoached cricketer shows an enlarged angle of more than 60^{o}, whereas images 6.3 and 6.4 of coached cricketers shows a small angle of less than 40^{o}. It can be deduced that cricketers who have a lateral angle of the back lift of more than 50^{o} might have a better chance of hitting the ball effectively.

STRENGTHS AND LIMITATIONS

The strength of this study was the ability to capture videos for both groups of participants analysing 12 various ball deliveries for each participant. Another strength of this study was that each group of participants played in their same environment and in the same month which limited a seasonal effect. Biomechanical and video analysis of the players were also obtained objectively and were not self-reported. A limitation of this study was the paucity of statistics available for the adolescent group posing a challenge to conduct an additional statistical analysis. Furthermore, the researchers accounted for perspective error by limiting the type of videos observed and including horizontal lines in the background.

CONCLUSION

Uncoached cricketers adopted the lateral batting back lift technique, whereas coached cricketers adopted the straight batting back lift technique. Coaching implications from this study suggests that cricket coaches should teach the basic fundamentals of batting techniques to cricketers, allow a young cricketer to play naturally and coach them based on their individual ability. If such players are not coached, they automatically hit the ball using a lateral back lift which indirectly suggests that early coaching emphasising traditional techniques could be less favourable to the young cricketer. Aside from the stance, grip, downswing and follow through of cricket batting, the back lift is a key contributor to effective batsmanship and, therefore, it should not be excluded in any performance analysis

in cricket. Future research is required to evaluate the coaching methods of the batting back lift techniques taught by coaches at various levels in most International Cricket Council countries, as this can inform what the current practice of coaching is across a varied spectrum.

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Mr. Habib NOORBHAI: Department of Sport Management, Faculty of Business and Management Sciences, Cape Peninsula University of Technology, Republic of South Africa. Email: NoorbhaiM@cput.ac.za

(Subject Editor: Dr Najeebullah Soomro)

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SOCIO-ECONOMIC FACTORS AND PSYCHO-PHYSICAL WELL-BEING AS PREDICTORS OF SAUNA USE AMONG MALE UNIVERSITY STUDENTS

Robert PODSTAWSKI[1], Dariusz CHOSZCZ[2], Antii HONKANEN[3], Anja TUOHINO[3] & Ewelina KOLANKOWSKA [2]
[1] *Department of Physical Education and Sport, University of Warmia & Mazury in Olsztyn, Prawocheńskiego, Olsztyn, Poland*
[2] *Faculty of Technical Sciences, University of Warmia & Mazury in Olsztyn, Oczapowskiego, Olsztyn, Poland*
[3] *University of Eastern Finland, Centre for Tourism Studies, Savonlinna, Finland*

ABSTRACT

The aim of this study was to assess the influence of socio-economic factors and psycho-physical well-being on the popularity of sauna usage among male university students. The research was conducted in 2012 on 550 first-year male university students aged 19 to 20 years (20.23±0.83yrs). The participants were asked to complete an anonymous questionnaire in which they described their frequency of sauna usage and their psycho-physical well-being on the day of use and on the following day. Firstly, the findings revealed that these students rarely used the sauna and that most of the evaluated socio-economic factors, including place of permanent residence, mother's educational background, the monthly budget of the student and the type of secondary education, had no significant influence on sauna usage. However, two factors did contribute significantly to the frequency of sauna usage, namely the father's educational background and the location of secondary school. Secondly, psycho-physical well-being (impressions on the day of sauna usage and on the following day), significantly influenced the sauna usage and had a significant positive influence on the respondents' well-being.

***Key words*:** Sauna usage; First-year male students; Socio-economic status; Psycho- physical well-being.

INTRODUCTION

Socio-economic factors, such as monthly income, parents' educational and cultural background, time management and relaxation, physical activity, type of social environment, social relations and customs and traditions significantly influence lifestyle. Urbanisation seems to be a key factor because urban, small town and rural residents differ considerably in their physical development (Eiben *et al.*, 1996). Children raised in urban environments grow and mature faster due to better health care and living conditions (nutrition, hygiene, medical care) (Eiben & Mascie-Taylor, 2004). Wolański *et al*. (1991) identified the following characteristic features of metropolitan residents: stronger body build; better nutritional status; lower blood pressure; and better perspiration characteristics, excluding higher respiration rate which probably results from higher air pollution.

In human ecology, the family is the fundamental social unit that forms the basic environment for a growing child (Wolański *et al*., 1991). Income determines the financial status of a family or a social or professional group (Roche & Sun, 2003). Diversified incomes and expenditures involve different cash management strategies (Tanner, 1994). A study of family types that have evolved under different cultural and economic conditions of Poland, Bulgaria, Japan, Korea and Mexico revealed that a child's development is largely influenced by the civilizational context (Wolański *et al*., 1994). Children from families with a high educational status tend to have a more ectomorphic body type and are more likely to be taller than the offspring of farmers, who are characterised by a stocky build. Children of more educated parents mature faster and are characterised by higher values of somatic features (Eiben & Pantó, 1988). It would appear that children from upper class families are more often enrolled in secondary schools (Podstawski *et al*., 2013c).

An individual's biological status is reflected in his/her physical, mental and social health (Tanner, 1994). In highly developed countries, motor fitness is an important determinant of biological status (Eiben *et al.*, 1996). Motor fitness takes on a new significance in view of the global decline in physical activity levels, in particular in developed countries (Singhal *et al.*, 2007). Research clearly indicates that the deterioration of biological status increases susceptibility to lifestyle diseases (Church *et al.*, 2007).

Influence of sauna on the human body

Sauna bathing is not only a popular form of relaxation, but also a treatment that delivers numerous health benefits (Cohen & Bodeker, 2008; Rouhiainen, 2008; Smith & Puczkó, 2008). Sauna delivers numerous health benefits by improving cardiovascular parameters and lowering blood pressure (Hannuksela & Ellahham, 2001). Sauna activates thermoregulatory mechanisms that trigger reactive changes throughout the body (Podstawski *et al.*, 2013b). Sauna bathing promotes the secretion of adrenalin (Kukkonen-Harjula & Kauppinen, 1988; Pilch *et al*., 2003), ACTH, cortisol and prolactin, which could be attributed to acclimatisation to high temperature (Pilch *et al.*, 2003). The endocrine system is activated to increase water retention in the body and maintain thermal equilibrium, because perspiration lowers serum sodium levels (Kauppinen, 1989). Sauna bathing improves the cholesterol profile by reducing the concentrations of low-density lipoproteins and increasing the levels of high-density lipoproteins (Pilch *et al*., 2010). Regular sauna treatment alleviates pain associated with musculo-skeletal injuries and improves joint mobility in patients suffering from rheumatism (Hannuksela & Ellahham, 2001; Kukkonen-Harjula & Kauppinen, 2006). Scoon *et al*. (2007) demonstrated that a three-week sauna treatment after exercise led to noticeable improvement in endurance running performance, and they attributed those results to increased blood volume. A study conducted with scuba divers revealed that one sauna treatment before diving significantly reduced circulating venous bubbles after a chamber dive, which lowered the risk of decompression sickness (Blatteau *et al*., 2008).

The health status of university students deserves special attention. Graduates are role models, who exert a significant impact on their social environment, and they play important roles in the economic and social development of a nation. A university degree is generally synonymous with social prestige and graduates are more likely to embark on professional careers and enjoy higher life prospects (Ansari *et al*., 2011). Educated individuals are more likely to be opinion

leaders who can visibly contribute to healthy lifestyle trends (Lee *et al*., 2005). The first year of university is a time of great change for most students whose physical and emotional well-being can be significantly compromised during that time. Students are expected to rise up to the challenges of a new social and educational environment (Podstawski *et al*., 2013c). They are deprived of parental care and support, and many of them find it difficult to cope with the pressure. University students should be educated about the importance of physical and mental well-being because they are still young enough to adopt more proactive attitudes towards a healthy lifestyle.

The health habits of university students are largely determined by the social, physical and economic environment of their families (Koivusilta *et al*., 2003). According to Basch (2011), low socio-economic status correlates with poor academic achievement. Health education for students has been researched widely, but not in every respect. There is a general scarcity of studies investigating the relationships between the popularity of saunas among university students, the students' knowledge about the health benefits and risks associated with sauna usage and their socio-economic status.

PURPOSE OF RESEARCH

The aim of the study was to assess the influence of socio-economic factors on sauna usage among Polish male university students. The study also determined whether sauna bathing influences the students' psycho-physical well-being and encourages them to pursue this type of treatment. An attempt was made to answer the following questions:

1. Do selected socio-economic factors, such as place of permanent residence, location and type of secondary school, educational background of parents and students' monthly budget significantly influence sauna usage and its frequency among first-year male students enrolled at a university in Poland?

2. Does sauna treatment influence the psycho-physical well-being of students during the treatment and on the following day, and does this experience encourage students to visit a sauna regularly?

METHODOLOGY

Participants

The study was conducted in 2012 involving 550 first-year male university students in Poland. The students were randomly selected from 249 groups attending physical education (PE) classes based on random selection tables to produce 56 groups. Male students aged 19 to 20 years (20.23±0.83yrs) constituted 98% of the subjects in the analysed groups. The size of the sample selected had to ensure that the survey could be completed within 1 week. Students who were absent on the day of the study due to illness or for other reasons were excluded from the experiment.

The current study on the popularity of sauna bathing was developed by a member of the Department of Physical Education and Sport at the university in question, who heads the cross-

sectional project entitled, “A Health-Conscious University”. The aim of the programme was to examine the popularity of sauna bathing among young men entering university. Sauna bathing does not form part of physical education (PE) curricula in Polish universities. Therefore, this study is a unique and pioneering undertaking, which provided students with sauna access during compulsory PE classes. The vast majority of the analysed subjects were first-year male students. The characteristics of the study group is presented in Table 1.

Table 1. **CHARACTERISTICS OF 550 MALE STUDENTS PARTICIPANTS**

Place/Location:		**Rural area**	**Small town**	**Large town**	**Small city**	**Large city**
Permanent residence	n	145	205	105	44	51
	%	(26.36)	(37.27)	(19.09)	(8.00)	(9.27)
Secondary school	n	6	106	291	86	61
	%	(1.09)	(19.27)	(52.91)	(15.64)	(11.09)

Type of school		**Gen. education school**	**Vocational school**
	n	437	113
	%	(79.45%)	(20.55)

Educational. background		**Primary**	**Secondary**	**Higher**
Father	n	112	211	227
	%	(20.36)	(38.36)	(41.27)
Mother	n	146	324	80
	%	(26.55)	(58.91)	(14.55)

Students' monthly budget		**<1000 PLN**	**1000-1500 PLN**	**1501-2000 PLN**
	n	305	240	5
	%	(55.45)	(43.64)	(0.91)

This study complements cross-sectional projects that have been conducted biannually since 2000 with the involvement of first-year students at the university in Poland to determine the lifestyle and motor fitness levels among young male adults (Podstawski *et al*., 2013a). The experiment was performed on homogeneous male groups for ethical reasons. Visitors to a sauna have to undress, and female participants could feel uncomfortable in the presence of men. Men and women have different preferences with regard to relaxation treatments, which can be partly attributed to the fact that women dedicate much more time to personal care (hair styling, make- up, etc.). Female participants could also be menstruating during the study, which would negatively affect their sense of well-being and influence the results of the experiment. A homogeneous sample supported accurate determination of relationships between sauna usage

and psycho-physical well-being. The overwhelming majority of the students were permanent residents of a region in north-eastern Poland.

The largest group of the analysed students resided permanently in small towns (37.27%) and rural areas (26.36%), followed by large towns (19.09%), large cities (9.27%) and small cities (8%). More than half of the respondents attended secondary schools in large towns (52.91%), whereas the smallest number of participants graduated from secondary schools in rural areas (1.09%). Nearly 80% (79.45%) of the respondents graduated from secondary schools of general education and the remaining 20% were from vocational schools. The highest number of students had fathers who were university graduates (41.27%), and mothers who were secondary school graduates (58.01%). In the smallest group of respondents, both mothers and fathers completed their education at the primary level (20.36% & 26.55%, respectively). More than half (55.45%) of the 550 respondents had monthly budgets of PLN 1000 (approximately USD 323) and the budgets of 43.64% of the subjects ranged from PLN 1000 to 1500 (USD 323- 484). Only 1 student had a monthly budget of PLN 1501 to 2000 (USD 485-645), and budgets higher than PLN 2000 (USD 645) were not encountered.

Ethics

The study was conducted with the prior approval of the Ethical Committee of the university. All participants were volunteers who signed informed consent forms before the study.

Self-administered questionnaires

Two anonymous questionnaires were used in the study. The first questionnaire was completed by the respondents immediately after a visit to the sauna, while the second questionnaire was completed based on the answers given by the respondents during a telephonic survey on the following day. The first questionnaire (completed immediately after a visit to the sauna), constituted of closed-ended questions, as well as open-ended questions, such as:

- "Please grade your psycho-social well-being on a 10-point scale, where 1-4 points denote low satisfaction, 5-6 points moderate satisfaction and 7-10 points high satisfaction";
- "How would you describe your feelings right now?" In this open-ended question, the respondents were asked to describe their feelings in their own words;
- In a closed-ended question, the participants were asked to indicate whether they would be willing to visit a sauna in future;
- In the last part of the questionnaire, the students were asked to state their gender, age and provide the following information describing their socio-economic status (independent variables): place of permanent residence; educational background of parents; students' monthly budget; location of their secondary school; the type of secondary school; and the influence of the above factors on the frequency of sauna usage.

At the end, respondents were given a slip of paper with the ID number of their questionnaire, and they were asked to present the ID number to a researcher who would contact them by telephone on the following day. This procedure was used to maintain anonymity and match the responses provided in the first and second questionnaire. On the following day, after the respondents had used the sauna, they were contacted by a researcher by telephone and asked to

complete the second questionnaire. The questions were identical to those used in the first questionnaire:

- Closed-ended question: “Please grade your psycho-social well-being on a 10-point scale, where 1-4 points denote low satisfaction, 5-6 points moderate satisfaction, and 7-10 points high satisfaction”;
- Open-ended question: “How would you describe your feelings right now?” The researcher wrote down the exact answer provided by the participants in their own words.

In this study, socio-economic status is defined as “an economic and sociological combined total measure of a person’s work experience and of an individual’s or family’s economic and social position in relation to others, based on income, education and occupation” (APA, 2015:1). The concept of psycho-physical well-being is part of the WHO’s definition of health: “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (Grad, 2002:984).

Analysis of data

The results were processed by the Statistica PL v. 10 programme using basic statistical procedures (Stanisz, 2008). Descriptive statistics were obtained and the structure indicator was determined at a significance level of $\alpha=0.05$. Differences were regarded as statistically significant when the calculated p-value was lower than α ($p<\alpha$). The following residential categories were established for the needs of this study: village and small town (population less than 20,000); large town (population of 20,000 to 50,000); small city (population of 50,000 to 100,000); and large city (population higher than 100,000).

RESULTS

A statistical analysis of the relationships between the evaluated environmental factors (place of permanent residence, mother’s and father’s educational background, students’ monthly budget, location of their secondary school and type of secondary school), and the popularity of sauna among male students revealed statistically significant differences ($p<0.05$) in most cases (subcategories within a given factor). The number of respondents who had not visited a sauna in the past was significantly higher than the number of participants who had. The only exception ($p>0.05$) were students who resided permanently in a small town ($p=0.1225$), whose mothers were university graduates ($p=0.2432$), who had monthly budgets of PLN 1501-2000 ($p=0.0877$), and who graduated from secondary school in a rural area ($p=0.2023$).

Factors such as place of permanent residence ($p=0.16$), mother’s educational background ($p=0.55$), students’ monthly budget ($p=0.17$) and type of secondary school ($p=0.17$) were not significantly correlated with the frequency of sauna usage by the surveyed students. For this reason, further analyses of the frequency of sauna usage were narrowed down to statistically significant correlations between the evaluated factors. The influence of selected socio-economic factors (father’s educational background and secondary school location), on the frequency of sauna usage and the influence of psycho-physical well-being resulting from sauna usage on the popularity and frequency of sauna usage are presented in Tables 2 to 4.

Table 2. **INFLUENCE OF EDUCATIONAL BACKGROUND OF FATHERS ON FREQUENCY OF SAUNA USAGE**

Frequency of sauna usage	Father's educational background					
	Primary		Secondary		Higher	
	n	(%)	n	(%)	n	(%)
1-2 times in life	19	(54.29)	50	(60.24)	43	(46.24)
3-20 times in life	10	(28.57)	16	(19.28)	15	(16.13)
1-2 times a week	3	(8.57)	7	(8.43)	7	(7.53)
1-3 times a month	0	(0.00)	6	(7.23)	17	(18.28)
1-6 times a year	3	(8.57)	4	(4.82)	11	(11.83)
Total	35	(100)	83	(100)	93	(100)

Degree of freedom = 8
Probability of exceeding the calculated value of chi-square p = 0.04
Chi-square value = 16.344

Differences are statistically significant at $p<0.05$

The influence of educational background of the parents on the frequency of sauna usage among male students is presented in Table 2. The results of an analysis of the frequency of sauna usage indicate that the highest percentage of participants had visited a sauna once or twice in their lives regardless of their fathers' educational background. Students who visited a sauna more often (1 to 3 times a month and 1 to 6 times a year), were more likely to have fathers with a university degree. The results of the above analysis suggest that the educational background of the father significantly influenced (p=0.04) the frequency with which their sons used the sauna.

Table 3. **INFLUENCE OF SECONDARY SCHOOL LOCATION ON FREQUENCY OF SAUNA USAGE**

Frequency of sauna usage	Location of secondary school				
	Rural area	Small town	Large town	Small city	Large city
	n(%)	n(%)	n(%)	n(%)	n(%)
1-2 times in life	2(100)	30(69.77)	65(50.39)	8(29.63)	7(70.00)
3-20 times in life	0	1(2.33)	20(15.50)	17(62.96)	3(30.00)
1-2 times a week	0	0	16(12.40)	1(3.70)	0
1-3 times a month	0	11(25.58)	11(8.53)	1(3.70)	0
1-6 times a year	0	1(2.33)	17(13.18)	0	0
Total	2(100)	43(100)	129(100)	27(100)	10(100)

Degree of freedom = 16
Probability of exceeding the calculated value of chi-square $p \approx 0.0001$
Chi-square value = $1{,}09195E^{-08}$

Differences are statistically significant at $p<0.05$

The influence of the location of their secondary school on the frequency of sauna usage is presented in Table 3. Based on an analysis of the frequency of sauna usage relative to the location of secondary school, students who attended secondary schools in rural areas were excluded from the study due to the small size of the sample (6 persons, of whom only 2 had visited a sauna). The highest percentage of students who had frequented a sauna once or

twice in their lives completed their secondary education in small towns (69.77%), large towns (50.39%) and large cities (70%). Most students who graduated from secondary schools in small cities had visited a sauna 3 to 30 times in their lives (70%). The above findings indicate that the frequency of sauna usage among male students was significantly linked (p=0.0001) with the location of their secondary school.

Table 4. **PSYCHO-PHYSICAL WELL-BEING AND ITS INFLUENCE ON STUDENTS' PROPENSITY TO SAUNA USAGE IN FUTURE**

Rating	Would you use a sauna again?	Level of well-being during sauna usage			Level of well-being on following day		
		n	Structure indicator	p-Value	n	Structure indicator	p-Value
1	Yes	1	0.0018	0.1598	2	0.0036	0.2826
	No	0	0.0000		1	0.0018	
2	Yes	2	0.0032	0.0795	2	0.0036	0.5000
	No	0	0.0000		2	0.0036	
3	Yes	3	0.0055	0.1545	6	0.0109	0.1604
	No	1	0.0018		3	0.0055	
4	Yes	2	0.0036	0.2826	6	0.0109	0.1604
	No	1	0.0018		3	0.0055	
5	Yes	7	0.0127	0.1841	11	0.0200	0.1106
	No	4	0.0073		6	0.0109	
6	Yes	8	0.0145	0.0668	10	0.0182	0.0967
	No	3	0.0055		5	0.0091	
7	Yes	21	0.0382	**0.0030**	23	0.0418	**0.0001**
	No	4	0.0073		4	0.0073	
8	Yes	50	0.0909	**0.0000**	47	0.0855	**0.0000**
	No	3	0.0055		2	0.0036	
9	Yes	45	0.0818	**0.0000**	43	0.0782	**0.0000**
	No	2	0.0036		3	0.0055	
10	Yes	53	0.0964	**0.0000**	30	0.0545	**0.0000**
	No	1	0.0018		2	0.0036	

Differences statistically significant at p<0.05

The students' psycho-physical well-being on the day of the sauna treatment and on the following day is presented in Table 4. The vast majority of the students (N=179) gave very high ratings to their sauna experience (7 to 10 points). In the above group, significantly more respondents would be interested in visiting a sauna in future based on ratings: 7 (p=0.0030), 8 (p=0.0000), 9 (p=0.0000) and 10 (p=0.0000). Similar results were noted in the group of 154 students who described their psycho-physical well-being as "very good" on the day following the sauna treatment, namely ratings: 7 (p=0.0001), 8 (p=0.0000), 9 (p=0.0000) and

10 (p=0.0000). Interestingly, in the group of students who ranked their psycho-physical well-being as moderate (5 to 6 points) or low (1 to 4 points), the percentage of respondents who would be inclined to use a sauna in the future was higher than the percentage of students opposed to the idea, yet the differences were not significant. The above observations indicate that a sense of well-being after sauna bathing significantly contributed to sauna usage.

DISCUSSION

The results of this study have significant theoretical and practical implications and can be used to promote sauna bathing among university students in Poland and other countries. In this study, socio-economic factors, such as the place of permanent residence, mothers' educational background, students' monthly budget and type of secondary school had no significant influence on sauna usage among males 19 to 20 years old residing in a region in north-eastern Poland.

It could come as a surprise since dry sauna is widely used in sport, recreation and rehabilitation, therefore, its popularity would be expected to be equally high in Poland. Most sport and recreational centres and water parks in Poland are equipped with spa facilities, dry and steam saunas. This is also the case in the specific region in Poland, a popular tourist destination that abounds in recreational facilities promoting health and physical fitness. The vast number of hotels, sport and recreational centres, spas and sauna parlours provide local inhabitants with extensive access to such amenities in both urban and rural areas. Students who find seasonal employment in such facilities are usually allowed access to a sauna for health reasons. In Finland, saunas are immensely popular, and they were even included in a national survey of the most popular pastimes (OSF, 2013).

At the university where the current study was conducted, all students have free access to spa facilities during PE classes held at the swimming pool, including sauna, whirlpools and other equipment. After a 60-minute swimming class, students are allowed to use spa facilities (sauna, whirlpool, etc.) for 30 minutes. It could seem that such a wide range of recreational options would encourage students to visit a sauna on a regular basis. In the student community, sauna bathing could also be expected to be a popular pastime that promotes a healthy and physically active lifestyle. Therefore, male students who attend swimming classes could be expected to take up sauna bathing as a regular leisure activity after exercise (Podstawski *et al*., 2013b). The low popularity of sauna among the students at the university in question, despite free access to modern facilities and free-swimming lessons, could indicate that most students are poor swimmers or have never learned to swim (Podstawski *et al*., 2014). In fact, students regard swimming as more difficult than other activities offered as part of PE classes, and enrolment in swimming courses is usually low. Research has also revealed that very few students use the sauna at home, which indicates that sauna bathing at home is still uncommon and rather incidental (Podstawski *et al*., 2013b).

Most Polish university students have a sedentary lifestyle (Lisicki, 2006; Umiastowska, 2007), and are not engaged in sport outside the compulsory PE classes, which could also explain the low popularity of sauna in this study. This highly undesirable trend was confirmed by cross- sectional studies of male students in the current study (Podstawski *et al*., 2013a; Podstawski & Choszcz, 2014). Research also demonstrated that the majority of Polish students are not aware of the numerous health benefits of sauna bathing (Hannuksela & Ellahham, 2001; Kukkonen- Harjula & Kauppinen, 2006).

