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THE ROLE OF ACTIVE TEACHING PROGRAMMES IN ACADEMIC SKILLS ENHANCEMENT OF GRADE 2 LEARNERS IN THE STELLENBOSCH REGION

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ABSTRACT

The premise of this study focused on the holistic approach to the human body, mainly the connection between the brain and the body. Learners attend school as holistic beings and both the body and the brain require sufficient stimulation throughout the day. The primary purpose of the current study was to determine the effect of two intervention programmes presented over a period of 8 weeks: (1) an integrated academic skills and physical development programme; and (2) a moderately intensive physical activity programme, on Grade 2 learners' academic abilities, particularly with regard to literacy and numeracy skills. The Grade 2 learners (N=149) originated from two schools (School A [n=76]: boys=35, girls=41; School B [n=73]: boys=35, girls=38). Data was collected by means of a pre- and post-test. The measuring instruments used were the VASSI Mathematical Skills Test and the ESSI Reading and Spelling Test. The results indicated that both schools showed progress in literacy and numeracy, although it was not statistically significant ($p<0.05$). Based on the results obtained by the current study, general recommendations were made for the education practice. It is essential to recognise the importance of physical activity as it can have an effect on the holistic development of the child.

Key words: Holistic development; Physical activity; Physical Education; Life Orientation/Life Skills; Literacy and numeracy skills.

INTRODUCTION

There is currently an increasing and alarming realisation that many school going learners fall through the academic cracks. Archaic teaching methods, unqualified teachers, overcrowded classrooms, financial problems, lack of facilities, unwilling teachers and inadequate knowledge and skills about the curriculum are examples of factors that have a direct impact on South African schools (Van Deventer, 2009; Curry, 2011). According to Mji and Makgato (2006), the above-mentioned factors affect learners' academic performance directly, which has an impact on the child's future. Kokot (2006) believes that, although regular changes in both the education system and teaching methods are made, learning problems still occur among learners. According to Kokot (2010:7), 51% of all learners in South Africa (SA) experience moderate to severe problems in two or more academic areas.

Pica (2011) argues that academic skills are part of children's lives from an early age and the acquisition of motor skills is not always seen as important as academic skills. Fredericks *et al*. (2006) suggests that the impact of movement programmes on academic and cognitive skills are ignored by society on a regular basis. It seems as if society is under the impression that the body and mind function as separate entities and that the brain is equipped with more important functions than the body.

De Jager (2007) suggests that the body and brain are interconnected during the learning process. When something new is learned, the whole body comes into play. Every part of the body makes a unique contribution to the learning process. Unfortunately, the reality is that children are expected from an early age to take a static position behind the desk, focusing only on the blackboard during an academic lesson (Hannaford, 1995). According to De Jager (2008), it is ironic that all processes (including conception, development in the womb, the physical growth process, childbirth, breathing, reaching developmental milestones and the use of senses) are active processes. This suggests that children need time, space and opportunities for movement. It is also said that if children are not confident, from a young age, in the development of their motor skills, complications can occur in other areas such as the cognitive, emotional and social domains (Hendricks, 2004). It appears that society believes that the development of motor skills is a natural process that occurs as children grow older (Pica, 2011). However, research shows the contrary (De Jager, 2008). Although it is natural for children to constantly want to move, like run, jump, roll, swing and crawl, it is imperative that formal and structural movement experiences must be created during the school day.

Opportunities within school Physical Education (PE) have steadily declined since 1994 and a scarcity of movement experiences during the school day is evident (Trost & Van der Mars, 2010). In SA, PE followed the same route as in other countries, such as in the UK, Australia and the USA. Since 1994 it was officially no longer recognised as part of the South African school curriculum and currently only forms a focus area of the subject Life Orientation/Life Skills.

The primary purpose of the first democratic government in SA was to transform the education system. During apartheid, SA had more than 19 different education departments. It was divided by way of race, geography and ideology (DOE, 2001). This education system prepared children for different social, economic and political roles, as determined by the apartheid regime. According to Rooth (2005), the South African education system was established on highly authoritarian and strict Christian values. This led to an uneven distribution of resources, such as the pursuit of a content driven curriculum that was biased towards certain races, as well as separate education departments for each race group. Rooth (2005) believes that the quality of teaching and learning, as well as the lives of many South Africans, were negatively impacted. The education departments had to merge so that a new, post-apartheid and democratic national curriculum for all could be developed.

The first major curriculum statement of the new democratic SA was the Lifelong Learning through a National Curriculum Framework document published in 1996 (DOE, 2001:4). It emphasised the importance of change in education and training in SA, the normalisation and transformation of teaching and learning, and the need for outcomes-based education (OBE).

In 1998, the first OBE curriculum, namely Curriculum 2005, was implemented in schools. The principles of Curriculum 2005 focused on the new South African constitution, which was based on human rights, equality, inclusiveness and social and environmental justice (Rooth, 2005). This curriculum defined specific outcomes and standards in specific learning areas. Although impracticalities have occurred within Curriculum 2005, it formed the basis on which the curriculum could be reviewed (Rooth, 2005). Curriculum 2005 was reviewed in 2000 after which it was renamed the National Curriculum Statement (NCS), which is an outcome-based, integrated knowledge system that focuses on a learner-centred methodology (Van Deventer, 2009).

According to Van Deventer (2009) transformation in the South African education system introduced not only Curriculum 2005 and OBE, but also a new learning area, namely Life Orientation. Life Orientation is one of eight subjects in the NCS. The scope of Life Orientation is aimed to develop learners on a personal, psychological, cognitive, physical, moral, spiritual, cultural and socio-economic level and for them to reach their full potential in a new democratic SA (DOE, 2003). Motor skills development and movement activities that are offered during Life Orientation, seek to form the foundation of sport skills and all learners are encouraged to take part in learner-centred, inclusive and integrated movement programmes. It encourages healthy living practices and mutual respect for other individuals (DOE, 2011). Life Orientation, therefore, attempts to assist teachers to develop and teach learners in a holistic, balanced and integrated way (Hendricks, 2004).

According to Hendricks (2004), holistic education focuses on the experience of intellectual, emotional, social, physical, creative and spiritual teaching. It is important that children not only participate in learning experiences inside and outside of the classroom, but also communicate with each other on a physical level so that positive interaction takes place between them. The problem is that the physical (movement) component of Life Orientation is not being taught in most public schools in SA (Pienaar, 2009; Van Deventer, 2009).

This phenomenon makes it difficult for learners, parents and teachers to believe that exercise is beneficial and that movement might have a positive effect on the body and the brain (Summerford, 2001). Coe *et al*. (2006) states that one of the many reasons for the absence of PE can be attributed to teachers and parents that believe participation in physical activity might interfere with learners' academic success. The Department of Education may also reason that funds spent on physical activities can be better utilised in other academic environments. According to Hendricks (2004), PE contributes to the functioning of most of the body's systems, including the skeletal, nervous and muscular systems. It also contributes to children's cognitive, motor and emotional development. Despite the benefits associated with participation in physical activities, children are far less active than in the past (Aldahesh, 2012). Except for reasons already mentioned in the literature, the blame can be placed on aspects such as electronic and/or social media, the high crime rate in SA (making it too dangerous for children to play outside unsupervised), and the absence of structured movement experiences in schools (Krog, 2010). Golden *et al*. (2006) believes that the school environment is the ideal place to provide opportunities to promote physically active lifestyles among children because they spend a large amount of time during the day at school.

In SA, this study can make an important contribution to similar research that has already been conducted in the area of the relationship between movement programmes and learning abilities. PE is not considered with the required seriousness it deserves and children are

deprived of the holistic benefits it poses. The present study aims to establish whether a relationship exists or not between participation in structured physical activities and cognitive functioning (specifically literacy and numeracy).

PROBLEM STATEMENT

The main problem was to determine whether two intervention programmes: (1) an integrated academic skill and physical development programme; and (2) a moderately intensive physical activity programme), had an impact on Grade 2 learners' academic abilities, especially in terms of literacy and numeracy skills.