The frequency of sauna usage was very low among the surveyed students, and most respondents had visited a sauna several to about 20 times throughout their lives. The two socio-economic factors that were strongly linked with the frequency of sauna usage were the father's educational background (in favour of fathers with a university degree), and location of secondary school (in favour of secondary school graduates from small cities). Perhaps better educated middle-class parents are more likely to visit a sauna with their children. As for the higher frequency of sauna usage in small cities, it should be noted that many small cities in the specific region in Poland have secondary schools that are attended by students from satellite villages and small towns.

The respondents' impressions following a visit to the sauna were interesting and they significantly influenced their interest in future sauna usage. Significantly more students who positively evaluated their psycho-physical well-being on the day of the treatment and on the following day (high ratings on the 10-point scale), were willing to visit a sauna in the future in comparison with the number of students who were less enthusiastic (lower ratings on the 10- point scale). Interestingly enough, some respondents who gave a lower ranking to their psycho- physical well-being on the day after the treatment were still interested in visiting a sauna, which could be attributed to curiosity, the desire to follow a trend or improve their health. The vast majority of students were of the opinion that sauna bathing significantly contributed to their psycho-physical well-being, leaving them refreshed and relaxed. Consequently, sauna treatment can be regarded as a positive contributor to mental health, which is a very important consideration during their attendance of the university. A study investigating male students of the same university demonstrated that only 0.53% of the participants visited a sauna to relieve tension (Podstawski *et al.*, 2013c). University years generally involve high levels of stress, in particular during the examinations (Bayram & Bilgel, 2008).

Students with adaptive personalities thrive at university, whereas others lack the emotional maturity to cope with stress and rise to the challenge of university experience (Pope, 2001). Research demonstrated that problem solving and alcohol use are the most common coping strategies among men (Wang *et al*., 2009; Esper & Furtado, 2013). A study of Polish male university students revealed high levels of binging and alcohol consumption, which indicates that young males have poor stress management skills (Podstawski *et al*., 2013a). Despite such alarming data, health promotion campaigns are rarely launched in academic communities. Polish universities are in dire need of such programmes to bridge the gaps resulting from discrepancies in the socio-economic status of students.

In Poland, mortality rates among adult males have been increasing steadily since the 1990s (Zatoński, 1996), which can be attributed to the growing incidence of lifestyle diseases, exacerbated by poor nutrition and low levels of physical activity (Wojtyniak *et al*., 2012).

Similar trends are observed around the world (Ferreira *et al*., 2006; Hennenberg & Grantham, 2014). The continuing rise in male mortality rates (Bartosińska *et al*., 2005) could have catastrophic consequences for Poland (Jopkiewicz, 1998). According to a World Bank report, Poland's productive output could be seriously compromised by high mortality rates among people of working age, high costs of living and medical treatment for people suffering from chronic diseases. In the experts' opinion, this trend could significantly obstruct Poland's continued economic growth (Feachem, 1994).

LIMITATIONS

To date, no other studies have examined the relationship between sauna usage and socio-economic factors, therefore, the current results could not be compared with those of Polish or foreign research. There have been no published studies into the use of saunas in PE curricula across Polish universities; therefore, the current research is a pioneering undertaking in this respect. It would be very difficult to expand this research into foreign academic communities because PE is no longer mandatory in institutions of higher education in most countries around the world. In Poland, PE classes are still compulsory at university, which provides academic instructors with a unique opportunity to promote physical activity and shape the students' pro- health attitudes.

CONCLUSIONS

The presented empirical results were obtained in a survey of a representative sample of 550 first-year male students enrolled in a state university with a varied educational profile. The respondents had varied academic interests in the area of humanities, social sciences, arts, biomedical sciences and technical sciences. The social and demographic profile of the surveyed population was representative of Polish male students attending state universities and these results could be generalised to such a population.

In this study, socio-economic factors did not exert a significant influence on the popularity of sauna among 19- to 20-year-old male university students. Statistically significant differences were observed only between the frequency of sauna usage and the following environmental factors: fathers' educational background; and location of their secondary school. The survey of the sense of psycho-physical well-being of the respondents revealed that the vast majority of students felt refreshed and relaxed during the treatment and on the following day. The above indicates that sauna has a highly positive influence on the psycho-physical well-being of students.

The results of other studies also indicate that sauna delivers health promoting effects, which justifies its use as an effective relaxation technique in health and physical activity programmes. The impact of the analysed factors was evaluated only partially because sauna enjoyed relatively low popularity among the students. Further work is needed to investigate the relationships between environmental parameters and sauna usage among university students by extending the range of examined factors to include sex and age. The popularity of sauna during obligatory and voluntary physical activity programmes could also be investigated among students of other Polish and foreign universities. Attempts could be made to popularise sauna treatments at another Polish university as part of health promotion programmes addressed to

students. Such programmes would expand knowledge about the influence of sauna on physiological and cardio-metabolic parameters.

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Dr. Robert Podstawski: Department of Physical Education and Sport, University of Warmia & Mazury in Olsztyn, ul. Prawocheńskiego 7, 10-720 Olsztyn. Tel.: (89) 523-33-08, Mobile: +48 601 65 25 27, Email: podstawskirobert@gmail.com

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EFFECTS OF EXERCISE TRAINING ON PERFORMANCE AND FUNCTION IN INDIVIDUALS WITH CEREBRAL PALSY: A CRITICAL REVIEW

Phoebe RUNCIMAN[1,4], Ross TUCKER[5], Suzanne FERREIRA[2], Yumna ALBERTUS-KAJEE[1] & Wayne DERMAN[3,4]

[1] *Division for Exercise Science and Sports Medicine, University of Cape Town, Cape Town, Republic of South Africa*

[2] *Department of Sport Science, Stellenbosch University, Stellenbosch, Republic of South Africa*

[3] *International Olympic Committee Research Centre, Cape Town, Republic of South Africa*
[4] *Institute of Sport and Exercise Medicine, Department of Surgery, Stellenbosch University, Stellenbosch, Republic of South Africa*
[5] *Department of Medicine, University of the Free State, Bloemfontein, Republic of South Africa*

ABSTRACT

This critical review article describes the exercise performance capabilities, and the effect of exercise training interventions, in individuals with cerebral palsy (CP). A literature search was conducted using PubMed, Medline, Embase, Scopus, Web of Science, Science Direct and Google Scholar databases from the earliest possible date to December 2014. Large impairments in exercise performance have been reported in individuals with CP, as well as large improvements following the implementation of training interventions. The physiology underlying the functional and physical impairments in CP were also reviewed, and grouped into categories, namely: motor impairments, central impairment, skeletal muscle morphology and physical inactivity. Although much research exists on individuals with CP, there is conflicting evidence for the benefits of exercise training in these individuals. This is due to the use of sedentary, paediatric populations and varied methodologies. Investigating individuals who have undergone high-volume exercise training from a young age might result in a better understanding of functional and physical performance in individuals with CP.

***Key words*:** Disability; Physical activity; Rehabilitation; Physiology.

INTRODUCTION

Origins of and definitions for cerebral palsy

Cerebral palsy (CP) was first termed "Little's Disease" after Dr. William John Little (1810-1894), who was the first to study infantile malformation, and the first to characterise spastic diplegic CP, attributing the condition to trauma at birth. Sir William Osler (1849-1928) later introduced the term "cerebral palsy" during his extensive clinical research on children with CP. Sigmund Freud (1865-1939), although not recognised for many years, contributed significantly

to the area of CP research by identifying pre-natal causes of the condition, as well as grouping the different forms of CP under the umbrella term "infantile cerebral palsies" (Osler.W., 1889; Longo & Ashwal, 1993). Cerebral Palsy, defined by Bax in 1964 as "a disorder of posture and movement due to a defect or lesion of the immature brain" (Bax, 1964:295) has an estimated incidence of 2.5 per every 1000 live births (Rosen & Dickinson, 1992). The definition has since been expanded to include a group of movement disorders caused by damage to the immature brain before, during, or directly after birth. The damage occurs in one or more of three main areas in the brain controlling movement, namely the motor cortex, cerebellum and basal ganglia (Bialik & Givon, 2009). Hypertonic CP is the most common form of CP, with athetoid, ataxic and mixed CP being less common (Reddihough & Collins, 2003). Limb distribution of the impairment is present in three main categories, namely hemiplegic, diplegic and quadriplegic impairment (Rosenbaum *et al.*,

2010).

Cerebral palsy and sport participation

Participation in competitive sport by individuals with disabilities is a relatively new phenomenon, with the first organised sports competition for disabled individuals held in 1948 for World War II veterans with spinal cord injuries. Between 1948 and 1960, the International Stoke Mandeville Games grew in size and eligible impairment types, until the first Paralympic Games were held in Rome in 1960. The Paralympic movement has grown over the years, with more than four thousand athletes from 164 countries competing in the 2012 London Paralympic Games, a significant increase from the 2008 Beijing Paralympic Games which hosted 3951 athletes from 146 countries (Anon, 2014). Athletes with CP compete in many sports, but predominantly athletics, football, swimming and boccia.

Research in cerebral palsy

With the growth of both clinical and sporting populations with CP over the last century, research in CP has been carried out, predominantly addressing the need for improved quality of life. Many interventions have aimed to address quality of life, exercise therapy being an example. The use of exercise in the treatment and management of individuals with CP has yielded positive results from both traditional and alternative methods (Damiano & Abel, 1998; Zadnikar & Kastrin, 2011).

The majority of these studies, however, have focused on quality of life within severely affected paediatric patients, and not exercise performance capacity in athletic adults, due in part to the relative urgency for research within highly affected populations. Although exercise performance measures are often reported in these studies, no studies to date have definitively described exercise and performance capacities of children and adults with CP from a sports performance perspective. Moreover, there is neither consistent nor longitudinal evidence for the use of exercise training to improve sport performance in this patient population.

PURPOSE OF STUDY

To provide consistency on this clinical condition, the present review summarises the current literature on the exercise and performance capacities of individuals with CP, describing: (1) the effect of CP on specific aspects of exercise performance; (2) the response to exercise training and results of interventions aimed at improving these aspects; and (3) how the physiology

underlying the functional or physical impairments present in CP can be better understood. For a complete summary of the intervention studies included in this review, see Table 1 later.

METHODOLOGY

A literature search was conducted using PubMed, Medline, Embase, Scopus, Web of Science, Science Direct and Google Scholar databases from the earliest possible date to December 2014. The medical subject heading (MeSH) terms included *cerebral palsy*, *brain injury*, *spasticity* and related terms. The search terms, matched with the MeSH included

classification, adult, athlete, exercise training, strength, aerobic, anaerobic, agility, speed, flexibility, electromyography, muscle morphology, physical inactivity and related terms. Abstracts were screened, and individual articles were selected based on quality and focus of the studies. Furthermore, the reference lists of articles were also searched for further studies. Only studies published and available in the English language were included.

This review primarily investigated individuals with CP, and excluded individuals with traumatic brain injury or other neurological disorders causing movement abnormalities. For clinical purposes within research, the functional abilities of individuals with CP have been classified into five discernible groups within the Gross Motor Function Classification System (GMFCS) (Palisano *et al.*, 1997). The system is scored from minimally affected (level I, unaided ambulation) to severely affected (level V, permanent wheelchair use) individuals with CP. For the purpose of this review, only studies using individuals in the GMFCS levels I and II were reviewed (Rosenbaum *et al.*, 2008). This ensured an appropriate comparison of functional performance between individuals with truly ambulant CP and typically-developed able-bodied individuals, as GMFCS classifications beyond level II infer the use of assistive devices or wheelchairs, which would not enable close functional matching.

Also, due to the scarcity of literature in athletic adult samples, studies using paediatric samples have been reviewed. Any literature identified in adults or athletes in GMFCS levels I and II were included.

RESULTS

Strength

Weakness in individuals with CP has been widely demonstrated, with strength impairments ranging from 30 to 73% in children (Elder *et al.*, 2003; Stackhouse *et al.*, 2005; Reid *et al.*, 2010) and 12 to 52% in adults (Van Meeteren *et al.*, 2007; De Groot *et al.*, 2012; Hussain *et al.*, 2014). Only one of these studies (De Groot *et al.*, 2012) used an athletic adult sample of cycling and soccer athletes. They reported an isometric knee extension strength impairment ranging between 31 and 47% in elite soccer players and cyclists with CP, compared to able-bodied soccer players and cyclists (De Groot *et al.*, 2012). Interestingly, a study examining jump performance in elite soccer players with CP found similar vertical ground reaction forces in the athletes with CP, compared to previous results in athletes without CP with 1.92 body weight for athletes with CP versus 1.51 body weight for able-bodied athletes (Camara *et al.*, 2013).

The most compelling studies that support the benefits of strength training in individuals with CP have found improvements of between 13 (Reid *et al.*, 2010) and 69% (Damiano & Abel, 1998) from six weeks of traditional strength training in hemiplegic and diplegic children in GMFCS levels I and II. This large range is the likely result of variation in methodology, differences between the size of muscle groups trained (smaller upper muscle group and improvement vs. larger lower limb muscle group and improvement), as well as normal inter-individual variations in response to training. Studies conducted on adults show similar results in strength gains, but with longer intervention periods (10 to12 weeks) (Andersson *et al.*, 2003; Ahlborg *et al.*, 2006; Johnston & Wainwright, 2011).

With the upper limit of strength improvement in clinical studies being 69%, it is an

intriguing question to ask whether individuals with CP can train strength to within the "normal" range of able-bodied individuals. There is no literature which definitively answers this question, but the investigation of athletes with CP, who have undergone high loads of strength training may provide clarity on this issue.

Of particular interest is the effect of strength training on the asymmetry between the affected and non-affected sides after training. This asymmetry has been found to be reduced, though not eliminated, by strength gains in hemiplegic individuals, suggesting a larger potential for strength gains on the affected side. In a study conducted by Damiano and Abel (1998), a 24% asymmetry was measured after the six week strength training intervention, and while this was a reduction from a pre-training asymmetry of 42%, the authors did not speculate whether a longer training intervention would further minimise this difference (Damiano & Abel, 1998). Their finding does, however, invite this possibility.

Aerobic capacity

The aerobic capacity of children with CP has long been recognised as limited compared to that of typically developing children (Verschuren & Takken, 2010). Reductions in VO_2 peak ranging from 15 to 42% compared to healthy controls indicate a compromised aerobic capacity in paediatric studies (Rieckert *et al.*, 1977; Hoofwijk *et al.*, 1995; Maltais *et al.*, 2005; Verschuren & Takken, 2010). These findings have been supported by 23 to 45% and 21 to 61% impairments in VO_2 peak in adult men and women, respectively (Fernandez *et al.*, 1990; Nieuwenhuijsen *et al.*, 2011).

Comparing able-bodied controls to aerobically trained athletic adults with CP, VO_2 peak was found to be 0.3 and 21% lower VO_2 peak for athletes in GMFCS levels I and II, respectively. This is significantly closer to age-matched controls compared to other studies conducted on sedentary individuals with CP (De Groot *et al.*, 2012), and suggests a potential benefit of exercise training.

Aerobic exercise interventions have been implemented in children as young as two years old (Mattern-Baxter *et al.*, 2009). Although existing intervention studies differ in terms of samples studied, testing methods, intervention structure and outcome measures, the general finding is that exercise training improves aerobic capacity significantly (Damiano & DeJong, 2009).

Self-selected walking speed, often used as an outcome measure for aerobic capacity in young children with CP in a clinical setting, increased after training interventions, along with energy

efficiency (Blundell *et al.*, 2003; Chan *et al.*, 2004; Phillips *et al.*, 2007; Provost *et al.*, 2007; Gorter *et al.*, 2009; Chrysagis *et al.*, 2012). A more rigorous testing method using the lactate threshold to determine exercise intensity has reported a 20% increase in aerobic capacity in children and a 12% increase in aerobic capacity in adults, using a similar protocol (Pitetti *et al.*, 1991; Shinohara *et al.*, 2002). Of interest in these studies was that arm ergometry power output was unchanged as a result of the exercise intervention, whereas leg ergometry power output improved significantly, indicating larger aerobic capacity when training larger muscle groups, as proposed previously (Shinohara *et al.*, 2002).

Anaerobic capacity and agility

Anaerobic performance of children with CP, assessed using the 30-second Wingate test, has been found to be two to four standard deviations lower than in typically developing children. Other studies report a 27 to 46% impairment in peak power output in children with CP using a 20 second Wingate test (Bar-Or, 1986; Parker *et al.*, 1992; Verschuren *et al.*, 2010; Balemans *et al.*, 2013).

Comparisons of agility between CP and control groups are limited. From the available literature, we found that the average time to complete a repeat sprint agility task was 39% longer in children with CP. Indeed, some participants with CP took over 60 seconds to complete a task that took only 19.5 seconds for the able-bodied participants to complete (Verschuren *et al.*, 2010).

There is also limited research on the potential to increase anaerobic capacity and agility with training in individuals with CP. In the only study found, Verschuren *et al.* (2007) reported a 25 and 15% increase in anaerobic capacity and agility, respectively, following an eight month intervention targeting these variables (Verschuren *et al.*, 2007). This intervention is one of the longest duration interventions in individuals with CP, and also included a four-month follow- up after completion of the study. This follow-up, during which time no supervised training or encouragement to train was provided, revealed a 9 and 4% reduction in anaerobic capacity and agility from peak values achieved at the end of the 8-month programme.

Flexibility

Although lack of flexibility and the presence of contractures has been well documented in individuals with CP, it has not yet been concluded whether training interventions can successfully improve flexibility. Some interventions have found improved dynamic flexibility, muscle tone and reduced hypertonia with the use of stretching interventions (McPherson *et al.*, 1984; Dickin *et al.*, 2013), while other studies found no change in flexibility, despite positive changes in other parameters, like hypertonia and functional ability (O'Dwyer *et al.*, 1994; Darrah *et al.*, 1999; Low *et al.*, 2003). The differences in these studies may be explained, again, by the age of the participants. The one study that reported only positive change in flexibility was conducted by McPherson *et al.* (1984) in children with CP, while the other studies that reported varying or inconclusive results were conducted on adolescents or adults with CP.

Table 1. SUMMARY OF INTERVENTION STUDIES INCLUDED IN REVIEW

Study	Participants	Intervention			Outcomes
		Type	Duration	Frequency	
Strength					

Ahlborg *et al*., 2006	Training group with CP: n=7 (21-41 years) Control group with CP: n=7 (21-41 years)	Training group: Whole body vibration therapy Control group: Strength training			• Spasticity • Isokinetic strength • 6 minute walk test • Timed up and go test • Gross motor function test	*Trai* decr *Trai* imp *Con* imp *Trai* *Con* *Trai* *Con* Trai sign
Andersson *et al*., 2003	Training group with CP: N=10 (23-44 years) Control group with CP: N=7 (25-47 years)	Strength training	10 weeks	2 days/week	• Spasticity • Range of movement • Isometric strength • Concentric strength • Eccentric strength • Gross motor function measure	NS NS *Trai* imp flex *Con* *Trai* imp kne *Con* NS *Trai* diff *Con*
					• 6 minute walk test • Timed up and go	*Trai* imp wall *Con* *Trai* diff *Con*
Damiano & Abel, 1998	CP: N=11 (6-12 years) Diplegic group: N=6 Hemiplegic group: N=5	Strength training	6 weeks	3 days/week	• Isometric strength • 3D gait analysis • Gross motor function measure	*Dip* *Hem* affe *Una* 24% mai Asy Imp
Healy *et al*., 1958	CP: N=5 (8-16 years)	Concentric and isometric strength training	8 weeks	3 days/week	• Concentric strength • Isometric strength • Knee ROM	Sign Sign NS

Johnston *et al*., 2011	CP: N=1 (49 years)	Cycling with superimposed electrical stimulation	12 weeks	3 days/week	• Spasticity • 6 minute walk test • Timed up and go test • Concentric strength • Gait parameters • Medical outcomes study 36-item health survey • International classification of functioning, disability and health	NS NS Sign Hip Hip NS Sign Sign
MacPhail & Kramer, 1995	CP: N=17 (12-20 years)	Eccentric, isometric, concentric strength training	8 weeks	3 days/week	• Peak torque • Peak work • Spasticity • Efficiency	Stre NS NS
Reid *et al*., 2010	CP: N=14 (9-15 years) Con: N=14 (9-15 years)	Progressive eccentric strength program	6 weeks	3 days/week	• Peak torque to body mass (T/BM) • Work to body mass (W/BM) • Angle at peak torque • Curve width • EMG activation	Con Ecc NS NS ↓ to
Toner *et al*., 1998	CP: N=6 (4-7 years)	Strength training with use of biofeedback	6 weeks	7 days/week	• Strength • Toe tapping ability	NS Imp
Aerobic capacity						
Chan *et al*., 2004	CP: N=12 (4-11 years)	Treadmill training and electrical stimulation	4 weeks	3 days/week	• 3D gait analysis • Ankle moment quotient Ankle power quotient • Gross motor function measure	NS NS NS Sign
Chrysagis *et al*., 2012	Training group with CP: N=11 Control group with CP: N=11	Training group: Treadmill without body weight support Control group: Traditional physiotherapy	12 weeks	3 days/week	• Spasticity • Self-selected walking speed • Gross motor function measure	NS *Trai* impr *Con* *Trai* impr *Con*
Mattern-Baxter *et al*., 2009	CP: N=6 (2.5-3.9 years)	Treadmill training	4 weeks	3 days/week	• Gross motor function measure • Paediatric evaluation of disability inventory • 10m walk test 6 minute walk test	Sign Sign Ove dist

Phillips *et al*., 2007	CP: N= (6-14 years)	Body weight supported treadmill training	2 weeks	2 times/day 6 days/week	• fMRI activation • 10 m walk test 6 minute walk test	fMR Ove dist
Provost *et al*., 2007	CP: N= (6-14 years)	Body weight supported treadmill training	2 weeks	2 times/day 6 days/week	• Energy expenditure • 10 m walk test 6 minute walk test • Single leg balance test • Gross motor function measure	Sign ener Ove dist NS Sign
Shinohara *et al*., 2002	CP: N=11 Leg group: N=6 (13.3-15.8 years) Arm group: N=5 (11.8-16.3)	Anaerobic threshold training Leg group: cycle ergometer Arm group: arm ergometer	20 weeks	2 days/week	• VO_2 at anaerobic threshold • Self-reported endurance capacity	Leg Arm Chil incr only
Anaerobic capacity and agility						
Verschuren *et al*., 2007	CP: N=86 (7-18 years)	Aerobic and anaerobic circuit training	8 months	2 days/week	• Muscle power sprint test • 10 x 5m Sprint test	Ana Agil

Flexibility						
Darrah *et al*., 1999	CP: N=23 (11-20 years)	Active stretching for lower extremities	10 weeks	3 days/week	• Spasticity of triceps surae • Sit-and reach (hamstring flexibility) • Adductor flexibility	NS NS NS
Dickin *et al*., 2013	CP: N=8 (20-51 years)	Individualised whole body vibration therapy	2 sessions	-	• Spasticity • Range of movement • 3D gait analysis	NS Dyn Sign Wal Sign
McPherson *et al*., 1984	CP: N=4 (10-18 years)	Year 1: static stretching Year 2: standing posture devices	2 years	Year 1: 5 days/week Year 2: 7 days/week	• Knee extensor range of movement • Muscle tone	Kne Yea
O'Dwyer *et al*., 1994	CP: N=15 (6-19 years)	Passive stretching	42 days	3 days/week	• Ankle range of movement • Contracture of triceps surae	NS Sign

PROPOSED FACTORS LIMITING PERFORMANCE

Motor impairments and functional performance

One of the explanations for decreased strength, speed and aerobic capacity is the combination of motor impairments present in the complex condition of CP. These include centrally-mediated muscular weakness, incoordination, hypertonia, contracture and co-activation. Incoordination, hypertonia, contracture and co-contraction are all observed in individuals where the central nervous system is disturbed or damaged in some way. Incoordination is the inability of the central nervous system to correctly utilise the proposed pathway to recruit motor units in the correct synchronicity to enable fluid movement (Neptune & Kautz, 2001). Hypertonia and muscle contractures are among the most prominent features in CP, and result in muscles that have increased resting and dynamic tone, rigidity and decreased range of movement. These muscle irregularities are a result of dysfunction, in part, of the stretch reflex found at the third level of the motor control hierarchy (Damiano *et al.*, 2001; Iqbal, 2011).

Movement can be severely affected, as a result of these irregularities. Co-activation is the simultaneous contraction of antagonist muscles during contraction of the agonist muscle, and is usually seen in typically developing individuals in small amounts during everyday activities and increased amounts only when a need for increased joint stability is required, such as when walking over highly unstable surfaces (Osternig *et al.*, 1984). However, co-activation during normal tasks in CP has been highlighted as one of the factors causing impaired performance, by activating both agonist and antagonist muscles to the extent that fluid movement is counteracted due to highly opposing forces on the joints (Damiano *et al.*, 2002). The combination of motor impairments seen in individuals with CP would thus result in abnormal gait patterns, increased energy requirements for the same task, as well as increased time needed to complete the task (Lundberg, 1978; Lundberg, 1984; Damiano *et al.*, 2000). These impairments have been attributed to several large contributing factors, described below briefly.

Central impairment

Stackhouse *et al.* (2005) superimposed electrical stimulation during a maximum voluntary contraction, in order to examine the possible central contribution to impaired performance, and discovered that voluntary muscle activation was 33% and 49% lower in the quadriceps and triceps surae, respectively, compared to able-bodied individuals (Stackhouse *et al.*, 2005).

This demonstrates a substantial impairment in the brain's ability to recruit muscle, which is consistent with other research (Elder *et al.*, 2003). However, the number of motor units available to be used was similar, as measured by M-wave amplitudes, and this suggests under-activation of muscle due to central inhibition (Frontera *et al.*, 1997; Rose & McGill, 2005), rather than an impairment at the level of the muscle or motor neuron junction. This occurs along with co-activation of antagonist muscles (Stackhouse *et al.*, 2005), leading to the theory that muscular impairments observed in individuals with CP are the result of a combination of muscular under-activation (Reid *et al.*, 2010), decreased central input to the muscle due to damage to the supraspinal centres (Leonard *et al.*, 1990) and co-activation of antagonist muscles (Myklebust *et al.*, 1982; Reid *et al.*, 2010).

Skeletal muscle morphology

Several authors have attributed muscular weakness to an identified increase in Type I muscle fibres in lower extremity muscles in children with CP (Rose *et al.*, 1994; Ito *et al.*, 1996; Stackhouse *et al.*, 2005). In addition to Type I muscle fibre predominance, increased intramuscular fat, atrophy and decreased muscle size in the paretic limbs have also been identified as an outcome of CP. These changes have been consistently attributed to sustained

low-frequency muscle fibre firing, caused by hypertonia and altered central drive in muscle affected by CP (Castle *et al.*, 1979; Rose *et al.*, 1994; Ito *et al.*, 1996; Rose & McGill, 2005; Stackhouse *et al.*, 2005; Hussain *et al.*, 2014) and these findings indicate changes at both central and peripheral levels in individuals with CP.

Physical inactivity

It is widely accepted that children with CP engage in less physical activity than their typically developing peers, with almost exclusively negative consequences (Maher *et al.*, 2007; van Eck *et al.*, 2008; Verschuren & Takken, 2010). Durstine *et al.* (2000) proposed a circular mechanism for physical inactivity in disabled populations, whereby individuals with a disability engage in less physical activity, which results in deconditioning which further decreases their level of functioning and thus volitional engagement in physical activity (Durstine *et al.*, 2000). Most of the studies in the area of CP, whether in children or adults, attribute some level of poor performance to a relative lack of exercise training when compared to control groups. Engaging in physical activity, however, has been observed to be one of the most important factors for the successful maintenance of function in this population (Conchar *et al.*, 2014). Therefore, the participation of those with CP in exercise programmes is particularly important, maybe even more so than their typically developing peers, for proper physiological development (Gorter *et al.*, 2009).

CONCLUSIONS

Research on individuals with CP has focused mainly on improving quality of life for severely affected and sedentary children, with little research on exercise performance capacity in adults and athletes with CP. It has been established that individuals with CP: (1) present with a large range of impairments in exercise performance; and (2) improve significantly with participation in exercise training of different modalities. However, most of the studies have been short in duration and predominantly investigated sedentary individuals.

Through reviewing the existing literature on exercise performance impairments in individuals with CP, as well as investigating the possible mechanisms responsible for these impairments, it has become clear that, although CP has been extensively researched, there is conflicting evidence and no solid consensus regarding the effect of CP on human physiology and physical function. This is mainly due to the use of paediatric samples, physical inactivity in the samples investigated, and the relatively short interventions administered. It must also be acknowledged that the grouping of clinical studies and sporting performance studies in this review can make the reporting of results difficult, as these two groups of research prioritise different aspects of physiology. Clinical studies generally prioritise health-related outcomes whereas sporting performance studies prioritise sporting performance and physiology. However, due to paucity

of research in the sporting category, the categories have been grouped in an effort to understand the overall effect of CP on human physiology.

To be able to definitively describe the effect of long-term exercise training on individuals with CP, it is suggested that researchers investigate individuals where the confounding factors of low activity status and age have been eliminated as far as is possible. That is, studying individuals who have participated in high-level training over a long period of time would enable better identification and understanding of the physiological effect of CP on the body. In-depth investigation into an athletic sample would also give insight into the effect of long-term

exercise training on the impairments observed in CP. Studying this population may provide further evidence for the use of exercise as a rehabilitation and management tool in CP, possibly providing improved management for both severely affected and ambulant individuals with CP of all ages.

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Dr Phoebe RUNCIMAN: Institute of Sport and Exercise Medicine, Department of Surgery, Faculty of Medicine and Health Science, Stellenbosch University, Tygerberg Campus, Francie van Zijl Drive, Bellville 7505, Republic of South Africa. Tel.: +27 (0)790 740 097, Email: phoebe.runciman@gmail.com
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OLYMPIC MEDALS: SUCCESS PREDICTIONS FOR RÍO-2016

Patricio SÁNCHEZ-FERNÁNDEZ[1] & Antonio VAAMONDE-LISTE[2]
[1] *Governance and Economics (GEN) Research Network, University of Vigo, Campus Universitario, Ourense, Spain*
[2] *Business School, University of Vigo, Vigo, Spain*

ABSTRACT

Medals are the maximum exponent of successful sporting events. One of the most relevant of these sporting events is the Olympic Games, which gathers major athletes and teams from across the world every four years. Predicting the distribution of the medals at these Games is nothing new. As a matter of fact, this practice gained considerable popularity just before the latest edition of the London-2012 Games. After the games were over, this study took a look at the results and the predictions made at the time to determine which of these predictions had been the most accurate. This information was then used to carry out an estimation exercise to predict the medal distribution for the upcoming edition of the Games in Rio-2016. To guarantee a

greater predictive success, several predictions were carried out in ranges for the main Olympic delegations. The final estimation provides a ranking of medals per country. This classification is consistent with former rankings, especially those of leading countries.

***Key words*:** Olympic Medals; Olympic success; Predictions; Rio-2016.

INTRODUCTION

The Olympic Games are the ultimate sports showcase. These Games follow a long tradition dating back to ancient Greece, which Pierre de Coubertin portrayed in the first edition of the modern Olympic Games in Athens in 1896[1]. The Olympic Charter defines the values of Olympism as "a philosophy of life which exalts and combines the qualities of body, will and spirit as a balanced whole. Blending sport with culture and education, Olympism seeks to create a way of life based on the joy of effort, the educational value of setting a good example and the respect for fundamental universal ethical principles" (IOC, 2014:14). Baron de Coubertin probably never imagined that the movement created in the late 19th century was going to turn into an entirely economic event. The legacy of the Olympic Games, the maximum paradigm of mega-sporting events, is far beyond a mere sport event for the territories hosting them (Hiller, 2000). Sporting success or failure of participating delegations has been analysed and evaluated increasingly from an economic standpoint (Humphreys *et al*., 2011). As Kasimati (2003) points out, a great number of countries considers that this event serves as a showcase for publicity beyond their borders, as well as an engine to spur economic development.

[1] The games took place in Athens from 6 to 15 April 1896 in commemoration of the birth of the Olympic Games in Greece.

Even though the London Games were not the first games to see this, 2012 witnessed the proliferation of predictions and approximations of sporting results for each of the delegations. Once the games were held, the objective for this study was two-fold: (a) to check on the accuracy of past predictions; and (b) to use what was learned from these methods to improve predictions. Following Wicker *et al*. (2012), improved predictions are useful to the participating countries' sport authorities who, in light of this information, may better establish goals, allocate resources, define sport policies or plan activities. All sports can benefit from knowing more about the current situation, as well as knowing more about the expected medium-term situation.

PURPOSE OF RESEARCH

The hypothesis for this research relies on the likelihood of determining Olympic success through more accurate predictions. After checking the extent to which the predictions are fulfilled, new methods were applied in an attempt to improve previous ones. Once this premise is proven, a prediction is made for the Olympic medals for Brazil's Rio de Janeiro-2016 Games. The methods which improve prediction will be submitted jointly but only for those countries where the likelihood of success is greater, namely the ones that will obtain more medals (Forrest *et al*., 2010).

This article is organised as follows. The second section reviews the predictions made of Olympic medals to date with special attention to the predictions made on the occasion of the London-2012 Games. The third section weighs up two key aspects of the prediction process dealing with the variables and the methods applied for several predictions. The fourth section proposes the predictions for the Rio-2016 Games and the final section concludes with the main results of the study.

REVIEW OF OLYMPIC MEDAL PREDICTIONS

Predicting the number of medals obtained by athletes participating in the Olympic Games is nothing new. Indeed, stakes were one of the main attractions of the classic games in competitions like racing or cockfighting, in which the importance of the bet usually overshadows that of actually winning the game. However, as from the 1950s, the importance of the sport component of these games has given way to the ever-increasing importance of economic, sociological and political components which has, in turn, begun to capture the interest of academics and researchers alike. Sporting success is quantified according to the variable "medals won", as well as the type of medal won.

Within the Academia, one of the pioneers in this kind of prediction is Professor Daniel Johnson of the University of Colorado, who made predictions on four Olympic Games using an assorted set of data for his predictions (including economic variables)[2]. Likewise, Andrew Bernard of Dartmouth College has also been making his own predictions since the year 2000[3]. Andreff *et*

[2] A summary of this may be found in:
https://faculty1.coloradocollege.edu/~djohnson/olympics.html
[3] More information in: http://mba.tuck.dartmouth.edu/pages/faculty/andrew.bernard/

al. (2008), Maennig and Wellebrock (2008) and Shibli and Bingham (2008) joined Bernard (2008) and Johnson and Ali (2008) in making predictions for the Beijing Games. Although London-2012 represented the milestone for the moment, the exponential growth of this type of work, this numerical growth came along with the use of more complex techniques and an increased number of variables in the design models. Williams technically implemented Bernard's usual predictions (Williams, 2012). Likewise, the predictions of Johnson and Alonso-Arenas (2012) also became available. Authors, such as Andreff (2010), Forrest *et al*. (2010), Kuper and Sterken (2012) and Nevill *et al*. (2012), all conducted their own predictions in much the same way.

In the private sector, consultants and financial institutions carried out similar studies. The investment bank, *Goldman Sachs*, conducted one of the most wide-spread studies to predict the number of medals for each country at the Games. This financial institution based its predictions on an economic indicator called "Growth Environment Score"[4], which described each country according to the function of its state of development (Goldman Sachs, 2012). *PricewaterhouseCoopers* (2012) made its own projections by using the services of the company, Infostrada Sports, and crossing macro-economic data. In Spain, the consultancy firm, Conento (2012), also developed a statistical model to predict medals for the major countries participating in the London Games. Similarly, the Australian Olympic Committee estimated a rank of medals for the Olympics in 2012 based on the results of the World Championships, World Cups and other major international events[5]. Additionally, the media have not only

echoed the projections, but they have also attempted to use them to make their own predictions. The most relevant examples of this are "medal tracker"[6] of *USA Today* and "virtual forecaster" of Australia's *Herald Sun*[7]. The latter still predicts who will step up on the Olympic podium according to sporting criteria given by experts of the brands used by athletes at each of the international sport meets. Finally, *Financial Times*, elaborated the so-called "consensus estimate"[8], a compendium of a vast number of predictions.

METHODOLOGY

The previous section reviewed the prediction models for the Olympic medals based on calculations and predictions using economic data over recent years. These models use *data mining* techniques to obtain correlations or patterns for cases like those used for this research, in which data is abundant. The starting point within this data-set should purely be sport information, namely the athletic performance of each of the delegations. However, nearly all of the variables used are economic (Flatau & Emrich, 2013). The reason for not using other

[4] This self-elaborated indicator gathers a series of political, economic and social conditions that affect the productivity and growth of these countries.

[5] http://corporate.olympics.com.au/09715C2F-5056-B031-6A82E667D964D795

[6] http://usatoday30.usatoday.com/sports/olympics/medal-tracker.htm

[7] http://www.heraldsun.com.au/sport/london-olympics/medal-table

[8] http://blogs.ft.com/ftdata/2012/07/26/olympic-medal-table-predictions-london-2012/

variables (technical or sport) is the great heterogeneity among the different sports[9] and the fact that this type of information is required for all the countries. Andreff and Andreff (2010) point out that, when predicting, one should bear in mind a number of issues that will affect the final results. Among them are:

- The state/condition of host country (in the current or previous editions);
- The differences between team and individual sports;
- The influence of sport stars; and
- The country's political regime (dictatorship vs. democracy)

Economic variables help explain and predict success in the Olympics, that is, the number of medals won by the athletes in each of the Olympic events. A totally other matter is the extent to which these variables may affect the number of medals that are actually won. Following Bernard and Busse (2004), it may be said that achieving Olympic medals closely correlates with the population and the wealth of a country. The population indicator is evident (although there could be an alternative to the absolute population figure). However, this is not the case when quantifying the second indicator. The first question that arises here is whether wealth should be a relative or absolute term. The relative term, per capita, is the most common.

Recent studies have extended the range of economic variables employed. Complementary to the country's income (measured in terms of GDP), the aforementioned study by Bernard and

Busse (2004), had already incorporated the income level of the population. This same variable was once again present in studies conducted on the occasion of the London-2012 games, for example by the consultancy firm, *PricewaterhouseCoopers* (2012). Since then, additional economic conditions like macroeconomic stability, macroeconomic conditions, human capital, technology and the microeconomic environment (concerning businesses) have also been observed. Finally, Vagenas and Vlachokyriakou (2012) also incorporated aspects like the degree of urbanisation, inflation, unemployment and health expenditure for each of the countries.

As for the prediction methods, Andreff and Andreff (2010) suggest the work of Bernard and Busse (2004) to be "the best economic model developed for estimating and predicting Olympic performance". These authors used a Tobin (1958) model in which the two main independent variables are those identified above: population and gross domestic product. The same model was used by Bian (2005), Forrest *et al*. (2010) and Nevill *et al*. (2012). The other benchmark for Olympic predictions, Johnson and Ali, used a Probit model (Johnson & Ali, 2008). Other authors, like Andreff (2010), used a logit model, while Shibli and Bingham (2008) and PricewaterhouseCoopers (2012) used a linear regression. The regression with panel data has been used as a prediction method by Kuper and Sterken (2012) and Goldman Sachs (2012), while Conento (2012) developed a mathematical model obtained through a Poisson regression[10]. Neural networks have also been employed to predict medals. Such is the case of Condon *et al.* (1999) for the 1996 games. Even though this method was never used for the Games again, it has been used for other mega-events. Hematinezhad *et al*. (2011), for example, used it for the Asian Games[11].

[9] This aspect has an important impact in terms of individual sports as opposed to team sports. In the first case, the medal is for the athlete, while in the second case, the medal is for the team and this affects the final medal count.

RESULTS

Before estimating the medals for the Rio-2016 Games, the study first examined the results of London-2012 to determine which of the predictions had been the most successful. Seven predictions were found to be accurate given that their correlation with the actual medals was above 97% (Table 1).

Table 1. **CORRELATIONS BETWEEN MEDAL PREDICTIONS AND LONDON-2012 RESULTS**

Prediction made by:	**Correlation**	**Number**
Financial Times (UK)	0.9865966	85
Williams (2012)	0.9825133	85
PricewaterhouseCoopers (PWC)	0.9822014	77
Goldman Sachs	0.9818714	48
Herald Sun (Australia)	0.9775409	71

USA Today	0.9773890	71
Johnson (2012)	0.9719374	61

The *pairwise* method was used to optimise the calculation of each coefficient, thus the number is different for each case. The correlations are very high; therefore, all the predictions could be considered fairly accurate. Moreover, the first 2 predictions were good for 85 countries. The first 2 methods are the ones that correlated best with the actual results. This justifies why the researchers chose to focus on them. Of interest is the fact that the *Financial Times* (the most effective) used a combination of various prediction methods for its forecasts.

Table 2 shows the economic variables employed. These variables are conditioned by their availability in *The World FactBook*, which the CIA issues and makes available online periodically[12]. The literature broadly considers the first 2, GDP and population, to be the main factors (Bernard & Busse, 2004; Andreff *et al*., 2008). Data concerning the medals of each country are added to this.

[10] The *USA Today* prediction method is the only one that uses a classification algorithm based on prior recent sports results.
(http://usatoday30.usatoday.com/sports/olympics/medal-tracker.htm)
[11] Celik and Gius (2014) indicate that neuronal networks have been extensively employed in the analysis of sports success in the Olympics, even though predicting was never the purpose.
[12] https://www.cia.gov/library/publications/resources/the-world-factbook/

Five prediction methods were considered: Linear regression model; Poisson regression model; Random Forest (RF); Support Vector Machines (SVM); and Relevance Vector Machine (RVM). The first 2, Linear and Poisson, have already been used in the literature: Shibli and Bingham (2008) and PricewaterhouseCoopers (2012) for the former and Conento (2012) for the latter. The other 3 forecasting methods have not been applied to estimate Olympic medals yet. However, they are being used in other sport fields increasingly. For example, Hothorn and Müller (2010), Schumaker *et al*. (2010) and Demers (2015) use them to carry out their estimations.

Table 2. **VARIABLES**

Variables	**Unit of measurement**
Gross domestic product	$ billions
Population	No. of people
Life expectancy	years
Health expenditure	% of GDP
Employment rate	%
Youth employment rate	%
Gross fixed investment	%
Public debt	% of GDP
Inflation rate	%
Value of stock on the stock market	US$
Direct foreign investment entered	US$

Checking account balance	US$
Exports	$ billions
Imports	$ billions
Gold and currency reserves	US$
Electricity consumption	Billions of kWh
Petrol consumption	Barrels/day
Natural Gas consumption	Cubic meters
Telephones	Landlines in use
Internet users	Number
Railways	km
Roads	km
Airports	Number

The Random Forest is a nonlinear regression method using a large number (500) of regression trees obtained through random permutation. Each tree is constructed by choosing the partition (corresponding to an explanatory variable) at each step which minimises the mean squared error (MSE). This is then applied to a different bootstrap sample obtained from the original data leaving out a third of the cases. This allows one to measure the error rate and avoid overfitting, a problem common to other procedures. The Support Vector Machines (SVM) (Vapnik & Vapnik, 1998) is a non-probabilistic regression model supervised by neural networks. Finally, the Relevance Vector Machine is a Bayesian regression model with neural networks and the same functional form as the SVM, which usually renders better results. The best prediction method was selected as follows. First, a prediction was made for the last games

held, which in this case would be for London-2012. In so doing, use was made of variables, such as sport medals for the previous two games, Beijing and Athens. The regression and prediction methods with the greatest explanatory power were verified and contrasted the results with the actual results obtained in London. After this, these methods were applied to predict the medals for each country at the Rio-2016 Games.

Table 3. **CORRELATION BETWEEN PREDICTIONS AND LONDON-2012 MEDAL RESULTS**

Prediction method	**Correlation with medal results 2012**
Linear regression model	0.9899380
Relevance Vector Machine	0.9879273
Poisson regression model	0.9852042
Support Vector Machines	0.9081173
Random Forest	0.8919492

Table 3 displays the correlations between the number of actual medals in London-2012 and the various predictions in descending order. The top 3 models (Linear, Relevance Vector Machine and Poisson) had a higher correlation with the target variable for the best predictions (*Financial Times* 0.983; PWC 0.980, Williams 0.979). The degree of adjustment of the first 2 may be observed in Figure 1 and Figure 2. This, therefore, justifies the use of the 3 methods to estimate Rio-2016. Table 4 summarises the predictions.

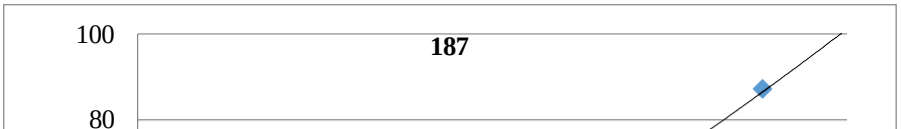

Figure 1. **ADJUSTMENT OF *FINANCIAL TIMES* PREDICTION FOR LONDON-2012**

Table 4. **PREDICTIONS FOR MEDALS IN RIO-2016**

Country	No. predicted medals			Country	No. predicted medals		
	Linear	Poisson	RVM		Linear	Poisson	RVM
United States	101	106	104	Switzerland	6	4	6
China	81	80	88	Ukraine	21	20	6
Russia	87	88	81	Bulgaria	2	2	5
Great Britain	69	60	65	Colombia	9	8	5
Germany	46	47	44	Slovakia	3	4	5
Japan	43	42	37	Slovenia	3	4	5
Australia	30	31	36	Greece	1	1	5
France	31	29	33	Kenya	9	9	5
South Korea	29	31	27	Lithuania	5	6	5
Italy	28	28	25	South Africa	9	10	5
Canada	20	19	17	Trinidad & Tobago	6	5	5
Netherlands	23	23	17	Tunis	5	5	5
Spain	19	20	16	Uzbekistan	6	5	5
Brazil	17	17	13	Venezuela	2	2	5
Mexico	10	11	11	Armenia	3	3	4
Iran	14	14	10	Estonia	2	2	4
Jamaica	12	12	10	Ethiopia	8	8	4
Finland	2	2	9	Georgia	4	4	4

Poland	11	11	9	Latonia	2	2	4
India	7	8	8	Moldova	1	2	4
Morocco	3	2	8	Mongolia	4	4	4
New Zealand	16	15	8	Algeria	3	1	3
Portugal	2	2	8	Ireland	3	4	3
Argentina	0	2	7	Norway	4	5	3
Denmark	9	9	7	Turkey	3	2	3
Egypt	7	6	7	Azerbaijan	5	7	2
Kazakhstan	10	12	7	Bahamas	2	1	2
Czech Republic	9	10	7	Thailand	2	2	2
Dominican Rep.	2	2	7	Chinese Taipei	2	2	1
Singapore	5	3	7	Tajikistan	-1	0	1
Sweden	7	7	7	Belgium	3	2	0
Croatia	8	7	6	Belarus	5	5	0
Cuba	9	11	6	Indonesia	-1	0	0
Hungary	16	17	6	Malaysia	4	3	0

RVM= Relevance Vector Machine

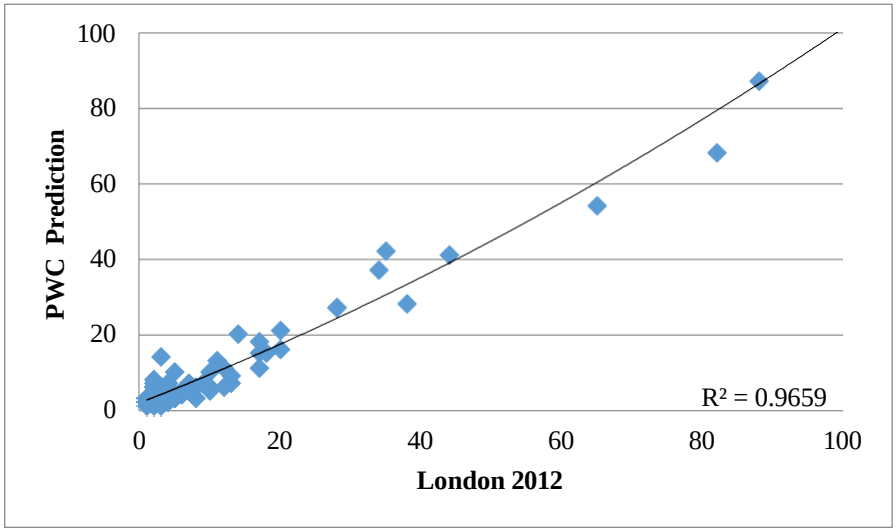

Figure 2. **ADJUSTMENT OF PRICEWATERHOUSECOOPERS PREDICTION FOR LONDON-2012**

CONCLUSIONS

Predicting Olympic Games medals is nothing new. However, the predictions for the latest edition of the 2012 London Olympics witnessed a considerable increase in the methods and variables used for this purpose. This paper provides innovative methodological elements and new statistical techniques to predict sport results better than previous methods have.