The sub-problems of the research were:

- to determine whether there was a significant difference between the participant's literacy and numeracy results before and after the intervention programmes;
- to determine whether there was a significant difference between the results and outcomes of both intervention programmes and whether the results and outcomes of the intervention programmes can be compared in terms of academic skills; and
- to determine whether boys' and girls' academic skills were influenced differently by the intervention programmes.

METHODOLOGY

Ethical issues

Ethical approval was obtained from the Ethics Committee of Stellenbosch University (No. HS703/2011), and permission to perform the study in the schools was obtained from the Western Cape Education Department (WCED). The principals of the schools were approached by means of a formal letter explaining the aim and protocol of the study and requesting permission to perform the study during school hours. Consent forms had to be completed and signed by the Grade 2 learners' parents. Information regarding the procedures of the study was explained in the consent form. If the learners' parents agreed, the learners also had to sign an assent form agreeing to participate in the study.

Participants

The study took place at two primary schools (School A= Quintile 5; School B= Quintile 2) in the Stellenbosch area. The participants in the study were Grade 2 Afrikaans-speaking learners.

Only 6 Grade 2 classes (N=149) were made available for the purpose of this study. Because of the rules that the schools set, it was not possible to randomly select the sample, therefore, a convenient sample was used. The participants from School A (n=76) consisted of 35 boys and 41 girls, while there were 35 boys and 38 girls from School B (n=73) (Table 1). The average age of the participants in School A and School B was 7.33 years and 7.47 years respectively.

***TABLE 1*: PARTICIPANTS**

Variable	School A	Variable	School B	Total
Boys	35	Boys	35	70

Girls	41	Girls	38	79
Total	76	Total	73	149
Mean age (yrs)	7.33	Mean age (yrs)	7.47	

Two Grade 2 groups, one from each school, served as the experimental groups (n=97) and took part in the intervention programmes. One group from each school served as the control group (n=52) who did not participate in the intervention programmes and went about their school day as usual. The experimental and control groups were randomly assigned.

Measuring instruments

Numeracy and literacy

Standardised tests were used to measure the literacy and numeracy skills of Grade 2 learners. The standardised tests used during the pre- and post-test were the VASSI Mathematical Skills Test and the ESSI Reading and Spelling Tests.

The VASSI Mathematical Skills Test is a South African assessment tool that was originally designed for diagnostic purposes (Vassiliou, 2004). The test is standardised for English-, Afrikaans- and Sotho-speaking learners in the Foundation Phase (Grades 1-3), and in the Intermediate Phase (Grades 4-6). The test determines whether a learner experiences math problems and if so, in which particular area the problem occurs. It also determines whether learners meet the expectations of the curriculum and indicates which cognitive processes require stimulation (Vassiliou, 2004). The specific cognitive processes refer to receiving, interpreting, organising, implementing, memory and problem-solving skills that apply during mathematical tasks. The VASSI Mathematical Skills Test can identify and address these problems. Assessment can be conducted in groups or individually. Specific items were removed from the test that could be harmful to cultural groups, making it a reliable and valid measurement tool (VGM, 2004).

The ESSI Reading and Spelling Skills Test is a South African assessment tool that can be applied diagnostically. English- and Afrikaans-speaking Grade 1-7 learners can participate in this test. The rationale of the tests is based on the belief that reading and writing skills not only have an impact on learners' achievement levels in language subjects, but also affects other academic subjects. Therefore, the assumption can be made that learners with spelling and/or reading problems will also experience other learning problems. Thus, it would affect their overall school performance adversely (Esterhuyse, 1997).

Intervention programmes

The current study focused on an integrated academic skill and physical development programme and a moderately intense physical activity programme to find a possible relationship between academic skills and participation in physical activities for Grade 2 learners. Both programmes were implemented over a period of 8 weeks consisting of 3 days a

week, 30 minutes per day.

The *integrated* academic skills and perceptual-motor development programme was presented outside the classroom. The two experimental groups in both schools participated in this programme. The programme focused on sensory- and perceptual-motor skills that form the basis of cognition and intellect, which is of vital importance for academic progress (Kranowitz

& Newman, 2010). During this programme the learners participated in a series of integrated activities. The activities were designed to stimulate the following sensory and perceptual-motor skills: balance; bilateral coordination; body awareness; directionality; laterality; midline crossing; and spatial orientation.

The *intensive* physical activity programme was presented outside of classroom where the two experimental groups in both schools participated in moderate to strenuous activities which included the following activities: appropriate warm-up activities; stretching exercises; strength and resistance exercises; aerobic/cardiovascular activities; and appropriate cooling down activities. The outcomes of this programme focused specifically on the possible positive correlation between academic performance and moderate to intense physical activity.

The experimental and control groups both completed the standardised literacy (ESSI Reading and Spelling Test) and numeracy (VASSI Mathematical Skills Test) tests 1 week before and 1 week after the intervention programmes were implemented. The pre-test was conducted in the first week of the study (week 1). The experimental groups of both schools were involved in the intervention programmes, where they participated in either the 1) integrated academic skill and perceptual-motor development programme or the 2) moderately intensive physical activity program (weeks 2 to 9). On completion of the intervention programmes, both the experimental and control groups completed the post-test (week 10). A research assistant helped the researcher to conduct the pre-test of the Grade 2 learners. The test instructions were given verbally and the answers were completed in the test booklet supplied by the researcher. The researcher conducted the post-test individually, with the aid of some of the teachers from both schools.

Research design

In this study a quasi-experimental design was used. The study took place in schools that were conveniently selected due to financial constraints. Quantitative data were used and the data was converted into numerical form for statistical analyses.

Statistical analysis

The statistical analysis was performed by the Centre for Statistical Consultation at Stellenbosch University. Before and after measurements between the different treatment groups were compared using a mixed model, repeated observations and analysis of variance. This type of analysis was chosen as before and after measurements (repeated measurements), which was performed on the same children. Descriptive results are reported through averages and standard deviations. The level of significance chosen was 5% ($p<0.05$).

RESULTS AND DISCUSSION

Before the study commenced, it became clear that the participants of the respective schools' differed in literacy and numeracy abilities, as well as in their participation in physical activities. The statistical analysis indicated that the schools as independent variables played a role in the effect of the intervention, namely the third-order interaction. This interaction is indicative of the school's role in the effect of the intervention. The results were statistically insignificant and, therefore, the tendencies or possibilities (second-order interaction) were considered.

***TABLE 2*: ACADEMIC SKILLS: P-VALUE AND PERCENTAGE IMPROVEMENT (Pre- vs. post-tests within a school)**

Variable	Pre (n)	Post (n)	Experimental variable	Pre-Test M±SD	Post-Test M±SD	**p-Value	Improvement
School A (n=76)							
Vassi Math	25	25	*Integrated Pr.*	47.5±23.1	52.9±29.8	0.65	11%
	26	26	*Intensive Pr.*	62.9±27.9	66.6±27.0		6%
	25	25	*Control group*	47.5±29.4	57.6±26.0		21%
Essi Spelling	25	24	*Integrated Pr.*	63.7±58.2	87.5±50.1	0.33	37%
	26	26	*Intensive Pr.*	88.4±58.6	116.3±57.7		32%
	25	25	*Control group*	99.5±62.5	121.0±51.1		21%
Essi Reading	24	25	*Integrated Pr.*	121.3±34.9	159.5±43.5	0.83	31%
	25	26	*Intensive Pr.*	100.0±62.0	130.6±59.1		31%
	24	20	*Control group*	125.5±51.6	175.6±19.4		40%
School B (n=73)							
Vassi Math	23	23	*Integrated Pr.*	10.6±13.5	22.8±23.0	0.40	78%
	23	22	*Intensive Pr.*	16.0±16.5	30.7±26.2		92%
	27	23	*Control group*	9.4±11.2	16.7±13.4		115%
Essi Spelling	22	22	*Integrated Pr.*	49.2±29.0	61.4±27.7	0.009*	25%
	23	23	*Intensive Pr.*	17.9±15.3	41.2±24.5		130%
	26	27	*Control group*	35.8±26.7	42.7±28.1		19%
Essi Reading	23	23	*Integrated Pr.*	90.5±76.7	104.2±67.9	0.10	13%
	22	23	*Intensive Pr.*	59.6±67.9	76.6±67.0		30%
	26	26	*Control group*	43.2±60.0	47.3±57.9		0%

*p<0.05 **= Second-order interaction

According to the second-order interaction, the result of School A (VASSI Mathematical Skills Test: p=0.65; ESSI Spelling Test: p=0.33; ESSI Reading test: p=0.83), and School B (VASSI Mathematical Skills Test: p=0.40, ESSI Spelling Test: p=0.009; ESSI Reading Test: p=0.10), was also statistically insignificant (p<0.05) (Table 2). The inference that can be made was that the improvements for both schools were the same. Based on the non- significant third- and second-order interactions, it was, therefore, possible to determine the

effect of the intervention (if any) without distinguishing between the two schools.