Error! Reference source not found shows a summary of the predictions. Following Forrest *et al*. (2010), it combines the three methods at intervals and focuses only on countries with over 10 medals. The width of the window does not indicate a confidence interval; it does not intend to measure the accuracy of the estimate, but rather show the differences between the three proposed models. The authors believe it was more reasonable to apply each of the methods separately. Thus it is up to the reader to judge the adequacy and reliability of each of the methods based on the criteria set (correlation of prediction with actual results in the past for each method) rather than building a single prediction by combining the final results of the different methods[13].

The summary in Table 5 combines the three prediction methods. Presenting a range of possible medals improves the chances of predicting successfully. Countries with a small number of medals are excluded from the prediction because their expected results vary more than the actual results. In this case, the threshold was set at 10 medals; that is, this is a tenth of the medals won by the team winning the most medals. Finally, it is important to stress that medal

[13] A combined prediction does not necessarily improve the degree of adjustment of each of the methods one by one.

ranking is traditionally very stable, especially in terms of the leading countries, although this is less so in terms of positions. The current predictions confirm this.

Table 5. **PREDICTED MEDALS AT RIO 2016: SUMMARY OF MAIN COUNTRIES**

Country	**No. of predicted medals[14]**
United States	101-106
Russia	81-88
China	80-88
Great Britain	60-69
Germany	44-47
Japan	37-42
Australia	30-36
France	29-33
South Korea	27-31
Italy	25-28
Netherlands	17-23
Canada	17-20
Spain	16-20
Brazil	13-17
Iran	10-14
Jamaica	10-12

Mexico	10-11
Poland	9-11
New Zealand	8-16
Kazakhstan	7-12
Czech Republic	7-10
Hungary	6-16
Cuba	6-11
Ukraine	6-21
South Africa	5-10

In conclusion, participating countries are the first to benefit from improved Olympic sporting result predictions. These predictions provide information, in advance, that may help plan medium- and long-term national sport policies. Sport with a greater chance of success will also

[14] This only includes countries expected to win more than 10 medals

benefit because local authorities will presumably focus greater attention on them. Furthermore, improved predictions may also affect the sport industry as a whole given that greater economic resources may be assigned and administered much more efficiently.

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Dr Patricio SÁNCHEZ-FERNÁNDEZ: GEN and University of Vigo, Faculty of Business and Tourism – Campus Universitario, 32004 Ourense, Spain. Tel.: +34 988368720, Email: patricio@uvigo.es

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RELATIONSHIPS AMONG RESIDENCE ENVIRONMENT AND INDIVIDUAL LEVELS OF EXERCISE IN THE REPUBLIC OF KOREA

Seyong JANG[1]; Byoung-Wook YOO[2]; Wi-Young SO[3]& Eun-Ju CHOI[4]
[1] College of Sport Science, Sungkyunkwan University, Suwon, *Republic of Korea*
[2] *Department of Sport Science, SPKOREA, Busan, Republic of Korea*
[3] *Sports and Health Care Major, College of Humanities and Arts, Korea National University of Transportation, Chungju-si, Republic of Korea*
[4] *Division of Sport Science, College of Science and Technology, Konkuk University, Chungju-si, Republic of Korea*

ABSTRACT

The present study explored the relationship among urban and rural residence living and level of exercise in the Republic of Korea. The study analysed the data from the 2012 Korean Survey of Citizens' Sports Participation project with a total of 4,479 males and 4,521 females participating. The sampling method used the square root of the proportional allocation design with clustering and stratifications in such way that the survey sampled represented all the people of the Republic of Korea. Multivariate logistic regression analyses were carried out to examine whether residence was related to frequency, intensity, time and duration of exercise, adjusting for the covariate age. The results show that Korean women in rural areas had lower levels of exercise than their urban counterparts in terms of frequency, time, duration and intensity of the exercise. However, there was little or no relationship among exercise levels and place of residence among Korean men. In addition, Korean men and women in rural areas had lower levels of access to "systematic fitness management", such as fitness instructors and exercise facilities.

***Key words*:** Exercise; Republic of Korea; Residential area.

INTRODUCTION

Exercise has been shown to impact a variety of health outcomes (Andersen *et al*., 2000; Manson *et al*., 2002). For example, the risk for a number of medical outcomes including cardiovascular

disease, type 2 diabetes, obesity and other chronic conditions can be reduced by regular exercise. As a result, national organisations continue to promote public awareness of the benefits of regular exercise (US Department of Health and Human Services, 2010). Additionally, the World Health Organization named proper diet and regular exercise as public health priorities (World Health Organization. 2014). For this purpose, the area of systematic fitness management has also flourished. Examples of systematic fitness management include training in private or national facilities, such as an institute, gym or field with a certified instructor, educator, or trainer.

Due to urbanisation, there have been a number of changes in infrastructure, land use, transportation planning and urban design to public environments (Popkin, 2001; Popkin, 2002). In many developing countries, including China, individuals living in urban areas have higher

rates of individuals that are overweight and obese compared to individuals living in non-urban environments (Caballero, 2001; Lee, 2004; Popkin & Gordon-Larsen, 2004). In spite of this, few studies have considered the links between exercise and urbanisation (Ojiambo *et al*., 2012). Similarly, little work has systematically explored the independent effect of urbanisation on exercise patterns of adults in countries undergoing transition (Popkin *et al*., 1995; Lambert *et al*., 2001).

PURPOSE OF RESEARCH

Most studies on urbanisation classify regions as urban areas by using a simple urban-rural dichotomy in spite of the fact that more detailed classifications are available and have been successfully used in research (McDade & Adair, 2001). Recent findings on the effects of urbanisation on exercise have been mixed. For example, Assah *et al*. (2011) reported that living in urban areas was associated with lower rates of exercise compared to rural areas. However, Short *et al*. (2014) reported that people who lived outside urban areas had a higher risk of being sedentary. A Korean study has yet to examine the relationship between urbanisation and exercise. Hence, the goal of the present study was to explore whether exercise was related to urbanisation in the Republic of Korea.

METHODS

Ethical approval

The details of the data collection procedure are described elsewhere (Korea Ministry of Culture, Sports and Tourism, 2012). As the survey did not collect any private information, such as names, social security numbers or the exact home address, an ethics committee approval was not required. All the study procedures were approved by the Korea Ministry of Culture, Sports and Tourism on 9 September 2013.

Participants

This study used data from the nationwide Korean Survey on Citizens' Sports Participation conducted by the Korea Ministry of Culture, Sports and Tourism. A total of 4,479 males and 4,521 females participated in the survey. The questionnaire-based interview for each participant was conducted by well-trained personnel and each subject filled in the questionnaire during the interview. The sampling method used the square root of the

proportional allocation design within clustering and stratifications for the survey sampling to represent the population of the Republic of Korea. The data of a nationally representative sample of participants were collected and analysed. The characteristics of participants are shown in Table 1.

Dependent variables

Urbanisation was determined by classifying regions from their name designations into either urban ("Dong") or rural ("Eup" or "Myeon") in Korean address designations. "Dong" usually denotes addresses with modern buildings, stores and apartments, whereas "Eup" or "Myeon" are usually for areas surrounded by rice paddies, farms and mountainous areas. Based on responses, participants were divided into 1 of 2 subgroups: [1] urban (reference) or [2] rural.

Table 1. **CHARACTERISTICS OF PARTICIPANTS**

Variables		Male (n=4,479)	Female (n=4,521)
Age (years)	Urban	40.29±18.02	41.55±18.58
	Rural	46.45±18.45	48.01±18.49
Residence	Urban	3,041 (67.89)	3,078 (68.08)
	Rural	1,438 (32.11)	1,443 (31.92)
Systematic fitness management	No	4,200 (93.77)	4,339 (95.97)
	Yes	279 (06.23)	182 (04.03)
Exercise frequency	None	2,061 (46.01)	2,564 (56.71)
	2/3 X per month	290 (06.47)	140 (03.10)
	1 X a week	505 (11.27)	231 (05.11)
	2 X a week	366 (08.17)	290 (06.41)
	3 X a week	420 (09.38)	484 (10.71)
	4 X a week	203 (04.53)	193 (04.27)
	5 X a week	284 (06.34)	310 (06.86)
	6 X a week	120 (02.68)	99 (02.19)
	Every day	230 (05.14)	210 (04.64)
Exercise time (min)	None	2,061 (46.01)	2,564 (56.71)
	Under 59	249 (05.56)	361 (07.98)
	60–119	1,200 (26.79)	1,236 (27.34)
	120–179	632 (14.11)	256 (05.66)
	Over 180	337 (07.52)	104 (02.30)
Exercise duration (months)	None	2,061 (46.01)	2,564 (56.71)
	Under 23	540 (12.06)	598 (13.23)
	24–47	789 (17.62)	692 (15.31)
	48–71	492 (10.98)	354 (07.83)
	72–95	119 (02.66)	72 (01.59)

	Over 96	478 (10.67)	241 (05.33)
Exercise intensity	Almost sedentary	2,061 (46.01)	2,564 (56.71)
	Low level	361 (08.06)	446 (09.87)
	Middle level	1,603 (35.79)	1,339 (29.62)
	High level	454 (10.14)	172 (03.80)

Data: mean±standard deviation OR number (%)

Independent variables

"Systematic fitness management" was determined with the following question: "Do you systematically manage your fitness based on science"? The response options were, [1]=yes and [2]=no. "Exercise frequency" was evaluated using the following question: "In the last month, for how many days did you exercise for more than 30 minutes? Please do not include walking in your leisure time". Response options were as follows: [1]=0; [2]=2 or 3 times per month; [3]=once a week; [4]=twice a week; [5]=3 times a week; [6]=4 times a week; [7]=5 times a week; [8]=6 times a week; and [9]=every day.

"Exercise time" was assessed using the following question: "For how many minutes did your exercise routine last"? Response options were as follows: [1]=0; [2]=under 59 minutes; [3]=60-119 minutes; [4]=120-179 minutes; and [5]=over 180 minutes. The question, "For how many months have you kept up your regular exercise"?, was used to establish the "duration of exercise". Response options were as follows: [1]=0; [2]=under 23 months; [3]=24-47 months; [4]=48-71 months; [5]=72-95 months; and [6]=over 96 months. "Exercise intensity" was determined by the question, "How do you feel about exercise intensity"? The response options were: [1]=almost sedentary; [2]=low-level intensity; [3]=midlevel intensity; and [4]=high-level intensity.

Covariate variables

The age of the participants, as defined by the Korean Survey on Citizens' Sports Participation, was used without modifications.

Statistical analysis

The results are presented as mean±SD. Multivariate logistic regression analyses were performed to examine whether residence was related to the frequency, intensity, time and duration of exercise, adjusting for the covariate age for gender-specific data (male and female). The analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC, USA). Statistical significance was set at $p<0.05$.

RESULTS

The results of the multivariate logistic regression analyses (odds ratio and 95% confidence interval) are shown in Table 2 and is presented on the next page. The results show that Korean women in rural areas had lower levels of exercise than their urban counterparts in terms of frequency, time, duration and intensity of the exercise. However, there was little or no relationship among exercise levels and place of residence among Korean men. In addition, Korean men and women in rural areas had lower levels of access to "systematic fitness

management", such as fitness instructors and exercise facilities.

DISCUSSION

This study examined the relationship between urbanisation and exercise in the Republic of Korea. The results show that both Korean men and women in rural areas had lower systematic fitness management. Also, in rural areas, Korean women had lower exercise levels than women in urban areas, but there was little or no relationship between exercise and residence, namely

whether in urban or rural areas, for Korean men.

Investigators have argued that household and neighbourhood factors are important indices of social class to consider (Krieger & Fee, 1994). In large samples of adolescents, researchers found that access to play areas and equipment was associated with higher rates of exercise (Sallis *et al*., 2000). That is, Korean men and women in rural areas, as opposed to urban areas, had lower levels of exercise as reasonable environments, such as a good facility or instructors for exercise or training, were not available. This may be due to the high competitiveness of fitness centres and trainers in urban area, whereas there is a lack of adequate number of fitness centres and trainers in rural areas.

Table 2. **MULTIVARIATE LOGISTIC REGRESSION ANALYSES FOR RESIDENCE IN RELATION TO FREQUENCY, INTENSITY, TIME AND DURATION OF EXERCISE AMONG KOREAN MALES AND FEMALES**

Variables		Urban (reference) vs. Rural					
		Males (n=4,479)			**Females** (n=4,521)		
		OR	95% CI	p-Value	OR	95% CI	p-Value
Systematic fitness management	No	Ref.			Ref.		
	Yes	**0.729**	**0.550-0.967**	**0.028***	**0.604**	**0.421-0.865**	**0.006****
Exercise frequency	None	Ref.			Ref.		
	2/3 X per month	0.950	0.727-1.242	0.708	1.322	0.929-1.880	0.121
	1 X a week	0.863	0.696-1.071	0.182	**0.704**	**0.518-0.956**	**0.025***
	2 X a week	1.067	0.841-1.354	0.594	0.983	0.756-1.277	0.898
	3 X a week	0.855	0.678-1.078	0.185	**0.611**	**0.487-0.766**	**<0.001*****
	4 X a week	0.947	0.695-1.290	0.731	0.723	0.520-1.005	0.053
	5 X a week	0.789	0.596-1.044	0.097	**0.710**	**0.544-0.925**	**0.011***
	6 X a week	0.678	0.444-1.036	0.073	0.949	0.622-1.447	0.807
	Every day	1.230	0.927-1.632	0.151	**1.391**	**1.041-1.859**	**0.026***
Exercise time (minutes)	None	Ref.			Ref.		
	Under 59	0.939	0.707-1.247	0.665	0.812	0.637-1.035	0.092
	60–119	**0.801**	**0.684-0.938**	**0.006****	**0.838**	**0.722-0.972**	**0.012***
	120–179	1.187	0.982-1.435	0.078	0.848	0.639-1.125	0.252
	Over 180	0.917	0.716-1.176	0.496	0.774	0.504-1.189	0.242
Exercise duration (month)	None	Ref.			Ref.		
	Under 23	0.971	0.784-1.203	0.787	0.932	0.765-1.136	0.486
	24–47	0.903	0.754-1.082	0.269	**0.715**	**0.593-0.864**	**<0.001****
	48–71	0.903	0.730-1.116	0.345	0.995	0.786-1.259	0.964
	72–95	0.996	0.672-1.477	0.984	0.974	0.597-1.591	0.917
	Over 96	0.910	0.735-1.127	0.387	**0.683**	**0.510-0.914**	**0.010****

Exercise intensity	Almost sedentary	Ref.			Ref.		
	Low level	**0.774**	**0.605-0.989**	**0.040***	**0.720**	**0.575-0.901**	**0.004****
	Middle level	0.926	0.803-1.067	0.285	0.902	0.781-1.041	0.158
	High level	1.061	0.848-1.328	0.604	**0.610**	**0.420-0.885**	**0.009****

OR: Odds Ratio; CI: Confidence Interval; *p<0.05, **p<0.01, ***p<0.001; tested by multivariable logistic regression analysis after adjusting for age

Also, even though in some cities there are many places to exercise, people do not know how to exercise or participate in fitness programmes or have a chance to be involved in health programmes as there is lack of information, leadership for sport and adequate instructors. The results of the present study replicated findings from other national cross-sectional studies showing that people living in rural areas had lower systematic fitness management, as well as lower rates of exercise with respect to frequency, intensity and duration (King *et al*., 2000; Brownson *et al*., 2001; Parks *et al*., 2003). According to the Korea Community Health Survey, people living in rural communities had lower rates of walking and higher obesity rates. In this survey in the Republic of Korea, people living in urban areas used public transportation more and walked more due to frequent traffic jams.

Conversely, due to the fact that public transportation in rural areas is not as developed as it is in urban areas, people living in rural areas often used their own car reducing the number who walked. Moreover, there is a tendency for elderly people to live in rural areas and young people to live in urban areas further explaining the exercise discrepancy between the two living environments (Korea Centre for Disease Control and Prevention, 2013). The Korea National Health Insurance Service reported that women living in rural areas were exposed to higher rates of obesity due to income (Korea National Health Insurance Service, 2005). This is consistent with the finding that income affects health management rates of Korean women in such a way that they are more interested in health compared to men in rural areas. According to the survey, health management rates were lower in rural than in urban areas among men.

The reasons for contrasting findings regarding the extent of physical exercise between women from rural areas and those from urban areas is not clear. It can be speculated that in Korean culture, particularly in the rural areas and on farms, men are usually in charge of physical work, such as moving heavy loads and splitting firewood, whereas women are in charge of household chores, such as cooking and cleaning. Because of this, women in rural areas may have lower levels of exercise than they otherwise would. But this is only conjecture, and the specific reasons behind this finding are not known. Well-designed studies need to be undertaken in order to determine the individual effects of the residence area on levels of exercise, particularly among women.

The current work has two major limitations. Firstly, this study did not measure the exercise level of the subjects directly, but did so through a self-reported survey. Therefore, future research should aim to improve on this research design by measuring exercise levels directly. Secondly, the current work utilised the data of a cross-sectional survey, thus only the correlation between residence area and exercise could be assessed and not a cause and effect analysis. Nevertheless, by investigating a large and nationally representative sample in the Republic of Korea, the findings could be compared to other research findings with the theme of exercise and residence environment with respect to gender.

CONCLUSION

The present findings show that there were no gender difference in fitness management, but Korean women in rural areas performed lower levels of exercise than women in urban areas. Also, both men and women in rural areas did not access systematic fitness management, such as training by instructors and exercising in special facilities, resulting in lower exercise levels

that may have a bearing on fitness levels and health conditions.

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The authors declare that there is no conflict of interest.

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Prof Eun-Ju CHOI: Division of Sport Science, College of Science and Technology, Konkuk University, 268 Chungwon-daero, Chungju-si, Chungcheongbuk-do 380-701, Republic of Korea. Tel.: 82-43-840-3505, Fax.: 82-43-840-3498, Email: ooj7990@kku.ac.kr

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PHYSICAL EDUCATION IN SOUTH AFRICA: HAVE WE COME FULL CIRCLE?

Leoni C.E. STROEBEL[1], Johnnie HAY & Hermanus J. BLOEMHOFF
[1] *School of Social Sciences and Language Education, Faculty of Education, University of the Free State, Bloemfontein, Republic of South Africa*
[2] *School of Education Studies, Faculty of Education Sciences, North-West University, Potchefstroom, Republic of South Africa*
[3] *Department of Exercise and Sport Sciences, Faculty of Health Sciences, University of the Free State, Bloemfontein, Republic of South Africa*

ABSTRACT

Physical Education (PE) in South Africa has been on the receiving end of curriculum reform with far-reaching consequences. Prior to 1994, PE existed as a stand-alone school subject. In 1997, PE was reduced to a learning outcome of a new learning area titled, Life Orientation, within the new curriculum, Curriculum 2005. Shortly thereafter, a Revised National Curriculum Statement (R-NCS) was established. A second revision of the curriculum followed in 2009, resulting in Curriculum and Assessment Policy Statements for each subject. The purpose of this article is to outline the historical development of Physical Education as subject/partial-subject in South Africa from before 1994 until the present, with regard to the content, state and status and teacher training. The actual implementation, as well as the proposed reinstatement of PE as a stand-alone subject, are addressed, in order to attempt elucidation of the question: "Have we come full circle?"

Key words: Physical Education; South Africa; Curriculum; Subject status; Implementation.

INTRODUCTION

Physical Education (PE) as school subject may have come full circle in South Africa over the past three decades. 'Full circle' in this instance means that, three decades ago, it was a stand-alone subject in the school curriculum, which was integrated into the learning area Life Orientation (LO) since 1997. Now calls have been made to have it reinstated as a stand-alone subject again.

Pangrazi (2007) alleges that the pursuit of a lifelong physically active and healthy life originates in the PE class. The school is considered the ideal environment to provide the most effective structure and opportunity for all children to learn and develop movement skills, attitudes, knowledge and understanding of the benefits of lifelong participation in physical activity and sport (Green & Collins, 2008; Hardman, 2010; Trost & van der Mars, 2010; Van der Merwe, 2011; Van Deventer, 2012; Balyi, 2013; Discovery, 2014).

Comprehensive research has been done on PE in respect of the perceptions of teachers and learners (Prinsloo, 2007; Amusa & Toriola, 2008; Frantz, 2008), the role in schools (Hendricks,

2004), problems and challenges (Du Toit, *et al*., 2007), status (Rooth, 2005; Van Deventer, 2011), and implementation (Van der Merwe, 2011; Perry *et al*., 2012; Van Deventer, 2012), of PE in South Africa.

This study attempted to analyse this seemingly circular road of PE in South African school curricula and broader society and the challenges it faces. The historical development of the PE curriculum in South Africa from 1994 to date will be outlined, illuminating three periods: before 1994, the era of Curriculum 2005 (C2005), and the current National Curriculum Statement, referred to as the Curriculum and Assessment Policy Statement (CAPS). A brief overview of the content, state and status of the subject at the time, and the implications with regard to teacher training of each period will be highlighted. The current situation in South Africa with regard to challenges concerning implementation of the LO curriculum will also receive attention.

PERIOD 1: PE CURRICULUM BEFORE 1994

Prior to 1994, the National Department of Education (DoE) of the National Party Government controlled education. Pelser (1989) points out that PE was taught to boys and girls separately and the syllabi differed. Mabumo (2014) confirms that PE was recognised as an approved subject, but the separate education departments of the Houses of Parliament approached this differently. In the House of Assembly, each Provincial DoE had its own specific syllabus functional to its own needs while two PE periods a week were allocated for all grades in accordance with the curriculum (Pelser, 1989). Although it was a compulsory subject from Grade 1 to12 before 1994, many schools either did not implement it as such or started phasing it out because of staff implications, a shortage of equipment and facilities, or allocating less time on the timetable to PE in favour of 'more important subjects' such as Mathematics and Science (Van der Merwe, 2011).

Content

A differentiation between the syllabi of boys and girls existed, with the programme for boys mainly focusing on sporting activities, while that of the girls consisted of both sport and independent activities (Pelser, 1989). The programme for boys was divided into the following phases: Junior Primary, Senior Primary, Junior Secondary and Senior Secondary (Pelser, 1989).

The first national syllabus for PE for girls was officially prescribed by all education departments following the publication thereof in 1972 (Nel *et al*., 1981). Hence, Nel *et al*. (1981) claim it represented a completely new approach and method of presentation of the subject. As indicated in the Free State Syllabus for Girls (Free State Education Department, 1986), the programme comprised four phases, namely the discovery phase, mastery phase, refinement phase and enrichment phase. The activities throughout the phases consisted of dance, gymnastics, games and water activities, distributed across the four school terms and linked to the seasons. The content of the programme for girls was also divided into the following components:

- The General Programme (Standards 1-3; currently Grades 3-5) encompassed the

development of movement but no specialisation in movement activities took place. This programme served as the basis for movement divisions that followed from Standard 6 (currently Grade 8) onwards.

- The General/Specific Programme (Standards 4-7; currently Grades 6-9) included the expansion and continuation of the General Programme emphasising the improvement of execution capabilities and improvement of creativity in movement;
- The Specific Programme (Standards 8-10; currently Grades 10-12) contained a higher level of execution linked to knowledge. It also involved the introduction to a wide variety of movement and recreation opportunities (Free State Education Department, 1986).

Van der Merwe (2011) reports that formal apparatus gymnastic activities were regarded as high priority for both boys and girls, but teachers and learners perceived this as negative. Many schools did not have the appropriate facilities to present this form of gymnastics, and in other cases it was regarded as time-consuming and impractical, which led to the teachers simply ignoring that part of the syllabus and concentrating on 'easier' activities. Furthermore, many children excused themselves from the said activities because of a lack of self-confidence and not regarding themselves as 'gymnasts' (Van der Merwe, 2011).

These curricula were mainly applied in predominantly white schools and in only a few Indian, Coloured and Black schools. This implies that it was actually the former white schools that phased out PE as a school subject, as described earlier (Van Der Merwe, 1999). Although some schools maintained the 'status quo', others applied movement programmes presented by specialists from the private sector. Consequently, a vast number of learners were excluded because of the financial implications. The result was that PE teachers lost interest and accepted the fate that the subject was regarded as inferior. Therefore, learners were left simply to play games (Van der Merwe, 2011).

Teacher training

According to Van der Merwe (1999), preceding the curriculum changes in 1994, teacher-training colleges, amongst Higher Education Institutions (HEIs), provided specialist training for PE teachers. However, because of the restructuring of higher education and the phasing out of teacher-training colleges at the turn of the century, the succeeding period positioned PE as a discipline under pressure at HEIs (Van der Merwe, 2011).

PERIOD 2: CURRICULUM 2005

The period 1994-1999 was characterised by policy transformation processes (in terms of inter alia PE). After the 1994 election and the inauguration of the first democratic ANC Government in 1995, the new South African Schools Act was established in 1996 (DoE, 2000). Curriculum reform started in earnest in South Africa soon after this, and the first National Curriculum Statement called Curriculum 2005 (C2005) was introduced in 1997, based on the principles of Outcomes-based Education (OBE) (Van Deventer, 2000). For PE, the development was mostly driven by the National Education and Training Forum, which relied on input from interim provincial committees dealing with PE. The proposed PE policies that emerged led to the publication and implementation of Curriculum 2005 (C2005) (Cleophas, 2014).

School 'subjects' were replaced with 'learning areas', which led to the dawn of a new learning area called Life Orientation (LO) (Van Deventer, 2000). This drastic paradigm shift reduced

PE from a stand-alone subject to one of eight learning outcomes in LO (Van Deventer & Van Niekerk, 2009). LO was introduced in different stages, starting with the General Education and Training Band, constituting Grades R to 9 (Department of Basic Education, 2009). Grades were divided into four phases: The Foundation Phase (Grade R - Reception Year, to Grade 3); the Intermediate Phase (Grades 4 to 6); the Senior Phase (Grades 7 to 9) and the Further Education and Training Phase (Grades 10 to 12). One period a week was allocated to LO, of which Specific Outcome 8, namely *Human movement and development*, formed only part (DoE, 1997).

Content

Even though the learning areas varied in each phase, LO was one of the learning areas that were incorporated into all phases and were compulsory for all Grade R to Grade 12 learners. Each learning area had specific outcomes, assessment criteria and range statements. The learning area of LO contained eight specific learning outcomes, of which *Human movement and development* was one. With regard to Learning Outcome 8, the specific outcome stated, "to evaluate and participate in activities that demonstrate effective human movement and development" (DoE, 1997:237). The content in the Foundation Phase covered movements and movement variations, individually and in groups. The Intermediate Phase content comprised competence in specialised movement, mastery of skills and participation in group activities. In the Senior Phase, the content focused on skills to perform movement activities involving manipulation of objects and developing a movement repertoire (DoE, 1997).

State and status

Unfortunately, there were several adverse implications for LO and PE during this period. Van der Merwe (2011) claims that LO teachers loathed presenting PE. The children were reluctant to participate and the public regarded it as a waste of time and money. However, he implies that the mentioned stakeholders were thoroughly aware of the benefits of PE and physical activity for children.

Based on the aforementioned, the authors agree with Van der Merwe (2011) that a major challenge for LO was the prejudices that existed about the non-examinable status of its previous constituent subjects such as School Guidance, PE, Religious Education and Youth Preparedness. Moreover, it was the subject that was neglected most in order to allocate more time to externally quality assured subjects such as Mathematics, Science and Languages, which explained why children perceived LO as insignificant (Du Toit *et al*., 2007; Van der Merwe, 2011). Justifiably, this resulted in a negative impact on the status of PE during this period.

Teacher training

The training of teachers in the principles of OBE was done mainly via the various Provincial Departments of Education and not at HEIs (Van Deventer, 2011). According to Jansen and Taylor (2003), the Government's decision to close down the 120 teacher-training colleges during this period contributed to a negative attitude towards education as profession. They further suggested that a rationalisation process aggravated the situation, contributing to a loss

of nearly 16 000 educators, of which the majority were teachers with vital skills and experience (Jansen & Taylor, 2003).

By early 2002, the report of the task team reviewing the implementation of the National Curriculum Statement had identified inherent flaws in C2005, based on the major complaints and challenges encountered since its introduction. To address the shortcomings of C2005, a Revised National Curriculum Statement (R-NCS) was completed in 2002 and scheduled for implementation in January 2004 (DBE, 2009). Increased pressure from both the health sector and the new government system emphasised the necessity for the subsequent modifications (DoE, 2000).

Despite declining teacher-training opportunities in PE, the reinstatement of PE as a learning outcome of LO in the R-NCS continued and was completed in 2008 and the final phase was implemented in Grade 12 (Van der Merwe, 2011).

PERIOD 3: CURRICULUM AND ASSESSMENT POLICY STATEMENT

In 2009, a Ministerial Task Team was appointed to review the Revised National Curriculum Statement (R-NCS) (Grades R to 12). Following this, a Ministerial Project Committee developed the Curriculum and Assessment Policy Statements (CAPS) for each subject in the R-NCS, with the aim to improve the R-NCS's performance (DBE, 2010b). In the Curriculum and Assessment Policy Statement (CAPS), the study areas known as Life Skills (in the Foundation Phase and Intermediate Phase), and Life Orientation (in the Senior Phase and FET Phase) were aimed at guiding and preparing learners for life and its possibilities, including equipping learners for meaningful and successful living in a rapidly changing and transforming society (Van Deventer, 2011). With regard to the Foundation Phase, six hours were allocated to Life Skills (LS) per week, of which two hours were allocated to PE and Movement (DBE, 2011b). In the Intermediate Phase (Grade 4 to 6), two hours per week were allocated to LO and in the Senior Phase (Grade 7 to 9) 2¼ hours per week allocated to LO. The PE outcome is assigned 40 minutes of this time, which converts roughly into one period per week for both phases (Department of Education, 2008). In the Further Education and Training Phase (FET) (Grade 10 to 12), two hours per week are allocated for LO, and 60 minutes of this time are assigned to PE, which convert to 50% of the time per week (DoE, 2008).

Content

The subject Life Skills aims to develop learners through an array of diverse, but interrelated study areas, such as Beginning Knowledge, Personal and Social Well-being, Physical Education and Creative Arts (DBE, 2011b). The content for the Personal and Social Well-being and Physical Education study areas addressed in the Intermediate Phase (Grades 4-6) relates to that in Life Skills in the Foundation Phase (Grade R-3) and LO in the Senior (Grades 7-9) and Further Education and Training Phases (Grade 10-12). The intention of PE in the Foundation Phase is to allow learners to enjoy the health benefits of exercise and develop social skills through participation in PE (DBE, 2011b). In the Intermediate Phase, PE targets the development of learners' physical well-being and knowledge of movement and safety. Through engagement, learners will develop motor skills and participate in a variety of physical activities (DBE, 2011c).

Building on the foundation laid in the previous phases, the focus in the Senior Phase is to provide opportunities for learners to demonstrate an understanding of and participate in activities that promote movement and physical development (DBE, 2010a). The outcome and content emphasis in the Further Education and Training Phase are to accumulate on the

previous experiences to expose learners to an understanding of the value of regular participation in physical activity (DBE, 2010b). Generally, the activities cover participation in physical fitness, games, sport, and recreation (DBE, 2010b).

State and status

LO, and therefore PE, is the only subject in the CAPS that is not externally assessed or examined in Grade 12 at the final end-of-year examination (DoE, 2008). Five internal formal tasks add up to the total mark in Grades 10, 11 and 12. In Grade 12, four tasks, which consist of a written task, mid-year examination, a project and a Physical Education Task (PET) are set and assessed by the Life Orientation teacher. The focus of the practical assessment for the PET falls into two broad categories: participation; and movement performance (DBE, 2010b). The fifth task, the final examination, is set as a common paper at provincial level and is marked by the LO teacher at the different schools (DBE, 2010b). Consequently, the low status can be attributed partially to the distinctive assessment method and non-examination status with reference to the final end-of-year examination (Du Toit, *et al*., 2007).

Despite promising policy development in terms of CAPS, Jacobs (2011) argues that the practice of LO, and subsequently PE has not shown any marked improvement. She maintains that the theory of CAPS and the practice thereof are far removed from each other, which results in ineffectiveness and negative attitudes among both learners and teachers. Rooth (2005) reports that teaching LO seems to be a transitory duty that changes from year to year, which means that these substitute teachers cannot take ownership of LO. In view of this, Morgan and Bourke (2005) highlight that insufficient teacher training and unqualified staff have a detrimental influence on the quality of PE offerings. A study done by Prinsloo (2007), on the implementation of LO programmes in South African schools, affirms that being 'qualified' in LO ranges from attending a three-day HIV and AIDS course to a two-hour LO workshop, or being an ex-Guidance, ex-Religion Studies or ex-PE teacher. Both Christiaans (2006) and Prinsloo (2007) concur that both the choice of teachers assigned to LO and the reasoning underlying the choice have an effect on how the subject is perceived. Van der Merwe (2011) shares this view that unqualified teachers certainly do not benefit the status of the learning area. In addition, lack of facilities and equipment and insufficient support with regard to implementation decrease the position and status of the subject significantly (Van der Merwe, 2011).

Teacher training

Van Deventer (2011:828) claims, "The new CAPS policy does not permit HEI's to train teachers specifically for LS in the Foundation and Intermediate Phases because with all its broad topics LS does not constitute a specific discipline at HEIs". Thus, one can deduce that controversy exists regarding current teacher training and training recommended by the Department of Basic Education (DBE) in 2009 (DBE, 2009). Proclamations such as "training for both Curriculum 2005 and the National Curriculum Statement was shown to be too superficial and too generic", "training has also been decontextualised and unsupported", substantiate the necessity for subject-specific training (DBE, 2009:55).

CURRENT SITUATION

In 2011, the Memorandum of Understanding, signed by the Ministers of Basic Education and

Sport and Recreation, committed the government to promoting mass participation and physical activities that are aimed at enriching the school curriculum. Furthermore, a commitment to deliver a sustainable integrated plan to provide school learners with the opportunity to take part in PE and organised sport through the creation of an accessible and implementable school sport-support system was made (DBE, 2011a:7). In addition, the DBE Action Plan 2014, which is part of the amendment of the NCS, indicates the facilitation of the implementation of PE in schools (DBE, 2009; DBE, 2011a). The National Sport and Recreation Plan (2012a) maintains that to maximise access to sport, recreation and PE in every school in South Africa, it is essential that skilled, qualified and active teachers support participants during all stages of their development (Balyi *et al*., 2013). This encompasses not only the re-introduction of PE as a curriculum subject/outcome with requisite time, but also assesses the capacity of educators to deliver PE and sport-specific training (Sport and Recreation South Africa, 2012a).

To strengthen the above line of thinking, Morgan and Hansen (2013) claim that factors such as reduced time to implement meaningful lessons, insufficient equipment and low levels of expertise and confidence have led to current PE programmes (as part of LO) being pronounced by teachers as inadequate in achieving key syllabus outcomes. Similarly, Du Toit and Van der Merwe (2013) state that as for the pre-1994 curriculum, several schools failed to provide a well-organised PE programme. Moreover, in many school's facilities, apparatus and equipment were non-existent or in dismal condition, which complicated the situation even more. Despite that, the DoE contends that the lack of equipment and apparatus cannot be used as an excuse for failing to present the compulsory PE periods (Department of Education, 2008).

Although all schools do not have the necessary facilities, apparatus, equipment or person power to implement or present physical activities, it is recommended by the DBE (2008) that LO teachers are educated and trained to improvise equipment and apparatus to utilise during PE periods until it can be provided. With regard to time and proficiency, the DBEs Director of Safety, Enrichment and Sport in Education, Me Mabumo, commented on the two-hour time allocation per week for PE as part of LO at the 2014 'Designed to Move' Conference. She suggested that "if a teacher is not trained and does not know what to do, it is a waste of time. For a teacher who is trained and knows what to do, the time is not enough" (Mabumo, 2014). In addition, Du Toit *et al*. (2007) recommend that addressing practical and didactical improvising skills in PE seems to be paramount. Therefore, the need for the re-skilling of educators to deliver PE, and finally resourcing schools with the requisite PE equipment, cannot be emphasised enough (Sport and Recreation South Africa, 2012a).

Numerous deliberations took place during 2014 to drive the promotion of physical activity and 'sport for all' in South Africa. At the 2014 *South African Sport and Recreation Conference* (SASRECON), Gert Oosthuizen, the Deputy Minister of Sport, emphasised the importance of accessibility of PE and school sport for all children in South Africa in his keynote address (Oosthuizen, 2014). The *Designed to Move Initiative and Sport for Social Change Network*

hosted a national conference from 25 to 27 November 2014 with the main objective being to enhance recognition of the improvement of sport and physical activity among schoolchildren in selected communities in South Africa. Creating awareness and gaining a common understanding of the current South African situation of physical activity before, during and after school hours were prominent issues. A *Physical Education Consensus Group* was formed at the "Life through Movement" conference on 12 September 2014 to chart a national initiative for the reinstatement of PE in South African schools as an independent subject in the primary

and secondary school curriculum. This initiative aims to structure a University Physical Education Forum to provide direction on research, resource development, education and training (Roux & Burnett, 2014).

CHALLENGES PE FACES

The difficulties that PE in South Africa experiences are not isolated problems. On the contrary, the problems seem universal, oscillating between challenges, such as low status, lack of facilities and apparatus, as well as inadequately qualified or unqualified teachers to present the subject (Van Deventer, 2004; Du Toit *et al*., 2007; Hardman, 2010; Lee & Cho, 2014). However, despite the proclaimed necessity and benefits of PE, as disclosed in the White Paper for Sport and Recreation of South Africa (2012b), these problems persist. Although PE in South Africa has undergone several changes over the past 20 years with regard to purpose and programme goals (Du Toit & Van Der Merwe, 2013), the status and delivery remained an obstacle. Gradually, the emphasis shifted from being an insignificant component of LO in C2005 to a reconstructed outcome as part of LO, leading to the subsequent proposed reintroduction of PE in the school curriculum as a stand-alone and compulsory subject (Sport and Recreation South Africa, 2012a). Such is the significance assigned to PE and sport that an appeal was made by Sport and Recreation South Africa to prioritise it to create a better future for the children of South Africa (Sport and Recreation South Africa, 2012a).

One of the reasons why the proposed reintroduction of PE is a focal point at present is the state of our children's health and physical activity. The Healthy Active Kids South Africa (HAKSA) Report Card examines the state of South African children's (6 to 18 years) health with particular reference to physical activity, healthy eating and maintaining a healthy weight (Discovery Vitality, 2014). Whilst healthy habits are endorsed, the information provides an evidence-based benchmark by means of a percentage of children achieving success. The overall score in 2014 with regard to physical activity and PE in schools was a D (20 to 39%) (Discovery Vitality, 2014). Keeping in mind that this indicates success with less than 40% of South Africa's children, it is an indisputable reason for concern. In view of that, the statement of Amusa and Toriola (2008) that PE as a school subject in South Africa generally has been neglected, misunderstood and regarded as inferior, rings true.

This bleak picture supports the disturbing tendency of the decline of PE and questions the actual implementation of the current CAPS curriculum. The HAKSA Report Card confirms that presently less than two-thirds of children participate in weekly PE classes! (Discovery Vitality, 2014). In urban primary schools, more than a third of 10-year-olds (34%) do not have PE during the week. Even though PE might be regarded as one of the 'best investments' for physical activity, if it is not implemented or executed, children will clearly not attain the benefits (Discovery Vitality, 2014). According to Pangrazi (2007), the pursuit of a lasting physically

active and healthy lifestyle originates in the PE class. Trost and Van Der Mars (2010) concur that school-based PE programmes have the potential to maximise opportunities for children experiencing barriers to engage in out-of-school physical activity programmes. Additionally, Balyi *et al*. (2013) affirm that it is the only environment where all children have the opportunity to develop fundamental movement skills, which are considered the building blocks for the learning of sport-specific skills.

Amidst all these challenges, the proposal of the reinstatement of PE in the school curriculum as a stand-alone and compulsory subject (Sport and Recreation South Africa, 2012a) surfaces

yet again, highlighting the apparent circular road PE has travelled, as illustrated in Figure 1.

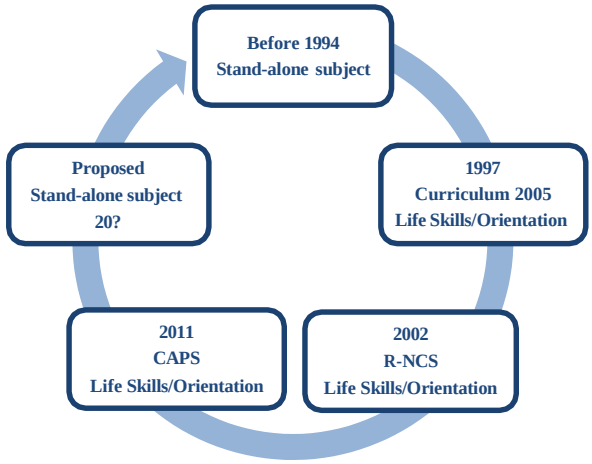

Figure 1. **CURRICULUM CHANGES**

DISCUSSION

Lambert (2014) suggests that the best way for the Government to promote physical activity for children is to prioritise the implementation of PE in schools. In order to realise this, capacity development through the training and support of educators is needed to match policy (Lambert, 2014). The proposal of Moss (2014) that a 'new generation' of PE teachers is needed to create a behaviour change in terms of physical activity and health, using technology to their advantage, should, therefore, be considered seriously.

Van der Merwe (2011) provides a novel perspective that has been overlooked throughout the process of curriculum change: the legal liability of the LO teacher who presents the PE learning outcome/topic. It is the only outcome where learners participate physically in a lesson environment. If any negligence can be proven in the case of injury, or inadequate safety measures transpire that could have been prevented by the teacher, serious implications and

consequences could ensue (Rossouw & Keet, 2011). The expectation that the PE teacher should possess the knowledge, skills and experience with regard to safety precautions, appropriate activities and supervision, should thus be seriously considered (Himberg *et al*., 2003). Additionally, Himberg *et al*. (2003) argue that in all probability teachers who do not meet the requirements, will avoid situations where they are at risk to be found negligent, adding to the number of reasons to circumvent the PE class. Ultimately, the opportunities for physical activity should not be jeopardised by the lack of safety procedures; essentially, it should be a priority.

In view of this, to assist schools to implement and sustain physical education programmes,

competent educators should provide opportunities to enhance the physical education experience of children effectively in order to lay the foundation for leading active and healthy lifestyles (Frantz, 2008; Hardman, 2010; Rink *et al*., 2010). Perry *et al*. (2012) claim that teacher education is integral to quality physical education delivery. In addition, the facilitators must be able to harness resources effectively and with responsibility (Robson *et al*., 2013).

Although the situation in South Africa is unique with regard to the educational environment and the position of PE at present, both developing and developed countries encounter problems with the effective implementation of policy requirements of national curricula and government initiatives that aim to enhance the quality of PE (Du Toit *et al*., 2007; Rainer *et al*., 2012). The recurring theme seems to be that although the importance and benefits of PE are not denied, the delivery and implementation are frequently under suspicion.

Political rhetoric is a general phenomenon in South Africa, although little often materialises (Van Deventer, 2012). Policies, reports and action plans do not necessarily revert to action. Cleophas (2014:21) points out that "the solution to the problem of the apartheid legacy of educational inequality and the lack of purposeful PE participation opportunities" was the motivation for the positioning of PE within the LO learning area, as part of C2005. However, in due course, the DoE admitted, that the "new curriculum was never researched or properly trialled and there was inadequate preparation and consideration of whether teachers, pupils and the system in general were prepared for such a fundamental change over such a short space of time" (DBE, 2009:12). Cleophas (2014) emphasises that departmental officials were not pedagogically prepared for the implementation of LO either. He advances that the majority of South African schoolchildren had limited purposeful opportunity to participate in PE under the apartheid regime and still lacks access to meaningful PE, despite all the changes that have taken place (Cleophas, 2014). In view of this, if the total well-being of society, social transformation and mass participation in physical activity and lifetime activity is a serious matter for the South African government, transferring years of oratory into action is key.

Hardman (2010:15) believes that the "quality of delivery of the school physical education curriculum is fundamental to the future not only of the subject in schools, but also to the future of active life-styles over the full life-span, for the two are inextricably entwined". Quality PE was defined at the World Summit on Physical Education held in 1999 as "the most effective and inclusive means of providing all children … with the skills, attitudes, knowledge and understanding for lifelong participation in physical activity and sport" (Green & Collins, 2008: 226).

Notably, the proclamation of the National Association for Sport and Physical Education (2007) states that highly qualified physical education teachers are required to facilitate improved teaching practices and to strengthen the quality of physical education instruction. If this serves as the benchmark, the criticisms against C2005 and the R-NCS regarding teacher training are explicable. Accordingly, the DBE recognised that a wide variety of factors interacted to have an impact on the quality of the education system in South Africa. However, it affirmed that teachers' poor subject matter knowledge and pedagogical content knowledge were important contributors (Christiaans, 2006; DBE, 2009; Van Deventer & Van Niekerk, 2009; Departments of Basic Education and Higher Education and Training, 2011).

CONCLUSION

It is evident that the changes to the PE curriculum from 1994 until present had a far-reaching

impact on the state and status of PE. The implementation of the post-apartheid curriculum in schools and the delivery of PE suffered a major setback as a result. Therefore, the current proposal for the reintroduction of PE as a stand-alone subject in the curriculum (as was the case prior to 1994), should not be considered lightly, as it has extensive consequences. If PE receives the requisite time, the capacity of educators to deliver PE is improved and schools are provided with the essential PE equipment, it may lay the foundation for a significantly healthier population.

In conclusion, Lambert (2014) reiterated in her keynote address at the South African Sport and Recreation Conference in 2014 that the Scientific Advisory Board involved with the 2014 HAKSA Report shares a vision for the future of South African children. She would like to report that, amongst other outcomes, teachers have been provided with training and support to promote physical activity and to deliver PE appropriately in the curriculum. Should this become a reality and Physical Education is reinstated as a stand-alone subject in the school curriculum, in response to the copious pleas - South Africa would indeed "have come full circle".

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Mrs. Leoni C E STROEBEL: School of Social Sciences and Language Education, P.O. Box 339, University of the Free State, Bloemfontein 9300. Republic of South Africa. Tel.: +27 (0)82 4402345, Fax.: 051 4017044, Email: stroebellce@ufs.ac.za

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A SYSTEMATIC REVIEW OF RECREATION PATTERNS AND PREFERENCES OF STUDENTS WITH PHYSICAL DISABILITIES

Simone TITUS, Marié E.M. YOUNG, Kenrique NASSEN, &
Semone A. OWNHOUSE

Department of Sport, Recreation and Exercise Science, University of the Western Cape, Bellville, Cape Town, Republic of South Africa

ABSTRACT

Students with physical disabilities at higher education institutions are often excluded from recreational activities due to lack of appropriate inclusive integration programmes. This study systematically reviewed literature that identified recreational

patterns and preferences of students with physical disabilities to provide recommendations for their recreational programmes. Articles were reviewed using Ebscohost (Medline, CINAHL, PsyArticles, Academic Search Complete), LANCET, Directory of Open Access Journals (DOAJ), Project Muse, BioMed Central Journal, JSTOR, Google Scholar and Sports Discus databases for the period 1997 to 2014. Articles extracted comprised qualitative, quantitative and mixed method studies that met level three on the JBI level of evidence scale. Articles that were favourably rated for methodological quality by two reviewers were included. The articles were methodologically appraised using a modified CASP instrument. A total number of 426 821 articles were identified, of which 90 were selected for further investigation whilst 69 were excluded after the first review and a further three following evaluation of methodological quality. Thus, 18 articles were included. There was a lack of recreational programmes available for students with physical disabilities. Opportunities for recreation for disabled students should be provided. There was a need for suitable holistic campus recreational programmes at universities.