***TABLE 3*: VASSI MATH: MEANS AND STANDARD DEVIATIONS FOR PRE- AND POST-TESTS FOR EXPERIMENTAL AND CONTROL GROUPS**

	Control group		Exp. Gr. 1 Integrated program		Exp. Gr. 2 Intensive program		**p-Value
School A & B	Pre-test (n=50) M±SD	Post-test (n=47) M±SD	Pre-test (n=47) M±SD	Post-test (n=47) M±SD	Pre-test (n=49) M±SD	Post-test (n=48) M±SD	

VASSI Math	28.3±29.0	38.0±29.6	33.0±24.6	42.9±28.7	38.4±35.0	46.5±34.2	0.33
% Improve-ment	34%		30%		21%		

*p<0.05; **= Second-order interaction M= Mean; SD= Standard Deviation

Table 3 shows that an improvement occurred from the pre- to the post-test in all 3 groups (the control- and the 2 experimental groups). It is evident in Table 3 that no statistically significant differences (p<0.05) between School A and B's interaction p-value (p=0.33), from the pre-to post-test, occurred. The latter improvements do not refer to the impact of the intervention programmes, but to the improvement of the participants' normal scholastic development (in mathematical and literacy abilities) from the pre-to post-test.

***TABLE 4*: ESSI SPELLING: MEANS AND STANDARD DEVIATIONS FOR PRE- AND POST-TESTS FOR EXPERIMENTAL AND CONTROL GROUPS**

	Control group		**Exp. Gr. 1 Integrated program**		**Exp. Gr. 2 Intensive program**		****p-Value**
School A & B	Pre-test (n=50) M±SD	Post-test (n=50) M±SD	Pre-test (n=47) M±SD	Post-test (n=46) M±SD	Pre-test (n=49) M±SD	Post-test (n=49) M±SD	
ESSI Spelling	67.9±57.4	80.8±57.6	56.9±47.0	75.0±42.6	55.3±56.2	81.1±58.7	0.007*
% Improve-ment	19%		32%		47%		

*p<0.05; **= Second-order interaction M= Mean; SD= Standard Deviation

Based on the second-order interaction, Table 4 shows that for both schools together the p-value (p=0.007) with regard to spelling was significant. This means that there was a tendency that the intervention programmes had a statistical significant (p<0.05) effect on spelling. The moderately intensive physical activity programme indicated the best improvement (in percentage), between the control- and experimental groups. There is a strong possibility that this programme had a significant effect on the spelling skills of the experimental groups. It would, therefore, be worthy to conduct further research.

***TABLE 5*: ESSI READING: MEANS AND STANDARD DEVIATIONS FOR PRE- AND POST-TEST FOR EXPERIMENTAL AND CONTROL GROUPS**

	Control group		**Experimental Gr: Integrated program**		**Experimental Gr.: Intensive program**		****p-Value**
School A & B	Pre-test (n=50) M±SD	Post-test (n=45) M±SD	Pre-test (n=46) M±SD	Post-test (n=47) M±SD	Pre-test (n=47) M±SD	Post-test (n=49) M±SD	
ESSI Reading	82.7±69.2	100.9±77.9	104.7±60.3	132.0±62.8	80.8±67.4	105.3±67.8	0.15

% Improve-ment	22%	26%	30%

*p<0.01; **= Second-order interaction M= Mean; SD= Standard Deviation

According to the second-order interaction p-value (p=0.15) (Table 5), it is clear that no statistically significant difference (p<0.05) with regards to reading occurred between the schools from the pre- to the post-test. From the latter, the conclusion can be made that the control- and experimental groups demonstrated an improvement from the pre- to post-test, regardless of the intervention. Therefore, improvement could be attributed to the participants' normal scholastic development (reading ability).

The statistical analyses further aimed to determine whether gender - as an independent variable - had an effect on the measurements during the period in which the intervention took place. The third-order interaction is an indication of the possible effect of the intervention on gender. According to the third-order interaction (VASSI Mathematical Skills Test: p=0.08; ESSI Spelling Skills Test: p=0.09; ESSI Reading Skills Test: p=0.32), the results were not statistically significant (p<0.01). Although the interaction p-values were not significant with regards to gender, it is clear that improvements occurred, but the improvements could be attributed to the participants' normal scholastic development.

From the averages and percentage improvements, the following tendencies among the boys and girls were derived:

- The boys that participated in the integrated and intensive intervention programmes showed better progress than the girls during the VASSI Mathematical Skill Test, specifically those who took part in the integrated programme.
- The girls that participated in the intensive intervention programme showed better progress than the boys in the ESSI Spelling Skills Test. The boys that participated in the integrated programme showed better progress in the ESSI Spelling Skills Test than the girls.

***TABLE 6*: GENDER: IMPROVEMENT, MEANS AND STANDARD DEVIATIONS FOR ACADEMIC SKILLS TESTS**

			VASSI Mathematical Skills Test		
Variables	Pre (n)	Post (n)	Pre-Test M±SD	Post-Test M±SD	Improve-ment
Boys					
Integrated programme	24	24	35.8±24.3	52.2±26.4	45%
Intensive programme	24	24	32.1±35.5	42.9±35.6	34%
Control group	21	21	29.4±31.5	34.7±33.1	18%
Girls					
Integrated programme	23	23	30.2±25.2	33.3±28.3	10%
Intensive programme	25	24	44.3±35.5	50.1±35.6	13%
Control group	29	26	27.5±28.2	40.6±26.7	48%
Third-order p-value				0.08	
			ESSI Spelling Test		

Variables	Pre (n)	Post (n)	Pre-Test M±SD	Post-Test M±SD	Improve-ment
Boys					
Integrated programme	24	24	52.2±40.7	73.6±35.3	41%
Intensive programme	24	24	45.0±49.6	67.2±55.8	22%
Control group	21	21	74.8±60.3	84.2±59.4	13%
Girls					
Integrated programme	23	22	61.7±53.3	76.5±50.2	24%
Intensive programme	25	25	65.1±61.2	94.4±59.5	45%
Control group	29	29	62.8±55.6	78.3±57.1	24%
Third-order p-value				0.09	

ESSI Reading Test

Variables	Pre (n)	Post (n)	Pre-Test M±SD	Post-Test M±SD	Improve-ment
Boys					
Integrated programme	23	24	113.5±53.6	144.5±54.7	27%
Intensive programme	23	24	66.9±64.9	89.0±69.0	33%
Control group	21	20	86.0±74.2	108.8±74.5	27%
Girls					
Integrated programme	23	23	96.0±66.3	119.0±69.0	24%
Intensive programme	24	25	94.1±68.3	120.9±64.0	28%
Control group	29	25	80.3±66.6	96.0±81.6	20%
Third-order p-value				0.32	

*p<0.01; M= Mean; SD= Standard Deviation

Therefore, it seems that the boys showed better progress in mathematical skills and that both the boys' and girls' spelling improved.

LIMITATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Certain restrictions occurred during the execution of the intervention, which played a role in the outcome of the current study's results. In the discussion that follows, the general limitations of the study will be highlighted. General recommendations for further research in this field will follow.