Key words: Physical disabilities; Mobile impairments; Recreation; Students; Inclusivity; JBI (Joanna Briggs Institute) Scale.

INTRODUCTION

The United Nations (2014) reported that approximately one billion people live with disabilities, many of whom fall within marginalised population groups (WHO, 2011). In the 2011 Census survey, Statistics South Africa identified 5.6% of the population as being disabled (Statistics South Africa, 2011), whilst Disabled Persons South Africa (DPSA) believe that close to 10% of the South African population are disabled (Parliamentary Monitoring Group, 2013). The World Health Organisation (WHO) broadly refers to disability as "impairments, activity limitations and participation restrictions" where impairments refer to body function or structural challenges which can hinder the individual's activities (WHO, 2014:online). Therefore, it is of the utmost importance to ensure that persons with disabilities are afforded fair opportunity to participate in various activities that promote integration and development. To this end, recreational activities may provide access to marginalised groups. Recreation can be understood as the opportunity for individuals to engage in activities that are able to restore soul, body and mind (Kelly, 1996). Individuals are able to partake in these activities in their free time and are able to choose the types of activities in which to engage, as it may ensure holistic development and provide numerous benefits (Kelly, 1996). Recreation is relevant for all ages, races, religions, cultures, genders and for people with various abilities and would be hugely beneficial for people living with disabilities.

The South African White Paper on the Transformation of Health Services in South Africa, recognises the importance of meeting the needs of people with disabilities (Republic of South Africa, 1997). To this end they have identified strategic objectives that may provide integration for persons with disabilities with the aim of fostering independence. In addition, the promotion of social reintegration and participation of persons with disabilities is lauded. Leisure and Recreation Association South Africa (2014) similarly identify the need to improve transformation and social inclusion in South Africa. These needs can be met by providing recreational opportunities for persons with disabilities, which could aid transformation and integration into communities.

Impact and benefits of recreation

The role and impact of recreation includes social inclusion, health and wellness for individuals and provides a psycho-social impact on the community being served (Wright & Titus, 2013). Rimmer *et al*. (2004) similarly recognise that moderate levels of physical activity among people with disabilities is an important goal for public health and public policy, as regular physical activity improves well-being and contributes to the prevention of chronic disease. Skills development is important for people with disabilities, including students in tertiary education who are able to engage in physical activity and recreation as extramural activities.

Wright and Titus (2013) highlighted that universities need to make more sporting and recreational opportunities available for students with disabilities. They believe that integrating students with disabilities will benefit students if they participate in recreational activities on campus. However, the physical, social and managerial constraints are acknowledged as having an impact on accessibility to recreation for people with disabilities (Wright & Titus, 2013). Therefore, recreation for students with physical disabilities should be specific in order to meet their needs and accommodate them according to their disabilities. However, the recreational patterns and preferences of recreational activities of students with mobile impairments appear to be dependent on the opportunities and programmes that are offered at their institutions.

Despite the numerous benefits of recreational activity for students with disabilities, it appears that these students have not been adequately integrated into their institutions. Students with disabilities at universities do not have sufficient access to a variety of recreational opportunities which are suited to their needs. The Department of Social Development (2004:2) in South Africa confirmed this by stating that "people with disabilities still face extreme social, economic and political levels of inequality and discrimination, contributing to their underdevelopment, marginalisation, and unequal access to resources and lack of service provision".

To further understand the barriers of recreational programmes for students with physical disabilities, Rimmer *et al*. (2004) suggested that it is important for facilitators of recreational programmes to understand the barriers that affect the participation of people with disabilities. It "could provide important information necessary for developing interventions that have a greater likelihood of success" (Rimmer *et al*., 2004:419). Some of the barriers include "inaccessible access routes, doorways being too narrow for wheelchair access, lack of elevators" (Rimmer & Rowland, 2008:144). In addition, high levels of competitiveness make it undesirable for sport coaches to accommodate people with disabilities (Rimmer & Rowland, 2008). As a result, there are few recreational programmes available that cater for all types of students and, therefore, the benefits of active participation in recreational programmes are lost.

PURPOSE OF RESEARCH

This study sought to determine the patterns and preferences of students with physical disabilities by means of a systematic review. Therefore, the aim of this study was to systematically evaluate/assess literature regarding the patterns and preferences of recreational activities of students with physical disabilities in order to provide recommendation for recreational programmes at higher education institutions. This study is guided by the following question, "what are the recreational patterns and preferences amongst students with physical

disabilities"?

METHODOLOGY

A systematic approach to the review was adopted and reported in a narrative form after each article was systematically evaluated/assessed and the relevant data extracted to support the study according to keywords agreed upon by the four researchers.

Search strategy for identification of studies

Databases used to extract articles were Ebscohost (Medline, CINAHL, PsyArticles, Academic Search Complete), LANCET, Directory of Open Access Journals (DOAJ), Project Muse, BioMed Central Journal, JSTOR, Google Scholar and Sports Discus. Articles searched covered the period 1997 to 2014. This period was used because the researchers took into account when the relevant policy documents were gazetted within the new democratic dispensation.

Manual searching of reference lists was undertaken and articles that were referred to the authors by experts in the field were also included. Search terms were constructed after some review of relevant literature and included students with disabilities, recreation participation, physical activity, tertiary institution scholars, college students, recreation preferences, recreation patterns and disability sport with various permutations.

Criteria for review

The search included qualitative, quantitative and mixed method studies on Level 3 of effectiveness on the JBI (Joanna Briggs Institute) scale. Effectiveness relates to the evidence about the interventions, for instance when the intervention is used appropriately, does it produce the desired outcome? It is thus used to evaluate the relationship between the interventions and the desired outcomes (Pearson *et al.*, 2005).

Method of review

The initial search was conducted by 2 researchers who also then reviewed the abstracts and the full articles. Firstly, a screening process was conducted by searching for articles on 9 databases by using permutation-specific key words, which included: leisure; recreation; students; participation patterns; and recreation preferences. The total hits were 426 821. Full text articles were then collected and the relevant articles amounted to 90. All of these articles were recorded on an excel database.

Table 1. **APPRAISAL TOOL**

	Questions	**Yes**	**No**
1.	Was the study conducted in a higher education setting?		
2.	Was the study conducted in the field of recreation?		
3.	Was the study conducted in the field of disability?		

4. Was the sampling process clearly stated?		
5. Did the research design appropriately address the research question?		
6. Was the research design clearly indicated?		
7. Are the research methods made explicit? (Interviews, focused groups, topic guide etc.)		
8. Had the researcher clearly responded to reflexivity during the study?		
9. Was the drop-out rate reported		
10. Has the ethical issues taken into consideration?		
11. Was the data analysis sufficiently rigorous?		
12. Were the findings explicit?		
13. Did the authors identify new areas for research?		
Grading of quality assessment checklist for observation score: 0-33% Poor; 34-66% Satisfactory; 67-100% Good	Yes=1	No=0

Based on the PICO criteria for this study, ultimately 21 relevant articles were chosen for review. The criteria were population (students), intervention (recreation programmes), comparison (global comparisons) and outcomes (recreation patterns and preferences). These articles were systematically evaluated/assessed using an evaluation/assessment tool developed from CASP instruments (Table 1). Of the 21 articles appraised, 18 articles were included in the study.

The data was extracted from the full text articles by using an excel database as shown in Table 2 to identify the relevant information, such as author, date, study design, population size, method of data collection, intervention and outcomes. The JBI level of evidence was assessed by each reviewer independently and, in cases where there was a dispute, a third reviewer was called in to adjudicate. The methodological quality of the articles was done using a quality assessment sheet[1]. The rating score had 3 levels: Poor (0-33%), Moderate (34%-66%) and Strong (66-99%).

Table 2. **SCORING SHEET**

	Reference	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	***TS**	**%**
1.	Blinde & Taub, 1999.	1	0	1	1	1	1	1	1	0	0	1	1	1	10	76.92
2.	Martinez, 2000.	0	0	1	0	1	0	1	0	0	0	1	1	0	5	38.46
3.	Amosun, Volmink & Rosin, 2005.	1	0	1	0	1	1	1	1	0	0	0	0	1	7	53.84
4.	Andrijasevic, Pausic,	1	1	0	1	1	1	1	0	0	0	1	1	0	8	61.53

	Bavcevic & Ciliga, 2005.															
5.	Beaton, 2005.	0	1	1	0	1	1	0	1	0	0	0	0	0	5	38.46
6.	Research Application, 2006.	1	1	0	1	1	1	1	0	0	0	0	0	0	6	46.15
7.	Faircloth & Cooper, 2007.	1	1	0	0	0	0	0	0	0	0	0	0	1	3	23.07
8.	Dik & Hansen, 2008.	1	1	0	1	1	1	1	0	0	0	1	1	0	8	61.53
9.	Yoh, Mohr & Gordon, 2008.	1	1	1	1	1	1	1	0	0	0	1	1	1	10	76.92
10.	Wise, 2009	1	1	0	0	0	0	0	0	0	0		0	0	2	15.38
11.	Collet-Klingenberg & Kolb, 2011.	1	0	0	1	1	1	0	0	0	0	0	0	0	4	30.76
12.	Koca-Atabey, Karanci, Dirik & Aydenir, 2011.	1	0	1	1	1	1	1	1	0	0	1	1	1	10	76.92
13.	Papasotiriou & Windle, 2012.	1	0	1	1	1	1	1	1	0	0	1	1	0	9	69.23
14.	Mullins & Preyde, 2013.	1	0	0	1	1	0	1	1	0	0	1	1	1	8	61.53
15.	Wright & Titus, 2013.	1	1	1	1		1	1	1	0	0	1	1	1	11	84.61

Scoring method: (*TS) Total score divided by the total number of items

[1]The appraisal tool below is an example of the qualitative tool only. Three tools were used based on whether the article was quantitative, qualitative or a mixed method study.

IDENTIFICATION

SCREEENING

Potential records identified:

Sports Discus ERIC, Emerald, Project Muse, Directory Open Access, PubMED, PsyArticles, BioMed Central, Ebsco Host

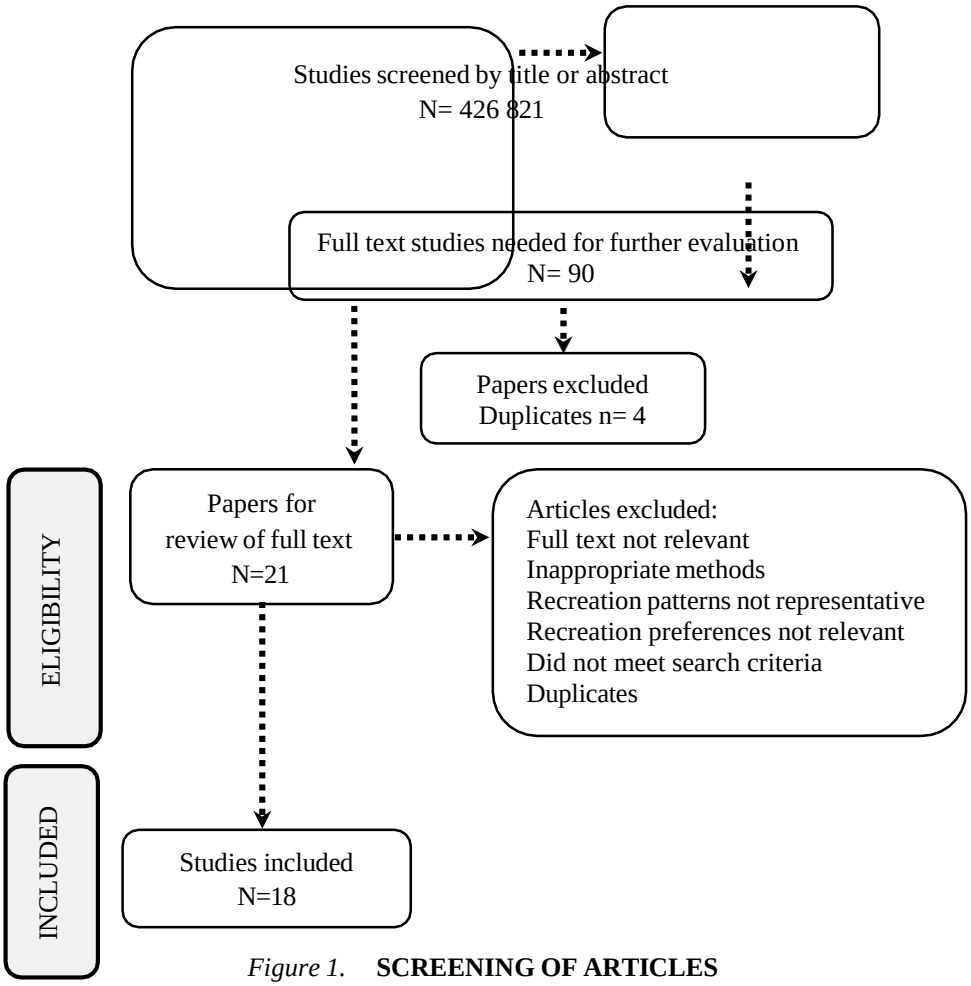

Figure 1. **SCREENING OF ARTICLES**

RESULTS

A total of 21 articles were appraised, of which 18 were included in this study. In Table 2, the appraised articles were extracted using the appraisal tool. The 18 articles met the criteria for inclusion in the study as can be seen in Table 3.

Table 3. **DATA EXTRACTION INFORMATION OF ARTICLES FOR THIS REVIEW**

Author & date	Study design	Population & sample size	Instrument	Country	Intervention
Morgan & Leung, 1980.	Quantitative	Physically disabled university students. 14 participants (9 female & 5 males) 18-40yrs old	Questionnaire	America	Effects of assertion training on physically disabled university students' acceptance of disability.
Blinde & Taub, 1999.	Qualitative	College students, physical disabilities. N=28 males	Interviews	America	Empowerment through sport and physical fitness

Martinez, 2000.	Qualitative	College students with physical disabilities. N=70 participants	Questionnaire	America	Explanatory style as a predictor of performance
Iwasaki, 2001.	Qualitative	University students. No sample size indicated.	Repeated assessment field design	Canada	Role of leisure in coping with stress
Kalyvas & Reid, 2003.	Qualitative Quantitative	Students with and without physical disabilities. N=35 Age 7-12 years.	Questionnaire & Interviews	Australia	Sport adaptation, participation and enjoyment
Amosun, Volmink & Rosin, 2005.	Qualitative/ ethnographic	2 undergraduate medical students	Assimilation	South Africa	Perceived images of disability

Table 3. **DATA EXTRACTION INFORMATION OF ARTICLES FOR THIS REVIEW** (*cont.*)

Author& date	Study design	Population & sample size	Instrument	Country	Intervention
Andrijasevic, Pausic, Bavcevic & Ciliga, 2005.	Qualitative	Sample of 449 (380 females & 69 males). Mean age of 21yrs	Questionnaire	Croatia	Inquiry into which students at University of Split spend their leisure time and what was the portion of sporting activities in it in relation to self-appraisal of their health status.
Beaton, 2005.	Qualitative	Disabled people	Descriptive account	Scotland	Outline of public library service offered to disabled people in Glasgow.
Research application, 2006.	Qualitative	81 university/ colleges. 52 public institutions 29 Private	Survey	America	Accessibility to campus recreation programmes
Sylvia-Bobiak & Caldwell, 2006.	Mixed methods	University students. N=874	Questionnaire	America	Complex relationship of social cognitive constructs, gender and active leisure.

Dik & Hansen, 2008.	Quantitative	Students, working age adults and retirees. 262 students, 409 workers and 194 retirees.	Questionnaire	America	Examination of the structure of leisure interests
Yoh, Mohr & Gordon, 2008.	Quantitative	College students with physical disabilities. N=122 participants.	Survey	America	Assessing satisfaction with campus recreation facilities

Table 3. **DATA EXTRACTION INFORMATION OF ARTICLES FOR THIS REVIEW** (*cont.*)

Author& date	**Study design**	**Population & sample size**	**Instrument**	**Country**	**Intervention**
Koca-Atabey, Karanci, Dirik & Aydenir, 2011.	Qualitative	Physically disabled students. 70 students.	Questionnaire	Turkey	Psychological well-being of disabled Turkish university students by examining influences of stress-related growth and psychological distress.
Papasotiriou & Windle, 2012.	Qualitative	Physically disabled university students. N=4 participants	Interviews	Australia	Experiences of physically disabled university students
Rochette & Loiselle, 2012.	Quantitative	Disabled students	Disability Creation Process model	Canada	Reflect on what it means to successfully perform a university student's role despite presence of impairments
Badia, Orgaz, Verdugo & Ullan, 2013.	Quantitative	Sample of 237 aged 17-65yrs, living in the community	Interviews	Spain	Participation in and preference for an interest in leisure activities of the young and adults with developmental disabilities
Mullins & Preyed, 2013.	Qualitative	University students with dyslexia, attention-deficit hyperactivity disorder and mental illness	Interviews	Canada	Perceptions of students with invisible disabilities experienced at university.
Wright & Titus, 2013.	Qualitative	5 students (3 male & 2 female) with physical, visual & hearing disabilities.	Interviews (face-to-face and telephonic).	South Africa	Experiences & perceptions of students with disabilities; recreational sport whilst at university.

Several articles were excluded from this review because the outcomes did not include recreation patterns and preferences of university students with disabilities. Of the 18 articles (Table 3) that were included in the systematic review, 13 of the articles were qualitative, 5 of the articles were quantitative and 1 was mixed methods. Eight of the studies were conducted in the USA, 3 in Canada, 2 in South Africa, 1 each in Australia, Croatia, Scotland, Spain and Turkey. Data were collected through interviews and questionnaires, and 1 by means of a descriptive account. The target population was 13 studies involving physically disabled university students. The other studies targeted males, working adults and reflective studies.

All the interventions differed from each other. These included, amongst others, empowerment through sport, disability imaging, leisure interventions, assertion training, accountability in campus recreation programmes and many more. As a result of the varied interventions, the outcomes for many of the studies were different. Outcomes from the interventions showed that social integration was good (Blinde & Taub, 1999) or limited (Papasotiriou & Windle, 2012). Satisfaction with facilities was also low, as well as under-used (Yoh *et al*., 2008) and recreation programmes for persons with disabilities were the least offered programmes (Research Application, 2006). According to the findings reported in the articles, there was a realisation of actualisation, increase in psychological well-being, improved academic results and an increase in cognitive awareness as a result of recreation activities (Iwasaki, 2001; Kalyvas & Reid, 2003; Dik & Hansen, 2008).

DISCUSSION

This systematic review was conducted on the recreation patterns and preferences of students with physical disabilities in order to provide recommendations of recreational programmes for persons with physical disabilities. The results of the study suggest that there is limited social interaction among university students with disabilities, which is due to exclusions as highlighted by Blinde and Taub (1999) and Papasotiriou and Windle (2012). Consequently, there are problems, such as helplessness-coping and other psychological implications. Positive psychological implications could include confidence, empowerment, well-being and self-concept of students with disabilities (Papasotiriou & Windle, 2012).

The findings in the current study suggest that universities that offered recreational programmes for students with physical disabilities included assertion training as an effective strategy for increasing acceptance of physically disabled university students (Morgan & Leung, 1980). This is particularly important as the social impact, as highlighted by Blinde and Taub (1999), played a major role in the empowerment of individuals through sport and physical activity. However, there were cases where students with disabilities reported limited social interaction within the institution due to exclusion attitudes with their peers (Papasotiriou & Windle, 2012). Exclusion by peers also impacted the willingness of students with disabilities to participate in recreation programmes. As a result, this would not be beneficial to their participation motivation as this would be dependent on the direction and intensity of efforts (Sage, 1977).

The findings indicate that students with physical disabilities did not engage with the tertiary institution's recreational facilities often because they were not satisfied with access to facilities or that they were the least offered programmes at institutions. In the research study conducted by Yoh *et al*. (2008) satisfaction with access to campus recreation facilities was low. The low

satisfaction can be explained through barriers for students with disabilities, such as inadequate availability of adaptive equipment (Yoh *et al*., 2008). Yoh *et al*. (2008) identified that physical activity of students with disabilities was affected by the lack of access and adaptive equipment for these students which contributed to the low satisfaction of students. A reason that these programmes were least offered was because of a lack in educational facilitators (Koca-Atabey *et al*., 2011).

Satisfaction with recreation programmes at tertiary institutions was low because they did not meet the accessibility needs of students with disabilities. Many students with disabilities identify that there were obstacles in the environment which hindered integration. Yoh *et al*. (2008) similarly identified that these environmental barriers, such as architecture, accessibility and design existed. Koca-Atabey *et al*. (2011) identified lack of facilities in the form of wheelchair access, lifts in buildings and sound alert systems as barriers. Yoh *et al*. (2008:107) also highlighted the lack of accessibility to outdoor environments, which included "narrow and damaged sidewalks, steep slopes, poor signage, and lack of available restroom facilities". Some of the barriers that students in wheelchairs were challenged with, included not having the physical strength to propel themselves around in certain facilities that were not wheelchair friendly (Amosun *et al*., 2005). Other implications included disability burden, daily stress factors and helplessness-coping (Koca-Atabey *et al*., 2011). Considering these barriers, students were hesitant to participate in these programmes.

CONCLUSION

Whilst this review focused only on students with physical disabilities, it does not detract from the invaluable evidence gathered with regard to recreation programmes available to students with other disabilities. This study has revealed that there is a great need for recreational programmes for students at universities, as it is evident that participation in these programmes at universities was poor. This could be due to lack of awareness of activities that were on offer. It is herewith recommended that the implementation of programme policies should be monitored and evaluated. This will bode well for recommendations linked to structural developments at higher education institutions that would facilitate accessibility to facilities and foster integrated recreation activities for persons with disabilities. Furthermore, it is recommended that skilled recreation practitioners develop programmes that are relevant and that can accommodate students with disabilities.

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Ms Simone TITUS: Department of Sport, Recreation and Exercise Science, University of the Western Cape, Private Bag X 17, Cape Town 7530, Republic of South Africa. Tel.: +27 (0)21 959 2245, Mobile: +27 (0)72 2343 342, Fax.: +27 (0)21 959 3688, Email: sititus@uwc.ac.za

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ACUTE EFFECT OF A PHYSICAL EXERCISE SESSION ON COGNITIVE FUNCTIONING: MODERATELY ACTIVE SPORTSPERSONS VERSUS SEDENTARY INDIVIDUALS

Karel J. VAN DEVENTER, Carynne COZENS, Kyle D. DU PLESSIS & Reghard P. LA GRANGE

Department of Sport Science, University of Stellenbosch, Stellenbosch, Republic of South Africa

ABSTRACT

In sport, physical activity (PA) and life in general, cognitive functioning plays a very important role in decision-making and performance. This study investigated whether the relationship between acute exercise and cognitive performance was beneficial and if there was a difference in this relationship between moderately active individuals and sedentary individuals. The acute effect of exercise on cognitive function was measured by means of the Stroop Test. The male participants (N=30; Age= MEAN±SD & range=18-25yrs) completed: (1) a trial Stroop Test; (2) a baseline Stroop Test; (3) a repeated sprint test; and (4) a final Stroop Test. The moderately active sportspersons were significantly ($p<0.05$) fitter than the sedentary group as they covered a greater distance during the Repeated Sprint test. There were significant differences ($p<0.05$) within and between groups, regarding pre- and post-Stroop Test performance. The moderately active sportspersons performed significantly ($p<0.05$) better in reaction time (RT) and in accuracy compared to the sedentary group. There was a beneficial relationship between acute exercise and cognitive performance and this relationship differed between moderately active sportspersons and sedentary individuals.

***Key words*:** Physical exercise; Cognitive functioning; Stroop Test; Repeated sprint test; Sedentary individuals; Moderately active sportspersons.

INTRODUCTION

In sport, PA (Physical Activity) and life in general, cognitive functioning plays a very important role in decision making and performance. In many sport events, participants have to simultaneously perform mechanical work with great physical demand and accurately perform decisional or perceptual tasks (Chang *et al*., 2014). Optimal cognitive functioning is, therefore, very important in a sportsperson's ability to be the best that he/she can be. Cognition or cognitive functioning refers to how individuals process sensory information, such as reasoning and memory, which all individuals require for daily activities (Neisser, 1967; Puente *et al*., 2016). Therefore, optimal cognitive functioning and its importance is not only applicable in sport but in the daily lives of individuals (Fitzsimmons *et al*., 2014).

Accumulation of recent research has indicated that exercise induces neuroplasticity, memory acquisition and specifically motor cortex plasticity. Kleim (2011) defines neuroplasticity as the capacity of neurons to structurally and functionally adapt. Plasticity is, therefore, the strengthening of certain neural pathways. In a review on selected biomedical and clinical studies, Ploughman (2008) postulates that exercise increases brain volume in specific regions implicated in executive processing and functioning. In the study of Ploughman (2008), involving 59 adults (aged 60 to 79), there were specific increases in the volume of the frontal lobe involved in higher order processing, memory and attentional control due to moderate aerobic exercise participation. The participants were involved in a six-month aerobic intervention that took place three times a week for 60 minutes.

Executive functioning is an umbrella term used to describe cognitive processes that are goal-orientated and the ability to adapt to changes within the environment or changing situations (Huizinga *et al*., 2006; Koziol & Lutz, 2013). Executive functioning is a critical high-level processing system that is involved in the orchestration of human cognition and action (Hogan *et al*., 2013). Executive functioning also involves goal-directed behaviour and controls multiple aspects of basic cognitive processes (Chang *et al*., 2014).

On the other hand, PA refers to any bodily movement produced by skeletal muscle that requires energy expenditure (Fitzsimmons *et al*., 2014). Research has shown that regular PA has a beneficial effect on cognitive functioning in individuals (Hogan *et al*., 2013). According to Colcombe and Kramer (2003), the benefits of PA are largely observed in executive functioning. Research has shown that although PA has cognitive benefits, these benefits differ when it comes to acute and chronic exercise (Pesce *et al*., 2011; Tomporowski *et al*., 2015).

Chang *et al*. (2014) argues that in various studies the effect of acute exercise on the cognitive performance of individuals has been well documented. In fact, from 1930 up to 1999, more than 200 studies have been executed on the influence of acute physical exercise on cognitive processes (Brisswalter *et al*., 2002). In the study by Pesce *et al*. (2011), in which 16, 60- to 80-year-old cyclists and 32 age-matched non-cyclists (16 endurance athletes and 16 sedentary individuals) performed a go/no-go reaction time task, it was found that with acute bouts of exercise, reaction time (RT=the time elapsing between a stimulus (visual or auditory) and the beginning of the reaction to that stimulus), improved in those individuals who took part in the exercise, compared to those who did not. Tomporowski *et al*. (2015) report similar results that were conducted on children. According to Hogan *et al*. (2013), cognitive performance was enhanced during, immediately after and after a delay of up to 20 minutes of acute bouts of exercise, once again showing the positive effect of acute exercise on cognitive performance. According to Córdova *et al*. (2009), both executive functioning and alertness are directly and simultaneously enhanced by acute exercise.

The reason for this improvement in cognitive performance, according to Yanagisawa *et al*. (2010), is due to the acute bout of moderate exercise, which corresponds with increased activation in the left dorsolateral prefrontal cortex. It should be noted that increased serum levels of the brain-derived neurotrophic factor, neuro-electrical activation following acute exercise, were found in individuals who ranged in fitness from sedentary to highly trained adults. This study was conducted in Taiwan with 36 (25 males and 11 women) college-aged adults (Chang *et al*., 2014).

According to McMorris and Graydon (1996), sportspersons process information and make decisions at a faster rate during moderate or vigorous PA. They stated that sportspersons can perform more cognitive functions under great physical demands efficiently. Therefore, this, suggests that sportspersons have better cognitive functioning. It seems as if fitness levels are directly linked to the level of executive functioning. In a study performed on 28 males in Spain (14 students; age range=17 to 23 years) with low fitness and 14 young male adults with high fitness levels (age range=18 to 29 years), Luque-Casado *et al*. (2013) found that highly-fit individuals possessed faster RT in a psychomotor task, as well as greater heart rate changeability, therefore, attributing their better executive functioning to their higher fitness levels. This raises interest in whether it is indeed the case that regular aerobic exercise increases executive functioning (Luque-Casado *et al*., 2013).

According to Córdova *et al*. (2009), many studies using animal models and the effects of chronic aerobic exercise on the brain, have suggested that taking part in regular chronic aerobic exercise may also stimulate neurogenesis and synaptogenesis and, therefore, improve cognitive function and learning in individuals. In addition to this, it also leads to an increased amount of cortical capillaries and levels of the brain-derived neurotrophic factor (Córdova *et al*., 2009). Other studies on animal models highlight possible mechanisms through which exercise may influence neurological development, increase neurological efficiency and enhance cognitive performance (Hogan *et al*., 2013). The processes of neural adaptation induced by exercise comprise an increase in regional blood flow, promotion of brain vascularisation, a rise in levels of brain-derived neurotrophic factor, as well as up-regulation of genes associated with cellular plasticity (Hogan *et al*., 2013). As a result of these neuro-plastic changes, Hogan *et al*. (2013) argues that brain function is more efficient and adaptive, thereby, supporting better learning and performance in animals. The findings of Hogan *et al*. (2013) are not only found in animals and have been widely confirmed in human studies and also highlight the benefits of chronic aerobic exercise (Hogan *et al*., 2013).

The study by Hogan *et al*. (2013) indicate the importance of the physical fitness levels of adolescents as it relates directly to executive functioning (Hogan *et al*., 2013). It has been suggested that higher levels of physical fitness coincide with higher levels of executive functioning (Chaddock *et al*., 2011). This suggests that the promotion of participation in regular PA, leading to higher levels of physical fitness, can improve executive functioning and cognitive processing (Chang *et al*., 2014).

As mentioned, there is a difference in the effect of chronic exercise bouts compared to acute bouts. The same could be said about the effect acute exercise has on trained as compared to untrained individuals. According to Chang *et al*. (2014), given the improvements in cognitive performance and the beneficial changes in the cerebral structure and function that have been shown to result from exercise, it is likely that individuals who are active may receive different benefits from an acute bout of exercise as compared to individuals who are less active. Pesce *et al*. (2011) agree with this and report that while favourable acute exercise effects were found in both trained and sedentary individuals, the greatest benefits were experienced by trained individuals.

According to a study conducted by Fontana (2007), the amount of experience in physical activity is a significant factor in explaining the better cognitive abilities, such as increased speed of decision-making and accuracy. Thirty-two subjects, 16 experienced (mean age=21.1yrs) and 16 inexperienced (mean age=19.5yrs) college male soccer players at a university in America participated in the study. Different exercise intensities were used and interestingly it was found that it had no significance in the relationship between the level of accuracy and the exercise intensity when accuracy and speed were not considered separately. When testing experienced and inexperienced soccer players, Fontana (2007) found that the experienced players, with a higher physical activity level, had faster and more accurate decision-making skills than the inexperienced players. Therefore, it is suggested that experienced sportspersons have increased and faster decision-making abilities than non-sportspersons.

A meta-analysis by Chang *et al*. (2012) examined moderator variables which were deemed particularly relevant to acute exercise. The authors included exercise intensity and duration, timing of the cognitive task administered, exercise mode and cognitive task type and came to

the conclusion that these mediators will, therefore, have an effect on the results being measured. Mediators and the affect they have on cognitive functions should not be observed in isolation as each variable has the potential to influence another variable (Tomporowski *et al*., 2015). For example, brain-derived neurotrophic factor response to exercise (as is seen during high intensity exercise), is dependent on the level of training of the participant (high-fit versus low-fit), with the former having higher levels of brain-derived neurotrophic factors than the latter (Ferris *et al*., 2007).

Tomporowski (2003) suggests an inverted-U hypothesis, which states exercise intensity will influence the size of the effect. It suggests that moderate intensity exercise will have the greatest benefits. The drive theory, as mentioned by Chang *et al*. (2012), suggests that the greatest benefits will be observed with high intensity bouts which are contrary to Tomporowski (2003). Chang *et al*. (2012) postulates that exercise intensity did not have a significant effect on cognitive performance assessed during exercise, but when cognitive performance is assessed following exercise there is an effect depending on when it is taken after the bout. When performed immediately following exercise, lighter intensity exercise will more likely show a positive result, however, when performed following a delay of more than one-minute, more intense exercise will more likely show a positive result (Chang *et al*., 2012). According to the meta-analysis performed by Chang *et al*. (2012), durations of at least 20 minutes of exercise are necessary to observe positive effects on cognitive performance; this is contradictory to other studies, such as Brisswalter *et al*. (2002) and Chang and Etnier (2009), which state that shorter durations elicit benefits.

The timing of the cognitive test administered is another important variable especially when viewed alongside variables, such as intensity. In a test administered during high intensity work, scores will be lower as the participant needs to focus on performing the PA. This can also be seen when comparing low-fit individuals to high-fit individuals (Chang *et al*., 2012). Neural resources, which are used when performing PA, compete with the same resources used to perform cognitive processing (Chang *et al*., 2014). Lower-fit individuals require more resources when conducting PA and thus have fewer resources available for cognitive performance (Chang *et al*., 2014). According to Chang *et al*. (2012), the type of cognitive task used to assess the effect of an exercise bout should be considered. A large beneficial effect has been found on motor skills and academic achievements, whereas a negative effect was seen on tasks relating to reasoning and verbal skills.

From the literature it can be derived that more research is needed on cognitive functioning with regard to the influence of exercise and the fitness level of the individual.

PURPOSE OF THE STUDY

Numerous studies have shown that exercise and especially acute bouts of exercise has a beneficial effect on cognitive performance (Hogan *et al*., 2013). More recently, however, a study by Chang *et al*. (2014) has shown controversial results. They found that after an acute bout of exercise, individuals with high fitness levels had poorer executive functioning in comparison to those with low to moderate fitness levels. Therefore, this study set out to attempt to determine whether there indeed was a beneficial relationship between acute exercise and cognitive performance and if there was a difference in this relationship between moderately active sportspersons and sedentary individuals.

METHODOLOGY

Ethical clearance

This study was submitted to the Research Ethics Committee of the university in question for ethical clearance. Permission from the Division for Institutional Research and Planning and from the residing residence head were sought, with regard to whether or not the students living in the residence could volunteer to participate in the study. Permission was also granted by the Sport Bureau of the university in order to ask players of various sporting codes of the university's top sport teams to volunteer to be part of this study. Participants were informed that they could withdraw from the study at any time if they wish to do so without being penalised.

Research design

The current study used a one-time cross-sectional design, which made use of an acute test (independent variable) to determine whether a specific outcome (dependent variable) occurs as a result of the test being implemented.

Participants

Bona fide male university students (N=30) between the ages of 18 to 25 years were asked to volunteer. Male students from a selected residence at the university (sample of convenience for financial and other logistical reasons) served as resource. A sample (n=15) that did not participate in any form of physical activity was randomly selected from this residence to participate in the study. Moderately active male students (n=15) were randomly selected from the university sport teams from various sport codes. The students (n=15) recruited from the university residence were the 'sedentary' individuals. According to Pescatello (2014), sedentary individuals are classified as those who do not participate in at least 30 minutes of moderate intensity physical activity (40%-<60% VO2 R), on at least 3 days of the week for at least 3 months. The participants (n=15) from the various sport teams were sportspersons who played for a Maties First Team or any sport team affiliated with a Maties club and who trained >3 times a week for at least 60 minutes. Participants all had to have normal vision, corrected-vision and normal colour vision. This was specified in the informed consent form that each participant had to sign. Participants who had injuries were excluded from the study. The same applied to individuals claiming to be sedentary. Students with chronic illnesses and/or disability, including those diagnosed with dyslexia, those who did not have corrected-vision or normal colour vision were also excluded.

Procedures on testing days

Upon arrival, participants were given a brief explanation of what the Stroop Test consists of, as well as how it worked and what they must do to complete the test. They could complete the test in their mother tongue, namely English and/or Afrikaans. Participants meeting the inclusion criteria were asked to complete 3 trials of the Stroop Test, the first being a practice trial for familiarisation and the second being Test 1 (Baseline). After completing Test 1, participants performed the repeated anaerobic sprint test, as described in Figure 1. Participants underwent a warm-up before commencing the test. The repeated anaerobic sprint test consists of 6, 35m-sprints at maximum pace with a 10-second rest period to allow the participants the time to turn around and rest. Directly after completing the repeated anaerobic sprint test, participants were asked to complete the Stroop Test for the third and final time.

Measurement instruments

International Physical Activity Questionnaire (IPAQ)

The IPAQ was developed in 1998 with 2 versions, a short 9 items and a long 31 items, to determine PA patterns of healthy individuals. It has satisfactory reliability in determining the level of PA of healthy individuals (Hagströmer *et al.*, 2005). The English long, self-administered questionnaire was used as it is feasible, acceptable and easy to complete by the participants. The long, self-administered questionnaire consists of 4 areas of PA: work-related activities; transportation; leisure time activities; and gardening/domestic activities. It also consists of questions related to time allocated to sitting, which contributes to sedentary activity and behaviour. The responses consist of scores which are categorised into low, moderate and high levels of PA. The IPAQ was used prior to classifying the participants into the respective groups namely, sedentary or active. This was done according to their PA level, as determined by the IPAQ.

Stroop Test

The Stroop Test that was used to measure cognitive performance was developed by John Stroop in 1935. Although the Stroop Test is 81 years old, it is a quick measure that is used regularly in screening for executive function deficits (Homak & Riccio, 2004). According to Homak and Riccio (2004:729), "research suggests that temporal reliability of the Stroop Test is good (r>0.80; O'Connor *et al*., 1988; Sacks *et al*., 1991; Graf *et al*., 1995), with some practise effects evident consistently across all 3 tasks (Feinstein *et al*., 1994)". Malek *et al*. (2013) found that RT and error of almost all cards of the Stroop were reliable and had a good differential validity. Their findings were similar to the reports of good reliability by Sacks *et al*. (1991, cited in Homak & Riccio, 2004), Feinstein *et al*. (1994, cited in Homak & Riccio, 2004), and Graf *et al*. (1995, cited in Homak & Riccio, 2004), who found a reliability higher than 0.80 for scores obtained in the Stroop Colour-Word Test.

Factor analysis is one method to determine construct validity (Homak & Riccio, 2004). According to Graf *et al*. (1995, cited in Homak & Riccio, 2004:729), the "Stroop performance loaded on the same factor as the Block Design, Digit Symbol, Similarities, and Digit Span subtests of the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981)". Shum *et al*. (1990, cited in Homak & Riccio, 2004:729), established that the Stroop loaded with

sequential deduction tasks. Congruent and incongruent trials of the Stroop Test were used and RT was measured in order to determine whether acute exercise affects cognitive function directly. In the test, individuals were asked to name colours which are randomised with words that are superimposed with the same colour ink but different spelling (McCleod, 1991). For instance, there could be a blue circle with the spelling inside spelling out 'red', this is known as an incongruent trail. The goal is to ignore irrelevant cues (spelling), and focus on the task relevant cues. Imaging methods including Positron Emission Tomography and Magnetic Resonance Imaging have demonstrated that the Stroop Test activates the subject's frontal lobe during the task (Smith & Jonides, 1999).

The two main areas of the frontal lobe that are activated are the Dorsolateral Prefrontal Cortex (DLPFC) and the anterior cingulate cortex (ACC). Both these areas have been shown to be responsible for conflict resolution and monitoring (Adleman *et al*., 2002). When there is an influx of competing information, the ACC activates to allocate attention resources and select appropriate responses. The DLPFC, on the other hand, is more responsible for reducing attention conflict. The DLPFC reduces the influence of irrelevant information affecting task

performance (Adleman *et al*., 2002).

Repeated Sprint Test (RST)

The RST was used as the acute anaerobic exercise performed between the administration of the pre- and post-Stroop Test.

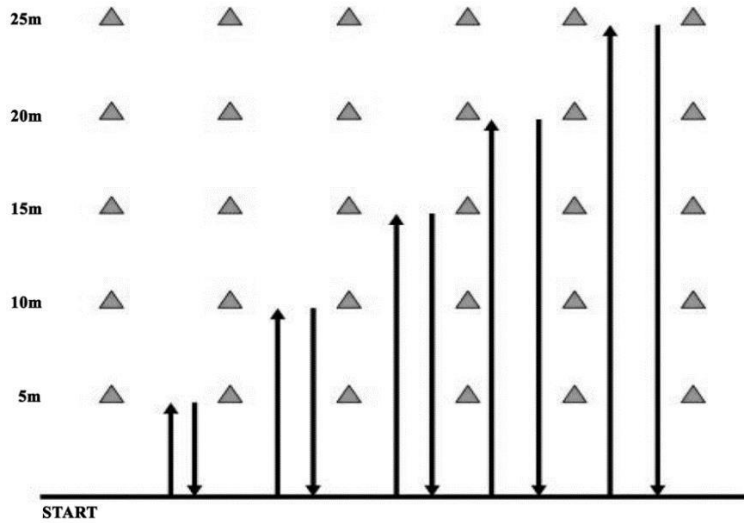

Figure 1. **REPEATED SPRINT TEST**

The repeated sprint test cones are placed 5m apart, up to 25m. The participants: (1) start by running to cone 1, 5m away, and then run back to the start; (2) followed by running to the second cone, 10m away, and then back to the start; (3) then to cone 3, 15m away, and then to the start; (4) then cone 4, 20m away, then back to the start; 5) then to cone 5, 25m away, then back to the start. The participants had 30 seconds to run as far as possible and then had a 35-second rest period. This procedure was repeated six times (Bucheit *et al*., 2010). Regarding the validity of the RST, Bishop *et al*. (2001) postulates that correlation coefficients between

dependent variables were calculated using Pearson's Product Moment (r). There was a significant correlation between power decrement during the 5 x 6s cycle test and decrement in 15-m time across the three periods ($r=0.76$; $p<0.05$), but not decrement in 10-m time ($r=0.54$) or 5-m time ($r=0.42$). These results suggest that the 5 x 6s cycle test is valid for assessing the decrement in 15-m time, but not the decrement in 5m or 10m time. The typical error of measurement (TE) was used to assess the reliability of the test variables. The TE for the total sprint time was 0.7% (95% CL, 0.5-1.2%) indicating that it was very reliable (T1: 26.79±0.76s versus T2: 26.83±0.74s). Yet, the percentage sprint decrement was less reliable (T1: 5.6±0.9% versus T2: 5.8±1.0%), with the TE being 14.9% (95% CL, 10.8-31.3%) (Spencer *et al*., 2006).

Statistical analyses

All values were computed as means and standard deviations. An unpaired *t-test* was used to determine the differences in the distance covered in the repeated sprint test between the moderately active and the sedentary groups. To assess the effects of the acute exercise bout on cognitive performance on the Stroop conditions, a paired *t-test* was used to analyse the seconds it took both the moderately active and sedentary groups to respond to the Stroop conditions.

The mean and standard deviations were used for only one congruent condition (pre-colour blocks and post-colour blocks), and one incongruent condition (pre-mixed question and post-mixed). An alpha of 0.05 was used as the target level of statistical significance.

RESULTS

Repeated Sprint Test Performance

The *unpaired t-test* revealed that the active group (691.66m±0.965, $p<0.05$) covered a statistically significant greater distance compared to the sedentary group (613.33m±11.902, $p<0.5$) during the repeated sprint test (Figure 2).

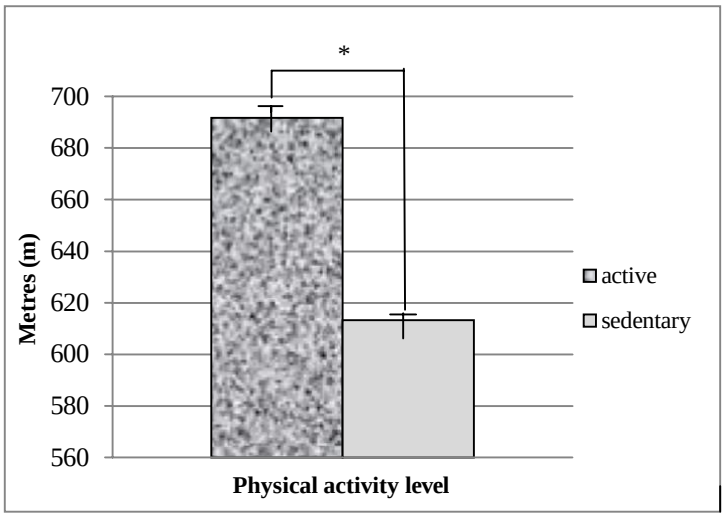

Figure 2. **TOTAL DISTANCE COVERED IN REPEATED SPRINT TEST** (*=$p<0.05$)

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Stroop Test Performance

Reaction time (RT)

Figure 3 presents the performance of the Stroop Test between pre- and post-tests for both the moderately active and sedentary groups. A shorter RT represents better performance. Data is presented as means. Results of the *paired t-test* revealed that each group made a statistically significant improvement in RT between the pre- and post-tests ($p<0.05$). The results reveal that the active group performed better than the sedentary group in both the congruent (colour blocks) and incongruent (mixed questions) conditions ($p<0.05$).

With regards to Stroop performance within groups (Figure 4), there was a statistical significant improvement from pre-test to post-test for both the sedentary and the active group in relation to the congruent and incongruent RT. The main findings of the *paired t-test* indicated that the active group performed significantly better than the sedentary group with regards to RT.

Accuracy

With regards to accuracy during the Stroop Test (Figure 5), the results indicate that the moderately active group performed more accurately in the congruent condition during both the

pre- and post-tests. Another main finding indicates a longer RT in the incongruent condition that was statistically significant in comparison to the congruent condition.

Figure 3. **REACTION TIME IN STROOP PERFORMANCE BETWEEN GROUPS: ACTIVE AND SEDENTARY** (*=p<0.05)

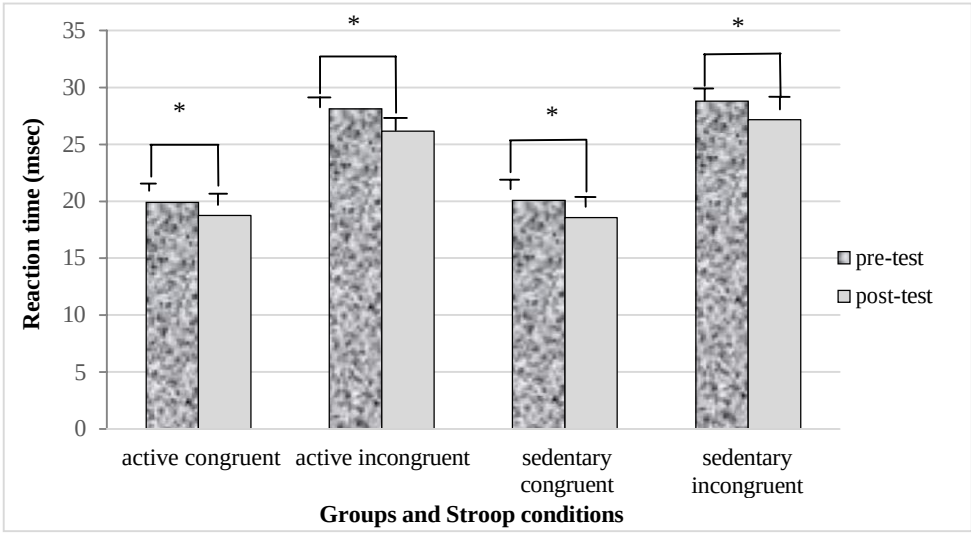

Figure 4. **REACTION TIME IN STROOP PERFORMANCE WITHIN GROUPS: ACTIVE AND SEDENTARY** (*=p<0.05)

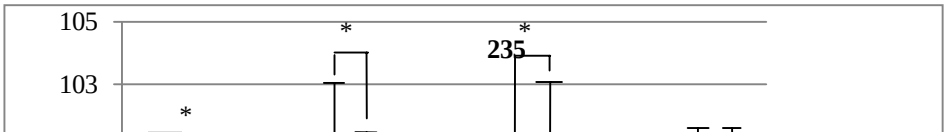

Figure 5. **ACCURACY FOR PRE- AND POST-STROOP CONDITION: ACTIVE AND SEDENTARY GROUPS** (*=p<0.05)

DISCUSSION

Previous research by Chang *et al*. (2014) found that cognitive performance is affected by fitness levels and that acute bouts of exercise benefit several types of cognitive performance differently. There are only a few studies that researched the potential for a combined interactive effect of PA and cognitive task types on the effects of acute exercise on cognitive performance (Brisswalter *et al*., 2002; Chaddock *et al*., 2011; Chang *et al*., 2012; Hogan *et al*., 2013; Chang *et al*., 2014). The purpose of this study was to assess if the level of physical activity and cognitive task type have an influence on the relationship between cognition and acute exercise.