Limitations

- The first limitation refers to the sample of the study. The sample does not represent the total population of Grade 2 learners in SA, but only learners in the Stellenbosch area. That is, the results obtained are not necessarily applicable for the rest of SAs Grade 2 learners. Therefore, generalisations regarding all Grade 2 learners could not be made.
- The participants' reading skills were a further limitation. Some of the Grade 2 learners' reading skills in both schools were limited. Therefore, the researcher and research assistant had to help the learners with the reading of the instructions for the questionnaires and tests (VASSI Mathematical Skills Test). Some learners could not work at their own pace because they had to wait until the questions were read. Other learners worked slowly

and did not keep up with the questions being read. This was very time- consuming. The subjects completed the tests in a longer period than planned.

- The lack of space for the presentation of the intervention programmes also limited the study. Permission was obtained at both schools prior to the study and provision was made for the study, but space was still problematic. This led to the intervention programmes at School B mostly being presented in the parking area of the school.
- During the intervention a heat wave hit Stellenbosch, and which made the presentation of the intervention difficult. Some day's learners could not participate for the whole 30 minutes because of the warm weather conditions.
- The duration of the intervention could also have been limiting. The study was conducted over a period of 10 weeks. The first week was for the completion of the pre-tests. The next eight weeks (three sessions per week) were spent on the intervention programmes and the last week was set out for the completion of the post-tests. Only one term was spent on the intervention. The study of Wells (2012) confirms the effect of these limitations on the results of an intervention. According to Wells (2012) the timeline for a study can cause the intervention programmes to not make a significant statistical difference in scholastic abilities.

During the intervention the current study was too time-restricted for certain activities (or the number of repetitions) to be repeated. The children had only one chance to master some of the physical activities. According to Cheatum and Hammond (2000), new skills should be repeated regularly. This rehearsal of skills form connections between neurons and ensure definite neurological pathways. The neurological pathways are responsible for learning. A previous study supports these findings and also found that the period of an intervention programme may have an effect on the results of the study (Lubbe, 2010). In the present study

it was possible that the short duration of the intervention programmes might have had an effect on the outcome of the results and not specifically the skills of the intervention programmes. The latter is a possibility; however, both factors mentioned might have played a role in the results.

Recommendations

- A larger sample: There has already been referred to the fact that the results only apply to the sample that participated in this study. It is recommended that future studies use larger and more diverse samples. Subjects form different environments and cultures in SA can be used to form a larger, more diverse and representative sample. The findings of this study may be used as a starting point for further research.
- The period in which the study should take place: It might be beneficial for similar future studies to rather perform the research later in the year. For example, the study should rather take place in the third term than the first term of a new school year, especially with regards to the transition from Grade 1 to Grade 2. This would enable the subjects to already have the necessary reading skills they need to complete the pre- and post-test. It might also be beneficial to engage teachers in the reading of the questionnaires and measurement instruments to save time (Lubbe, 2010).
- Space to present the intervention programmes: It is suggested that future researchers should draft a schedule with the school before the commencement of the study. This schedule should indicate the available space and time for the intervention. It must be clarified with the teachers in advance.

- The duration of intervention: The proposal is that for future research the intervention programme (specifically the physical activity programmes), should be presented over a longer period. The assumption is that when the intervention takes place over a longer period, the effect of physical activities on several cognitive, emotional, social and physical domains may be observed. Engelbrecht and Green (2007) believe that the development of children is an integrated process, that is, all domains are interdependent. Elliot and Sanders (2002) supports this view and also believes that movement forms an integral part of children's development mechanisms.

CONCLUSION AND RECOMMENDATION

Despite the limitations of the current study, the information obtained is still useful in terms of the contribution of intervention programmes on the different developmental domains (physical, social, emotional and cognitive). The effect of movement on these domains creates an overall picture of the importance of physical activity programmes for young, developing children. The current study also highlights the need for physical activity programmes (Physical Education) in South African schools. It emphasizes the important role that physical activity programmes can play in the school environment. It also supports a holistic approach to teaching that leads to an optimal learning environment. With all the information available, it is strongly recommended that the role of Physical Education in schools is reconsidered.

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NEUROPHYSIOLOGICAL, PSYCHOLOGICAL, SPORT AND HEALTH DIMENSIONS OF THREE MEDITATION TECHNIQUES

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ABSTRACT

The aim of this study was to record experiences of three meditation conditions: Ratio Breathing, Transcendental Meditation and Zazen, with special reference to sport, health, neuro-physiology and sense of coherence. The participants (N=9), seven males and two females were all British, actively competing across a range of individual and team sports, with no experience of using meditation techniques or practices in their sporting or daily lives. Their mean age was 31.56 years with an age range of 22 to 44 years. The study employed a within-subjects, repeated measures design, with each participant practising each meditation condition in a randomly counterbalanced order. Integrative findings support the value of all three meditation conditions for health and to a lesser extent for sport, especially with regard to their effect on focus. All three meditation conditions were associated with a decrease in respiration. The differential effect of the meditations was apparent. Participants valued Ratio breathing for its effect on concentration, Transcendental Meditation for its depth of meditation and Zazen for its effect on self and removal of external distractions. These qualitative findings were associated with differentially significant quantitative effects on lowered respiration rate in the Ratio Breathing group, increased physical relaxation and alpha activity in the Transcendental Meditation

group, and increases in both alpha and theta activity in the Zazen group.

Key words: Ratio Breathing; Transcendental Meditation; Zazen; Consciousness; Phenomenological.

INTRODUCTION

The word „meditation" derives from the same Greek and Roman roots as the word medicine: in Latin *meditari* means to contemplate or reflect (Hussain & Bhussan, 2010). Most wisdom, spiritual and/or healing traditions value some form of meditation and/or contemplation for transforming consciousness (Wilber, 2000, 2007). For example, in Christian contemplative prayer, Godhead becomes realised through silence and repetition of a meaningful word or phrase (Keating, 1997). In Buddhism, meditative practice is an end in itself with the journey to enlightenment viewed as a noble pursuit. Although many meditative practitioners may not

experience enlightenment, retrospective phenomenological accounts indicate that feelings of relaxation, stillness, emptiness and tranquillity characterise an individual"s experience during meditation (Travis & Pearson, 2000). These hedonic qualities have in turn been associated with positive neurological, physiological, psychological, health and sport outcomes (Murphy, 1992; Murphy & White 1995; Benson, 1997, 2000; Travis & Pearson, 2000; Wilber, 2001a, 2001b; Ivey *et al*., 2002; Watson & Nesti, 2005; Schreiner & Malcolm, 2008; Albrecht, 2011; Edwards, 2012, 2013a).

There exists an established literature extolling the benefits associated with employing breath based meditation techniques (Rama *et al.*, 1979; Cysarz & Bussing, 2005; Edwards, 2012). These approaches typically require participants to engage in a period of controlled breathing whilst directing awareness to bodily sensations (movement of the diaphragm, air flow in and out of lungs) and/or employing an associative or dissociative attentional focus (Wilber, 2000; Edwards, 2012). Such techniques have been routinely employed by communities in Africa, India, China and elsewhere for centuries. The writings of eminent yogis, monks and spiritual leaders has provided a wealth of ideographic data testifying to the efficacy of employing such meditation interventions (Reid, 1998; Mutwa, 2003; Iyengar, 2005). In Patanjali"s yoga sutras, breathing exercises (*pranayama*) constitute the fourth limb of yoga, which provides a base for advanced meditation practices, such as withdrawal of external sense awareness (*pratyahara*), control of attention and intention (*dharana*), sustained concentration and witnessing awareness (*dhyana*), and absorption into unity consciousness (*samadhi*) (Iyengar, 2001, 2005; Chopra & Simon, 2004; Horan, 2009). Breath control has become established practice in health and sport psychology, particularly in relation to arousal control, anxiety reduction and, in Western countries, cognitive behavioural techniques, such as mindfulness, many of which have older African and Asian roots (Edwards & Edwards, 2007; Edwards & Sherwood, 2008; Marks, 2008; De Perillio *et al*., 2011; Edwards & Beale, 2011; Weinberg & Gould, 2011). Such practice has been supported by modern scientific evidence that a decreased breath ratio of five to seven breaths per minute is associated with enhanced autonomic nervous system balance and heart-brain concordance (Yasuma & Hayano, 2004; Cysarz & Bussing, 2005; Breslin & Lewis 2008; Stanley, 2009).

Meditation traditions have often been categorised into broad overlapping categories, such as concentration and mindfulness meditation (Dunn *et al*., 1999; Horan, 2009). Analysis of four traditional Electro-encephalography (EEG) frequency bandwidth data, delta, theta, alpha and

beta, have empirically demonstrated strong mean amplitude frequency differences between concentration and mindfulness forms of meditation. These correspond to unique forms of consciousness, with mindfulness meditation producing more EEG activity, including relatively slower delta and theta activity, as well as relatively more fast, alpha and beta activity (Dunn *et al*., 1999). At the level of technique, a good case can be made for concentration and mindfulness as dimensions existing along orthogonal axes (Ivanovski & Malhi, 2007). Concentrative meditation has a convergent focus through use of some form of mental device, such as a mantra, body sensation, breath, or specific image. Mindfulness meditation, especially the pioneering work of Kabat-Zinn (1994, 2003), has increasingly become the focus of research over the past two decades (Shapiro *et al*., 2005), and typically involves divergent, objective witnessing of consciousness and experience that is typical of Vipassana and Zen. To some extent, these categories represent early and later patterns of

Hindu and Buddhist traditions, early and later phases of meditation practice, as well as methods employed by beginner and experienced meditation practitioners respectively.

Clearly there is considerable overlap. Some typically concentrative types of meditation, such as Transcendental Meditation, which uses a mantra, and Soto Zen, which uses breath, may also involve objective witnessing mindfulness and higher or deeper meditation stages, such as cosmic and unity consciousness (Wilber, 2000; Alexander, 2005; Cysarz & Bussing, 2005). In addition, both yogic and Zen traditions may include practices, which begin with some form of conscious breath work. In the present study, three relatively distinct meditation techniques are postulated. Transcendental Meditation is viewed as a concentrative technique and Zen Buddhism as a mindfulness technique. The third technique is Ratio Breathing, around six breaths per minute, as popularly employed by prominent sports coaches to promote health, team unity and optimum performance (Dunn *et al*., 1999; Watson & Nesti, 2005; Albrecht, 2011).

Although a wealth of phenomenological, social constructionist reports have been published examining outcomes associated with Zazen, Transcendental Meditation and Ratio Breathing based interventions, relatively less is known about the neurological and physiological correlates of different meditation practices in sport and health contexts. In keeping with the Vedanta view that meditation involves fourth (*turiya*) and non-dual (*turiyatita*) states of consciousness (Wilber, 2007), research indicates that mindfulness and concentration meditations are associated with EEG signature patterns that reflect qualitatively different states of consciousness (Badawi *et al*., 1984; Benson, 2000), that are distinct from eye closure relaxation conditions (Dunn *et al*., 1999). However, there is a relative dearth of research indicating the consistent evidence based effectiveness of such meditations under controlled, experimental conditions (Ivanovski & Malhi, 2007; Horan, 2009; Hussain & Bhussan, 2010). This relative dearth of knowledge and some inconsistent findings provided the motivation for the present research.

RESEARCH PROBLEM

The aim of this study was to compare the effectiveness of three meditation conditions, Ratio Breathing, Transcendental Meditation and Zazen, with special reference to their influence on selected neuro-physiologic and psychological variables in the context of sport and health. In view of the relatively inconsistent research findings, and the essentially exploratory nature of this study, the null hypothesis was set for all comparisons.

METHODOLOGY

Approach

Integral philosophy (Wilber, 1997, 2000, 2007) provides the overarching theoretical framework for this study. Wilber‟s AQAL model, which is shorthand for all quadrants, all levels, refers to a comprehensive approach that integrates quadrants and levels, as well as lines, states and types of consciousness (Wilber, 1997, 2000, 2007). The AQAL model postulates an essentially non-dual, spiritual-material universe, with 4 quadrants, reflecting interior and exterior aspects of the individual and collective. The fundamental linkages in this

universe are called holons, which are always both wholes and parts of other wholes, at various levels of consciousness experienced as matter, body, mind, soul and spirit. Wilber‟s (2007) integral methodological pluralism (IMP) transcends and includes theoretical, paradigmatic perspectives, such as positivism, interpretivism and social constructionism, and their related research methods (Terre Blanche *et al*., 2006). It may be argued that when studying human phenomena one needs to adhere to the principles that define rigorous scientific method, as for example, established by Popper (1959). Objectifying any human, wholly personal or unique experience provides insight that can then be evaluated by peers offering opportunities for future work to build on, and extend understanding in a given area. Qualitative approaches provide a rich source of data that enables a researcher to access the „lived experience‟ of the participant (Giorgi, 1970; Moustakas, 1994; Munroe-Chandler, 2005).

Participants and ethics

The participants (n=9), 7 males and 2 females with a mean age of 31.56 years, and age range from 22 to 44 years, all competed on an amateur basis across a range of individual and team sports. The participant group represented a convenience sample recruited via responses to posters displayed in the psychology department at the first author‟s institution. The participant group were all British and indicated that they had no experience of using meditation techniques or meditative practices in their sporting or daily lives. The participants signed consent forms and the study was granted ethical clearance by the institution referred to previously.

Apparatus

An Infiniti Thought Technology bio-feedback and neuro-feedback apparatus (Thought Technology, Ltd., Montreal Canada), was used to monitor and record the neuro-physiologic data. This apparatus distinguishes and records numerous physiological and electro-encephalographic variables. It was particularly suitable for recording baseline and meditation data for the dependent physiological variables of blood volume pulse (BVP), muscle tension/relaxation as recorded on electromyography (EMG), respiration rate (RES) in-breaths per minute, as well as EEG data bands of delta (0-3 hertz or cycles per second), theta (4-7 hertz), alpha (8-12 hertz), beta (13-30 hertz) and gamma activity (above 30 hertz).

Measures

Physiological, neurological, psychological and phenomenological data recorded in this study

were measured in the following way.

Physiological variables
BVP was taken from the index finger of the non-dominant hand. The participant‟s RES was recorded using a belt with strain gauge placed around the lower abdominal region in order to record diaphragmatic breathing. EMG electrodes were placed on the participant‟s trapezius muscle on the dominant side of the body.

Neurological variables
Electro-encephalography (EEG) was used to record neural activity across delta, theta, alpha, beta and gamma frequencies. Clasp electrodes were placed on each ear lobe with one open cup electrode being located in the area between the somato-sensory and motor cortex (CZ). This region was selected as it has been implicated in the experience of „flow‟ (Csikszentmihalyi, 1990), and sense of coherence (Antonovsky, 1987; Bischoff, 2008).

Psychological variables
Sense of Coherence (SOC) was reported using a shortened 9-item version of Antonovsky‟s (1987) scale, with a Cronbach alpha reliability coefficient of 0.79. This abridged version has been shown to demonstrate high internal reliability and concurrent validity when assessed against Antonovsky‟s original 29 item measure (Klepp *et al*., 2007). Participants reported their feelings in relation to items, such as "Do you have the feeling that you don‟t really care about what goes on around you?" (one of 9 items), employing a 7-point Likert scale anchored by *very often* and *very seldom*.

Phenomenological variables
After completion of each experimental condition, the participants were required to respond in writing to 4 open-ended questions using a maximum of 6 lines for each question: 1) Describe your experience of the (*enter experimental condition)*; 2) What value do you feel (*enter experimental condition*) may have for your sporting performance?; 3) What value do you feel (*enter experimental condition*) may have for your health?; and 4) What was your favourite condition and why? (The latter question was completed after the last trial condition only.) The participants were also invited to attend a focus group session scheduled for after the study had been completed that sought to explore the group‟s experiences of the 3 meditation conditions. The focus group took place in a classroom on university premises and was facilitated by the lead author.