The study classified individuals as either sedentary or moderately active based on their participation in physical activity over the past three months. The results of the repeated sprint test indicate that there was a statistical significant difference ($p<0.05$) regarding the total distance covered between the two groups, with the moderately active individuals scoring a higher average score than the sedentary group. This indicates that the moderately active individuals were indeed significantly fitter than the sedentary group.

Regarding cognitive function, the results of the current study indicate an improvement in executive functioning for both the sedentary and moderately active group. This is in agreement with Tomporowski *et al*. (2008), Chang *et al*. (2014) and Tomporowski *et al*. (2015), who also found statistically significant improvements in cognition following an acute bout of exercise.

Noteworthy improvements in the Stroop Test serve as an indicator that general improvements in cognition are partly as a result of the acute bout of exercise. The experimental design of the current study did not have a control group and, therefore, it is not possible to separate the effect of acute exercise from effects of learning or familiarity (Chang *et al*., 2014). However, participants were all provided with a trial-run of the Stroop Test, all subjects attained more than 90% accuracy prior to performing the actual pre-test. Therefore, this minimised the potential

effects of learning or familiarity.

Interestingly, the current study found that the moderately active individuals were superior to the sedentary individuals in all aspects of the Stroop Test besides accuracy in the post-test congruent scores (Figure 5). This could be as a result of numerous factors, which are beyond the scope of this article to explain. One, in particular, could be due to the high level of physiological stress placed on the moderately active individuals following a repeated sprint test. Moderately active individuals have been accustomed to exercise and consequently can do physical work at a higher physiological level. They have the ability to work physically at a maximal or near maximal level and this could lead to higher levels of fatigue post-test and consequently their congruent scores may suffer (Hung *et al*., 2013).

The acute exercise test used in this study, namely the repeated sprint test, mimics that of those used in other studies. These other studies (Brisswalter *et al*., 2002; Tomporowski, 2003; Córdova *et al*., 2009; Kashihara *et al*., 2009; Pesce *et al*., 2011; Chang *et al*., 2012; Hogan *et al*., 2013; Hung *et al*., 2013; Chang *et al*., 2014), according to Chang *et al*. (2014), repeatedly show an improvement in cognitive performance following acute exercise in comparison to control conditions. Therefore, it seems that the subjects in the current study had cognitive

performance benefits associated with performance from a single bout of moderate intensity aerobic exercise.

General consensus accepts that increased physiological arousal, following acute exercise, is one of the causes for change in cognitive performance (Kashihara *et al*., 2009). The inverted-U hypothesis links moderate arousal to optimal cognitive performance, while arousal levels too high or too low from optimal, would decrease these beneficial effects. Fontana (2007) and Chang *et al*. (2014) support this hypothesis. According to Chang *et al*. (2014), research found that neuro-electrical activation from a moderate intensity perspective to be more beneficial in comparison to low and high intensity conditions. Moderate intensity exercise may be the most optimal intensity, allowing for the most beneficial level of arousal and having the best effect on attentional resources, which are important for cognitive performance (Tomporowski, 2003; Ferris *et al*., 2007; Chang *et al*., 2012; Chang *et al*., 2014). Findings from the studies of Kamijo *et al*. (2004) and Larson *et al*. (2009) are consistent with the findings of the present study, which shows that PA levels did not influence the positive relationship between acute moderate exercise and cognition.

The results of the current study show a longer response in the Stroop incongruent condition when compared to the Stroop congruent condition for both the moderately active and the sedentary individuals. This is expected as the test trial uses different colours and words and subjects are, therefore, required to use more cognitive resources to prevent the automatic response, which is to read the word and, thus, interference, inhibition and selective attention are required to complete the task (Ploughman, 2008; Tomporowski *et al*., 2008; Hung *et al*., 2013; Chang *et al*., 2014; Tomporowski *et al*., 2015). This collectively results in a prolonged amount of time to complete the task.

Even though both groups show longer RT in the incongruent condition, the present results indicate that the moderately active individuals had better RT than the sedentary group for both the congruent and incongruent scores. This was statistically significant ($p<0.05$) and suggests that moderate physical activity may play a role in executive functioning. This is in agreement

with Córdova *et al*. (2009), Pesce *et al*. (2011) and Luque-Casado *et al*. (2013), who all found that acute exercise resulted in enhancements of executive functioning and alertness. Pesce *et al*. (2011) found that these enhancements were greatest in trained or fitter individuals in comparison to the sedentary individuals.

The main finding of the current study was that subjects at both levels of physical activity, namely sedentary and moderately active, showed an improvement in cognitive performance following the cessation of the acute bout of exercise, the moderately fit individuals saw the greatest cognitive improvements. These cognitive improvements following acute bouts of exercise were also seen in the study of Hung *et al*. (2013).

LIMITATIONS AND RECOMMENDATIONS

One major limitation of this study is that moderately physically active individuals from various sporting codes were used. Future studies could make use of a specific population in relation to sport. The current study only focused on two groups, with regard to PA levels namely, sedentary and moderately active individuals. Future studies could investigate the effects of

acute exercise on the cognitive performance of highly active individuals in comparison to moderately active individuals. Contrary to previous research, Chang *et al*. (2014) found that people with high fitness levels attained longer RT in the Stroop incongruent condition. This implies that high fitness is associated with poor performance for this measure of executive functioning. Tomporowski (2003), Ferris *et al*. (2007), Chang *et al*. (2012) and Chang *et al*. (2014) found that moderate PA levels resulted in better cognitive performance than lower or higher PA levels. Future research should explore how and why lower and higher levels of fitness are related to poorer performance. Additionally, it is suggested that future studies test the effect of a maximal aerobic and/or anaerobic exercise bouts on cognitive performance. Researchers might want to make use of popular maximal testing protocols, such as the VO_2-max or the Wingate test.

A second limitation of the current study was that no control group was used. This decision was based on the fact that there was substantial evidence in support of acute exercise having a benefit on the Stroop Test performance and the aim was to determine if the benefits, as determined by Stroop Test performance, would differ between sedentary and moderately active individuals (Chang & Etnier, 2009). However, it is recommended that a control group should be used in future studies of this nature. Another limitation was the omission of gender comparisons. It is also recommended that future research examine the extent to which acute exercise and PA levels affect the conflict adaptation effect (this refers to the observation that RT on a given trial is influenced by a previous trial).

CONCLUSION

The results of the current study are in agreement with previous studies in showing the beneficial relationship between acute exercise and cognitive performance for basic information processing, as well as executive control. It should also be noted that this trend can be seen regardless of PA levels. From a practical perspective, individuals should be aware of the significance of performing single bouts of exercise regularly and maintaining a moderate level of PA.

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Prof Kallie VAN DEVENTER: Department of Sport Science, Stellenbosch University, Private Bag X1, Matieland, Stellenbosch 7602, Republic of South Africa. Tel.: +27 (0)21 808 4715, Email: kjvd@sun.ac.za

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TELEPHONE VERSUS USUAL CARE IN MANAGEMENT OF ACUTE WHIPLASH ASSOCIATED DISORDER: A PILOT STUDY

Estelle D. WATSON[1] & Yoga COOPOO[2]

[1] *Centre for Exercise Science and Sports Medicine, School of Therapeutic Sciences, Faculty of Health Sciences, University of Witwatersrand, Johannesburg, Republic of South Africa*
[2] *Department of Sport and Movement Studies, Faculty of Health Sciences, University of Johannesburg, Johannesburg, Republic of South Africa*

ABSTRACT

Whiplash associated disorder (WAD) is a common and costly condition, and recommended management includes advice to "act as usual" and exercise. Providing this treatment through a telephonic intervention may help to improve access to care, and reduce costs. This pilot study assessed: (1) the effectiveness of a telephonic intervention for low grade WAD injuries; and (2) the comparison between this intervention and standard manual therapy. A quasi-experimental study design was implemented. Eighty-two (n=82) participants received the telephone remote intervention (RI), which included an exercise booklet and telephonic support every seven to 10 days for a period of 12 weeks. Forty-five (n=45) participants received standard manual therapy treatment (SMT). Outcome measures included pain rating, subjective range of movement and activities of daily living. Post-intervention follow-up outcomes were assessed telephonically for both groups at the end of the 12-week intervention period. A statistically significant improvement was found in all outcome measures in both the RI and SMT groups in the short term. No significant difference was found between the two interventions.

***Key words*:** Whiplash Associated Disorder; Management; Telephone; Manual therapy.

INTRODUCTION

Telephonic diagnosis and treatment is a possible solution for improving access to healthcare. One impetus for the development of telephone interventions was to decrease general practitioner (GP) workloads (Bunn *et al*., 2005; McCue *et al*., 2010). For example, the introduction of a telephonic nursing consultation service has been shown to decrease GP workload by up to 50% (Lattimer *et al*., 1998). Aimed at helping patients to self-manage, telephone interventions have reduced unnecessary demands on service provision (Bunn *et al*., 2005). In addition, provision of timely access to information and advice improves patient satisfaction (Taylor *et al*., 2002; Bunn *et al*., 2005). Furthermore, the conception of services, such as the National Health Service's *PhysioDirect* in the United Kingdom in 1998 (Foster *et*

al., 2011) may provide potential cost and time saving (Ekeland *et al*., 2010).

As many of these remote management services have only been around for the last 20 years, it remains an emerging field of research. There is little evidence regarding the effectiveness of telephone interventions, and much of the research is of poor quality (Rogante *et al*., 2010;

Foster *et al*., 2011). The balance between efficiency and safety has yet to be established (Giesen *et al*., 2007). Concerns regarding quality of care and adverse events still remain high (Foster *et al*., 2011). Therefore, there is a clear need for directed research, specifically in the area of remote management of musculoskeletal conditions.

The most common conditions presenting in physiotherapy practices include back, neck and shoulder complaints (Foster *et al*., 2011). Research in the area of remote management has concentrated on lower back pain (Lau *et al*., 2008), with very little evidence for other musculoskeletal conditions. One such condition that contributes significantly to disability and societal costs is Whiplash Associated Disorder (WAD). The incidence of WAD has significantly increased in the past three decades (Moore *et al*., 2005). However, there is still little consensus on a single appropriate treatment for WAD (Moore *et al*., 2005; Söderlund *et al*., 2009). In lower grade WAD injuries, it is generally accepted that treatment should involve an active approach, encouraging self-management, return to activities, exercises and education (Ferrari *et al*., 2005; Moore *et al*., 2005; Söderlund *et al*., 2009). Treatment that encourages clinician dependence and passive coping strategies is in fact associated with a poorer prognosis (Nicholas, 2008). Therefore, telephonic intervention may be a viable treatment option for the management of WAD injuries.

Physiotherapy-led telephone services are a relatively new area of research, aimed at improving patient outcomes by reducing waiting times. Timely access to these services is especially important, as early intervention is vital to prevent chronicity and absenteeism (Scholten-Peeters *et al*., 2002; Lau *et al*., 2008). These services offer an initial assessment and advice by telephone, usually supported by clinical algorithms (Zigenfus *et al*., 2000; Foster *et al*., 2011). They have been found to be a valid and reliable method of assessment, possibly comparable to that of face-to-face (Bishop *et al*., 2013). These interventions are proving to be an effective method of increasing physical activity levels in targeted populations (Marcus *et al*., 2006).

PURPOSE OF RESEARCH

The aim of this study was to assess the effect of remote telephone management in the treatment of Grade I and II WAD injuries and to compare telephone management versus standard face-to-face treatment in the management of low grade WAD injuries. Research comparing telephone interventions to usual, standardised physical therapy is still in its infancy stages.

METHODOLOGY

Participants

Participants referred to a private health insurance company for a WAD injury from a motor vehicle accident (MVA), through a third-party insurer, were invited to participate in the study. In line with a similar research protocol by Salisbury *et al*. (2009), the inclusion criteria were broad to maximise generalisability and reflect clinical practice (Table 1). Grade I and II WAD

was diagnosed as per the Neck Pain Task Force guidelines (Carroll *et al*., 2009). Information regarding the study was provided, and informed consent was obtained telephonically. The study was approved by the Human Research Ethics Committee of the University of the Witwatersrand (Certificate number M140399).

Table 1. **INCLUSION AND EXCLUSION CRITERIA**

Inclusion criteria	**Exclusion criteria**
• 16 years and older • WAD Grade I or II • Acute injury (within 4 weeks)	

- <16 years
- Secondary injuries to the upper and/or lower limbs
- WAD Grade III or IV
- Patients requesting hands-on physiotherapy
- Patients currently undergoing physiotherapy
- Diagnosed psychological condition (depression)

Interventions

At baseline all participants were contacted telephonically by trained Physiotherapists, Biokineticists and Chiropractors. Demographic, accident and symptom information was gathered at the initial call. All participants received a "Guide to Whiplash" booklet via the post. The booklet was evidence-based (Scholten-Peeters *et al*., 2002; Moore *et al*., 2005; Mercer *et al*., 2007), and provided information regarding the injury, self-management techniques, as well as 7 stretching and 4 isometric neck strengthening exercises. All participants were provided with advice to "act as usual" and resume their activities of daily living as far as possible (Ferrari *et al*., 2005; Kongsted *et al*., 2007).

At the initial telephonic assessment, the sample group was then divided into the remote intervention (RI) group and the standard manual therapy (SMT) group. The RI group (n=82) were then contacted telephonically every 7 to 10 days, over a 12-week period, and provided with further advice and education. The SMT group (n=45) was provided with an initial physiotherapy assessment within 1 week of the initial telephone call. An average of 4.2±2.3 physiotherapy treatment sessions, with a maximum of 10 treatment sessions, was provided. The SMT is described elsewhere and consisted of mainly joint mobilisations, stretches, soft tissue massage and mobility exercises (Watson & Coopoo, 2011). Post-intervention follow-up outcomes were telephonically assessed at 12 weeks for both groups.

Outcome measures

There were 3 main outcome measures assessed in this study. Firstly, pain intensity of the neck was rated on the numerical pain rating scale (NPRS). This was scored out of a possible score of 10, with 0 being "no pain at all" and 10 being "worst pain ever experienced". Use of these scales have been shown to be a valid and clinically important outcome measure (Wewers & Lowe, 2007), and has been used in previous whiplash related studies (Söderlund *et al*., 2009; Michaleff *et al*., 2014). Secondly, Range of Movement (ROM) of the neck was subjectively assessed. This was done by asking the patient "Out of a possible 0 and 100% movement (with 100% being normal pre-injury movement), how much movement do you feel you currently have?" Thirdly, activities of daily living (ADL's) were assessed. Participants rated themselves on 4 items: personal care; housework; driving; sleeping; and leisure activities (sport and recreation). Each item was scored on a 4-point Likert rating, ranging from 1 being "not affected" and 4 being "significantly affected" (Femia *et al*., 1997). The composite score of all these measures (out of a possible 16) was then calculated to give a score for general activities of daily living (GADLS). Demographic, occupation, accident, medication and other treatment details were also gathered at baseline.

Statistical analysis

For ordinal data, the median scores were calculated and displayed with the ranges. Non-normally distributed continuous data was log transformed for analysis. For ordinal data or data that remained non-normally distributed after transformation, a Mann-Whitney U-test for independent data and a Wilcoxon rank sum for paired data was used. For normally distributed continuous data, t-tests were used. A statistical significance of $p<0.05$ was accepted for all analyses. All analyses were done using STATISTICA (Version 11, Tulsa, USA) statistical package.

RESULTS

The study included 127 (65%) of the possible 191 participants that were assessed for eligibility. Participants were excluded when they specifically requested to be seen by a physiotherapist (n=20), missing data (n=12), chronic WAD (n=28) and no consent (n=4).

Table 2. **BASELINE CHARACTERISTICS OF PARTICIPANTS**

Demographic characteristics	**RI group** (n=82)	**SMT group** (n=45)
Age [M±SD years]	38.8±14.4	41.0±14.4
Gender [n(%)]		
Male	47 (57%)	26 (58%)
Female	35 (43%)	19 (42%)
Occupation [n(%)]		
Employed	68 (83%)	36 (80%)
At work	54 (66%)	28 (62%)
Off work	13 (16%)	8 (18%)
Light duties	1 (1%)	—
Unemployed	9 (11%)	5 (11%)
Student	3 (4%)	1 (2%)
Retired	2 (2%)	3 (7%)
Accident details [n(%)]		
Rear end	53 (65%)	31 (69%)
Side impact	20 (24%)	11 (24%)
Front impact	3 (4%)	3 (7%)
Head-on	4 (5%)	—
Other	2 (2%)	—

RI=Remote Intervention SMT=Standardise Manual Treatment

Eighty-two (65%) patients received telephone advice and remote monitoring of exercises. Forty-five (35%) patients received standardised manual therapy. Table 2 depicts demographic characteristics of the participants. The mean age (years) for the RI group was 38.8±14.4 and

41.0±14.4 for the SMT group, with no significant difference in age between the groups (p=0.338). At baseline, there were no significant differences in pain (p=0.064), ROM (p=0.772) and GADLS (p=0.198) between the RI and SMT groups. Gender, occupation and accident details are also shown in Table 2. There were marginally more males in both groups than females. Both the RI and SMT group showed the majority of the participants were currently employed and at work (66% and 62% respectively). The most common type of accident was a

rear end motor vehicle collision, reported in 65% of the RI and 69% of the SMT groups, respectively.

Table 3. **PRE- AND POST INTERVENTION OUTCOMES**

Outcomes	Remote Intervention (RI) Group (n=82)			Standard Manual Therapy (SMT) Group (n=45)			Difference at discharge p-Value
	Baseline Mean±SD	Discharge Mean±SD	p-Value	Baseline Mean±SD	Discharge Mean±SD	p-Value	
NPRS	5.7±1.5	2.1±1.6	0.01*	6.2±1.7	1.4±1.6	0.01*	0.139
ROM	71.9±22.2	97.2±8.9	0.01*	73.5±16.1	92.2±12.3	0.01*	0.156
GADLS	8 (2)#	5 (3)#	0.01*	9 (3)#	4 (1)#	0.01*	0.198
Daily living activities	Med(IQR)	Med(IQR)		Med(IQR)	Med(IQR)		
Personal care	2 (1)	1(0)	0.01*	2(1)	1(0)	0.01*	
Driving	2 (2)	1(1)	0.01*	2(1)	1(0)	0.01*	
Sleeping	2 (2)	1(1)	0.01*	2(1)	1(0)	0.01*	
Leisure activities	2 (2)	1(1)	0.01*	2(2)	1(0)	0.01*	

NPRS: Numerical Pain Rating Scale GADLS: General Activities of Daily Living Scale Med=Median
ROM: Range of movement * Significance=p<0.05 IQR=Interquartile Range # =Median (IQR)

Table 3 shows the mean difference in outcome measures from baseline to discharge. The RI group showed significant improvements from pre- to post-intervention on all 3 outcome measures, namely pain (p=0.01), ROM (p=0.01) and GADLS (p=0.01). The SMT group also showed significant improvements from pre- to post intervention in the same 3 outcome measures. A clinically important decrease in pain of at least 30% (Cepeda *et al*., 2003) was obtained in 87% of the participants in the SMT group and 70% in the RI group. Statistically, no difference was found between the RI and SMT groups for NPRS (p=0.139), ROM (p=0.156) or GADLS (p=0.198) at discharge.

DISCUSSION

The aim of this pilot study was to trial the effects of a telephone intervention for acute low-grade WAD in order to provide tentative results to guide further study design. This study showed short term improvements in pain, subjective ROM and ADL's with both remote intervention and standard manual therapy. No significant differences were found between the two interventions. Robust evidence is needed on the alternative approaches to the provision of physiotherapy services. Telephone interventions and remote monitoring may play a major role in reducing workload whilst providing time and cost saving (Salisbury *et al*., 2009).

These innovative interventions may be particularly useful in certain conditions, such as a low-grade WAD injury, where manual therapy may offer little benefit over advice, education and exercise. Recommendations for acute WAD injuries include active exercise, self-management and a return to normal activities (Mercer *et al.*, 2007). Physiotherapy appears to be useful in the event that symptoms persist (Mercer *et al*., 2007; Lamb *et al*., 2012). Otherwise, patients should be provided with an advice sheet and home exercises (Logan & Holt, 2003). These home exercises should be initiated and supported by a physiotherapist (Rosenfeld *et al*., 2003). These recommendations are what led the researchers to hypothesise an alternative, possibly cheaper, way of delivering this care.

In this small non-randomised study, between-group change showed that the RI group performed as well as the SMT group at 12 weeks. Both the SMT group and the RI group had improved pain relief (87 & 70%, respectively). Similarly, in a study of 172 participants, Michaleff *et al*. (2014) found advice to be just as effective as a comprehensive exercise programme to reduce pain in chronic WAD patients. Other remote interventions, such as educational videos or pamphlets, have also been shown to improve function after a WAD injury (Carragee *et al*., 2008). Thus, remote interventions may lead to similar outcomes when compared to standard care (Ferrari *et al*., 2005). Indeed, Kongsted *et al*. (2007) showed little differences between immobilisation, "act as usual" advice and mobilisation in the treatment of pain following a WAD injury.

In addition, other studies have shown that a well-planned, structured unsupervised exercise is comparative to supervised, standard care in properly selected patients (Jokl *et al*., 1989; Beard & Dodd, 1998). In economic terms alone, the potential savings of these types of services are tremendous. In fact, in a large scale randomised controlled trial, Lamb *et al*. (2012) found that physiotherapy treatment provided small, short term benefits in neck disability when compared to an advice session alone. Therefore, it appears that the evidence is lacking for using only one specific treatment for WAD. Referrals to supervised physiotherapy may be warranted if significant symptoms are present or persist (Mercer *et al*., 2007; Lamb *et al*., 2012) and long-term follow up is warranted for remote interventions to ensure safety and assess the reoccurrence of pain or symptoms. As mentioned in previous studies, clinicians should also be aware that patients who lack motivation or discipline, may require supervised treatment (Jokl *et al*., 1989). However, clinicians should avoid promoting frequent visits, as this may encourage passive coping strategies and dependence (Cote *et al*., 2005).

This study has several limitations. Firstly, further studies should adopt a more rigorous study design, such as a randomised controlled trial. This will reduce bias and control potential confounders within the results. Secondly, the study was limited by the health insurance company as to which outcome measures could be used. Although many of the outcome measures had been used in previous studies, there are limitations in the use of subjective measures of pain, disability and range of motion. However, this was the most feasible method to telephonically assess the outcomes within the restraints of a private insurance company setting (Shinar *et al*., 1987; Angst *et al*., 2004). The use of more robust outcome measures such as the Neck Disability Index (NDI) is warranted.

CONCLUSION

In this small pilot study, the researchers found no significant differences between the effectiveness of the two interventions, with the telephone intervention presenting a potentially cheaper option. Further research should aim to conduct a cost effective analysis to determine whether the costs of treating acute low-grade WAD patients will be alleviated with a well-structured telephone-supported home programme. This study forms a basis from which to formulate further research, specifically a randomised controlled trial, which would add to the growing literature on the benefits of these types of services (Jokl *et al*., 1989; Söderlund *et al*., 2009). Further randomised controlled trials should address the effects of telephone assessment and advice versus supervised physiotherapy in reducing pain and improving ROM and function, in patients with acute WAD.

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Dr Estelle D. WATSON: Centre for Exercise Science and Sports Medicine, Faculty of Health Sciences, University of Witwatersrand, 27 St Andrews Road, Parktown, Johannesburg 2050, Republic of South Africa. Tel.: +27 (0)11 7173227, +27 (0)828112688, Email: estelle.watson@wits.ac.za

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