Design and procedure

The study employed a within subjects, repeated measures design with 3 levels of the independent variable: Ratio Breathing (RB), Transcendental Meditation (TM) and Zazen Meditation (ZM). Each participant visited the laboratory to receive an initial briefing detailing the requirements for their involvement in the study. At this time the participants were attached to the Infiniti Thought Technology equipment so that they would become familiar with the experimental set-up prior to the first testing session. The lead author, who has experience in the delivery of meditative practice, then provided the participants with a description of the 3 meditation techniques and the main principles underpinning the use of each condition. The participants were provided with a description of the 3 meditation techniques and the main principles underpinning the use of each condition. The participants were then lead through a period of application whereby each technique was trialled. The meditation techniques were

delivered by a member of the research team who has expertise in the area and has extensive experience in the use of such approaches with a range of sportspersons. After each meditation technique had been trialled, the participants were invited to ask any questions that they may have regarding the use of the technique. At the end of the familiarisation period, the participants received a hand-out confirming the elements comprising each meditation technique. The participants was then instructed to practise each

meditation technique for 20 minutes on a daily basis over the course of the following week. All of the meditation conditions were practised and trialled with the participants seated and with their eyes open. The following are descriptions of the meditation techniques.

Ratio Breathing (RB)

The participants were required to regulate their breathing such that an in-breath lasted for 3 heart beats and an out breath for 7 beats. Following this sequence, the participants were required to establish a cyclic breathing pattern that equated to roughly 6 breaths a minute. The participants were instructed that they should direct their attention to the flow of breath, become attuned to the rhythm of their heart beat and synchronise these 2 activities. This approach has been used extensively in psycho-therapeutic interventions and has been shown to promote feelings of balance, control and access to higher states of consciousness (Yasuma & Hayano, 2004; Cysarz & Bussing, 2005; Breslin & Lewis, 2008; Stanley, 2009; Edwards, 2012, 2013a).

Transcendental Meditation (TM)

The TM condition required participants to witness their experience while slowly repeating the mantra "aum". The participants were informed that the duration of each cycle of the mantra should last for roughly 5 seconds and that the mantra should be repeated silently and in continuous cycles for the 20-minute experimental period. There was no stipulated time period between the end of completion of the mantra and the start of the next cycle with the only instruction being that the period should remain consistent, be comfortable and be limited to a few seconds. The construction of the TM condition was based on guidelines established by Iyengar (2001, 2005).

Zazen Meditation (ZM)

The participants were requested to sit in a chair with an erect posture with their hands placed in front of them on their laps, forming the "cosmic mudra" (grasp the thumb of the non-dominant hand with the fingers of the non-dominant hand and to wrap the fingers of the dominant hand around the outside of the non-dominant hand). With their arms at a comfortable position away from the torso the participants fixed their gaze on a spot on the ground roughly 2 metres in front of the chair. In Zazen there is no established or forced breathing pattern but participants were instructed to breathe using their lower abdomen whilst specifically directing their awareness to the sensations and movements of the belly during breathing. The participants were instructed that they should seek to transpose their consciousness allowing for a sinking effect such that their awareness moves from their head to the navel area. Guidelines for establishing the correct breathing, posture and hand positions were taken from Suzuki (1956).

The participants returned to the laboratory a week later and indicated on a 9-point Likert scale (9=*totally adhered*, 1=*not adhered*), the extent to which they had adhered to the practice requirements over the course of the previous week. This indicated that the participants had engaged in the process (M=8.2; SD=0.5), and that the time spent practising had been equal

across the 3 conditions. Each participant then assumed a seated position. The Infiniti© Thought Technology equipment was applied. At this stage the participants completed the SOC scale based on how they were feeling at that specific point in time. Having completed the questionnaire, a rest period of 4 minutes followed in which the participants were

instructed to remain motionless. Recordings taken during this time served as a baseline measure for each experimental condition. Each participant then commenced the meditation condition to which they had been assigned for that trial and remain in this condition for 20 minutes, an optimal time period for meditation (Edwards, 2012, 2013a). All meditation conditions were performed seated in a comfortable position, with the participant‟s back to the experimenters and with the eyes open. After completion of the period of meditation the participant was requested to return his/her consciousness to the present and complete the SOC scale in addition to the 4 questions outlined in the phenomenological measures. The participants returned to the same room at the same time on 2 further occasions to repeat the procedure with the other 2 meditation conditions. The order of the experimental conditions was randomised across participants. A focus group was conducted with all participants the week immediately following the completion of the experimental data collection from the meditation conditions.

Data analysis

Integrated qualitative and quantitative, subjective and objective analysis of the individual and collective data was performed via the following steps:

1. Phenomenological analysis based on the participants‟ written descriptions, focus group discussions and researcher notes (Giorgi, 1970; Moustakas, 1994);
2. Individual written accounts and verbatim focus group transcripts were analysed into the smallest naturally occurring units of experience (nmu‟s);
3. Each individual‟s description of the meditation experience was summarised;
4. Nmu‟s in relation to each meditation condition that emerged spontaneously across individual and group accounts were clustered together;
5. Participants‟ quantitative, individual neuro-physiologic recordings were analysed;
6. Group neuro-physiological recordings were analysed. All quantitative measures (EEG, EMG, BVP, respiratory rate and sense of coherence) were analysed via a 2 (time: pre vs. post) x 3 (condition: RB vs. ZM vs. TM), within subjects multivariate analysis of variance. Follow-up univariate analyses with a Bonferroni corrected significance level were completed where appropriate. All preliminary analyses were conducted with significance set at $p<0.05$;
7. Individual and group, qualitative and quantitative data were integrated, analysed and discussed; and
8. The completed research paper was given to each participant for critical reading and feedback. This also served as an ethics, validity and integrity audit.

RESULTS AND DISCUSSION

Qualitative findings

Qualitative findings follow in the form of question driven, phenomenological analysis of the participants‟ individual descriptive, smallest, naturally occurring units of experience (nmu‟s),

which are numbered for each participant. Individual profiles are followed by synthesis into collective profile themes for each treatment condition and question with an audit trail of

natural meaning units. The 9 participants are coded from A to I with regard to individual experience.

Ratio Breathing

Description of experience:

> Felt relaxed and very sleepy! It‟s an easy technique to do. (B:1)
> Comfortable and relaxing. Quite difficult to get the breathing timing right. (K:1)
> Calming and peaceful. (I:1)
> It was very relaxing but hard to focus on technique. I was tired, felt like I wanted to fall asleep. (J:1)
> Conscious breathing rhythm and timing feel relaxed and calm and slightly disorientated. (C:1)
> Strange for 20 minutes, struggled to remain „present‟ as I was constantly evaluating whether I was falling asleep or not. (D:1)
> Relaxing, approaching „sleepy‟, calm. (H:1)
> It was extremely calming and relaxing. Around half way through I went to a deeper level in that everything turned black – this sounds weird but I saw myself as a child and I had a big smile on my face. I felt very happy at this point. Session went very quickly. (E:1)
> I found the experience difficult to maintain. I felt my breathing pattern was varying throughout the 20 minutes of meditation. I did feel that I could not concentrate on the thoughts in my head as I had to concentrate on my breathing pattern. (A:1)
> Relaxed, sleepy. (B:1)

Participants experienced Ratio Breathing as very relaxing and calming. Some struggled with the breathing pattern, others transcended this.

Value for sporting performance:

> It could take away some of the nerves prior to competing. (B:2)
> Increase focus and meditation. (I:2)
> Reduce anxiety before competition. (J:2)
> Reduce anxiety – help positive sleep and recuperation by reducing the factors that may affect these. (C:2)
> Useful, though 20 minutes would feel too long. Being able to zone in quickly and finding the techniques rhythm would be useful. (D:2)
> I felt I was able to block external stimuli with this method and was able to concentrate on the task. This would probably transfer over to sporting activity. (E:2)
> Potentially providing calm period to focus more during performance. (H:2)
> It may enable me to control my breathing pattern to a better extent as this is something I have never focussed on or thought to keep at a certain rate. (A:2)
> Refocus during a competition. (B:2)

Participants valued Ratio Breathing for sport to reduce or prevent anxiety, increase focus and concentration, block external stimuli, assist sleep, control and calm.

Value for health:

> It could be beneficial as I am a stressful person. (B:3)
> Decrease stress and decrease anxiety. (K:3)
> Stress relief. (I:3)
> It was positive on health. I very rarely sit and just relax. Normally busy doing something. (J:3)

Reducing anxiety and improving health through better sleep. (C:3)

It was very good. Focussed time to relax and free my mind, undisturbed for a period of time, is a rare treat. (D:3)
Potentially reduce resting blood pressure (systolic/diastolic) and reduce resting heart rate. (H:3)
I felt extremely relaxed and calm after. Regular sessions like this would probably enhance resting heart rates and blood pressure so being good for cardiovascular health. Felt much calmer mentally – didn‟t have the grumpiness that I started out with so that‟s good too. (E:3)
I have never felt the need to perform a specific meditation technique and I am not convinced of any benefits it may have for my health. (A:3)
Could have a positive impact. (B:3)

Participants valued Ratio Breathing for health to decrease stress, anxiety, heart rate, blood pressure and negative mood, increase focus and concentration, assist with meditation and calm.

Transcendental Meditation

Description of experience:

Hard to concentrate on mantra. I feel very relaxed and slightly tired. (J:1)
I zoned in and out of being able to focus on the chant. Little distracted by external sounds though not a big problem when practising. (D:1)
Calmness, peace, restful. (I:1)
Despite my best efforts this session irritated me for some reason. I didn‟t feel particularly relaxed and was very aware that I was part of the environment – I felt very much on the surface of it all. I found it a distraction to focus on the mantra. (E:1)
Comfortable, relaxing. (K:1)
I found this condition to be the most relaxing of the sessions yet completed as it helped focus my meditation in my head rather than my body (breathing). (C:1)
I found the meditation method difficult to maintain. I found myself losing concentration as time progressed and found that a longer period passed between performing the „mantra‟. However, when I remembered I continued in the mantra but not that they were performed at regular intervals as planned. (A:1)
Calm, somewhat sleepy, refreshed none the less. (H:1)

Participants experienced Transcendental Meditation as relaxing. Some found it very relaxing, but most struggled with the mantra, distraction, zone, focus and concentration.

Value for sporting performance:

Increasing focus, could use with imagery. (J:2)
As a runner, very useful before or after training runs. (D:2)
It may improve focus and relieve stress before a competition. (I:2)
I wouldn‟t use this type, it irritated me and I kept feeling distracted. (E:2)
Reduce anxiety, help clear the mind of the small matters involved in daily living. (C:2)
As I found myself losing concentration I am not sure this type of meditation would help. Saying that, however, when I did perform the mantra it stopped me from thinking about other things and ideas in my head which was a comforting break from my normal state of mind. (A:2)
Potential value in busy times to take breaks and relax the mind. (H:2)

Participants valued Transcendental Meditation for sport to relax, clear and focus the mind, reduce anxiety and stress. Some found it distracting and irritating, others valued its use as distraction, and combined with imagery in competition.

Value for health:

High value to health. (J:3)
High value for stress relief. (I:3)
I don‟t think this would benefit me much. (E:3)
Decrease stress and decrease anxiousness. (K:3)
Reduce anxiety and include time in the week for peaceful thought and reflection. (C:3)
As I found it difficult to maintain I am not sure of any potential health benefits. However, as it forced me to stop thinking about current concerns, issues and workload it may help me to put things in perspective upon completion. (A:3)
Potential decrease stress hormones, resting heart rate, systolic blood pressure, gain greater meditation. (H:3)

Participants highly valued Transcendental Meditation for health, stress relief, anxiety, heart rate, blood pressure, as well as assist with peaceful thought and awareness control.

Zazen Meditation

Description of experience:

Very tired and sleepy post intervention. (H:1) Stress relieving, calm. (I:1)
Comfortable and relaxing. (K:1)
A lot of external distractions but was relatively easy to keep focus on breathing technique. (D:1)
Relaxing, 20 minutes feels very long. (B:1)
Difficult at first to focus and I periodically was aware of my mind wandering. When focussed on breathing I felt quite tired and yawned quite a bit. Was aware that my heart rate felt faster than usual. (E:1)
Was able to maintain focus for at least three prolonged periods and sensed that I was moving into a meditative state at these points. Following the condition I feel slightly floaty-peaceful. (C:1)
I found it hard to focus on purely abdominal breathing as this is my „norm‟ – deep, quiet, strong. I, therefore, tended to have numerous thoughts, ideas and planned activities running through my head so I did not feel as relaxed as in the other techniques. (A:1)

Participants experienced Zazen as stress relief, calming and relaxing. Some found it hard to focus, while others became involved and meditative and peaceful.

Value for sporting performance:

Immediately - I do not feel ready for vigorous activity; Long term - potentially relaxing effect. (H:2)
Helps focus. (I:2)
Good for pre-performance routines though not useful during performance. (D:2) Could be useful between rounds at a competition. (B:2)
With practice it would calm and focus the mind on the task at hand. (E:2)
To block out unnecessary worry of everyday (trivial) matters – to aid in restful sleep. (C:2)
As I found it difficult to truly relax I am not sure what effect this meditation session would have on my sporting performance if any. (A:2)

Participants valued Zazen for sport in terms of pre-performance routines, between rounds at competition, for meditation, focus and sleep.

Value for health:

Lower resting heart rate/blood pressure. (H:3) Decreases stress. (I:3)

Decrease stress, decrease anxiety and increase happiness. (K:3) Good
for relaxing, reduced tension. (D:3)
Could be beneficial. (B:3)
Again, a calming experience that takes you away from manic external stimuli. (E:3)
Anything that can reduce anxiety/stress should be good in reducing risk factors for CVD, etc. (C:3)
Again, as it was difficult for me to maintain and to feel my self-consciousness I doubt it will have any value or positive health benefits. (A:3)

Participants valued Zazen for health, to reduce stress, anxiety, heart rate, blood pressure and cardiovascular risk.

What was your favourite condition and why?

Ratio Breathing (RB):

Harder to do but very relaxing. (K:4)
I felt like I had disappeared for a while and although I was aware of the environment I didn"t feel part of it. I felt extremely relaxed and calm. (E:4)
Found it easier to focus on it. (B:4)
Felt more relaxed from this method than the others but also felt alert at which the others I felt rather tired. H:4)
Easier to stay focussed and the meditation and less likely for mind to wander. (I:4)
I found concentrating on heart rate and mantra difficult. I would say that all conditions were effective though. (J:4)

Six of the 9 participants preferred Ratio Breathing for its effect on meditation, focus and concentration.

Transcendental Meditation:

Transcendental was my favourite condition as I found it easiest to reach a deeper state of meditation when focussing on a sound in my head. This seemed to correspond to my breathing pattern which also seemed more smooth and rhythmical. (C:4)
Due to my inability to maintain a relaxed state I felt the third state (transcendental) to be my favourite as it gave me something to focus on and stopped me from having any normal, alternative thoughts. (A:4)

Two participants preferred Transcendental Meditation for its effect on depth of meditation and focus.

Zazen Meditation:

Having the mind focussed on myself and my breathing removed a lot of external distraction. (D:4)

One participant preferred Zazen for its effect on self, focus and removal of external distraction.

Focus group summary

There was consensus regarding the potential usefulness of the 3 meditation techniques with words such as "tranquil", "immersed" and "vacant" typically describing the experiences of the participants. A number of participants agreed with respect to the difficulties experienced

in establishing a relaxed state and then maintaining this for the full 20 minutes. There was a split in terms of the technique that was deemed the easiest to maintain with a roughly even spread of participants reporting a preference for each approach. The benefits for health were deemed to be more prevalent than for sport with the group questioning the usefulness of the techniques for sport performers. It was felt that significant refinement would be needed before the techniques could be used in an applied setting. The participants felt that all 3 approaches

might be useful for performers when trying to relax at night or the day before a competition.

Quantitative findings

Multivariate analysis of variance with pair wise t-test comparisons were employed to analyse both the neuro-physiological data and responses to the sense of coherence scale across the 3 meditation conditions. Parametric analyses were computed based on 3 considerations:

1. Inspection of the Kolmogorov-Smirnov statistic indicated that the null hypothesis be accepted ($p>0.05$) for all measures;
2. The level of measurement that the data represented; and
3. The acceptance that analysis of variance is considered to be robust enough to withstand violations of normality (Vincent, 1999).

Neuro-physiologic and sense of coherence findings

Neuro-physiological data were coded for blood volume pulse in mean number of beats per minute (BVP), muscle tension or meditation as measured on the electro-myograph (EMG), respiration in terms of mean number of breaths per minute and electro-encephalographic (EEG) activity in terms of percentage delta activity (0-3 hertz or cycles per second), theta (4- 7 hertz), alpha (8-12 hertz), sensory-motor activity (SMR) (13-15 hertz), beta (16-30 hertz) and gamma (above 30 hertz).

Sense of Coherence data were scored for the total scale (SOC), as well as for the subscales, Meaningfulness (ME), Manageability (MA) and Comprehensibility (CO). Pre- and post-test means and standard deviations (SD) for the 3 treatment conditions, Ratio Breathing (RB), Transcendental Meditation (TM) and Zazen (ZM) appear in Table 1.

Multivariate analysis revealed a significant within group effect (N=9) for respiration decreases ($F=33.61$, $p=0.000$, $\eta^{-2}=0.58$), for alpha increases ($F=10.01$, $p=0.004$, $\eta^{-2}=0.29$) and a weak effect for theta increases ($F=4.107$, $p=0.054$, $\eta^{-2}=0.146$). However, between groups analysis only revealed one significant finding. Tukey LSD test indicated significant differences in respiration (RES) between Transcendental Meditation and Ratio Breathing at the post-test ($t=4.08$, $p=0.0270$). Inspection of Table 1 indicates that this significant finding is associated with the relatively greater mean decreases in the Ratio Breathing condition than in the Transcendental Meditation condition.

In order to examine significance within groups pre- and post-test effects further, pair wise t-tests were run on each of the 3 groups separately. This indicated that the Ratio Breathing was associated with significant decreases in respiration. The Ratio Breathing condition pre-test respiration (15.2±3.7) was significantly higher than post-test respiration (9.6±3.4), with $t(8)=4.13$, $p=0.003$. Secondly, the Transcendental Meditation condition was also associated with significant decreases in respiration, from pre- (15.4±3.2) to post-test (13.7±3.0), with

$t(8)=3.50$, $p=0.008$, as well as significant decreases in muscle tension EMG from pre- (6.1±5.6) to post-test (3.12±2.6), with $t(8)=2.6$, $p=0.032$, and significant increases in alpha activity from pre- (12.5±7.4) to post-test (14.5±8.6), with $t(8)=2.73$, $p=0.026$. Finally, the Zazen was also associated with significant decreases in respiration from pre- (14.9±3.1) to post-test (12.8±4.5), with $t(8)=2.81$, $p=0.023$, as well as increases in theta activity from pre- (13.1±5.5), to post-test (15.5±6.7), with $t(8)=23.0$, $p=0.017$. These significant differences are observable in Table 1. There were no significant differences pre to post across any of the 3 meditation conditions with respect to either total sense of coherence score or the 3 constituent

subscales.

***TABLE 1*: RATIO BREATHING, TRANSCENDENTAL MEDITATION, ZAZEN: PRE- AND POST-TEST MEANS AND STANDARD DEVIATIONS (SD)**

Variables	Ratio Breathing		Transcendental Meditation		Zazen	
	Pre-test Mean±SD	Post-test Mean±SD	Pre-test Mean±SD	Post-test Mean±SD	Pre-test Mean±SD	Post-test Mean±SD
BVP	67.5±11.4	66.3±9.1	68.6±10.6	66.3±9.0	71.8±14.0	70.8±12.2
EMG	2.5±1.4	3.2±1.7	6.1±5.6	3.15±2.6	4.3±4.5	3.1±2.8
RES	15.2±3.7	9.6±3.4	15.4±3.2	13.7±3.0	14.9±3.1	12.8±4.5
Delta	14.2±3.4	12.6±3.1	13.8±3.6	12.2±3.8	13.8±5.2	14.1±4.5
Theta	14.1±5.7	14.0±5.8	12.2±3.5	13.9±6.0	13.1±5.5	15.5±6.7
Alpha	12.2±6.3	14.4±9.2	12.5±7.4	14.5±8.6	12.2±7.0	14.6±8.7
Beta	12.9±9.9	10.2±7.0	8.4±2.4	8.9±2.7	10.8±8.1	11.1±8.1
Gamma	4.9±4.6	3.4±3.3	3.0±1.2	2.3±0.4	4.2±3.7	3.8±3.7
SOC	48.2±3.2	50.0±4.5	46.6±9.9	46.6±7.1	48.9±5.3	49.0±5.1
ME	15.8±1.8	15.8±2.3	14.9±3.4	14.7±2.4	16.0±2.3	15.8±2.9
MA	16.1±1.6	16.6±1.7	15.9±3.8	15.8±2.9	16.4±1.7	16.7±1.7
CO	16.3±1.5	17.1±2.3	15.8±3.3	16.1±2.5	16.4±1.9	16.6±1.7

BVP= Blood volume pulse; EMG= Electromyography; RES= Respiratory rate;
Delta, Theta, Alpha, Beta, Gamma= Electroencephalography frequencies;
SOC= Sense of coherence; ME= Meaningfulness; MA= Manageability; CO= Comprehensibility

Integrative findings

There was consensus regarding the potential usefulness of the 3 meditation techniques with words such as “tranquil”, „“immersed” and “vacant” typically describing the experiences of the participants. Although the ideal of about 6 breaths per minute was not reached by any meditation condition, the integrated findings indicate the general value of breathing exercises in meditative, sport and health contexts. This finding supports related research on the qualitative value of breath consciousness in health and sport settings (Edwards & Edwards, 2007; Edwards, 2012), the value, albeit limited, of quantitative relationships between breath-ratios, spirituality perceptions and health perceptions (Edwards, 2013b), as well as clinical observations by sport psychologists that sportspersons tend to favour breathing exercises as the most valuable form of psychological skill to be learned and practised (Edwards *et al.*, 2013). The integrative findings generally support the evidence that concentration and mindfulness meditations are distinct forms of consciousness (Dunn *et al.*, 1999). The findings also support the value of all 3 meditation conditions for health and to a lesser extent for sport, especially with regard to their effect on focus.

The differential effect of the meditations was apparent with regard to both qualitative and quantitative findings. Participants valued Ratio Breathing for its effect on concentration, Transcendental Meditation for its depth of meditation and Zazen for its effect on self and removal of external distraction. These qualitative findings correlate nicely with differentially significant quantitative effects on lowered respiration rate in the Ratio Breathing group, increased physical relaxation and alpha activity in the Transcendental Meditation group and increases in both alpha and theta activity in the Zazen group. Such findings provide some basis for the theory that the 3 meditation conditions reflect increasing meditation depth as implied in Patanjali"s yoga sutras (Iyengar, 2001, 2005; Chopra & Simon, 2004), with associated differential neuro-plastic changes (Marks, 2008; Hallsband *et al.,* 2009). Patanjali"s last 3 yogic limbs, collectively referred to as *sanyama,* may also provide a theoretical basis for the neuro-psychological connections between mindfulness and creativity (Horan, 2009). Such theoretical speculation could be tested in future studies, via appropriate research hypotheses generated from relevant operational definition, differentiation and manipulation of meditation conditions.

The integrated findings support the psychological value of meditation training with special reference to general experiences, sport and health (Benson, 2000; Wilber, 2001a, 2001b; Kabat-Zinn, 2003; Alexander, 2005; Schreiner, & Malcolm, 2008). To the extent to which the study satisfies qualitative research criteria of credibility and dependability, as well as quantitative research criteria of validity and reliability, integrated and/or triangulated validity claims apply with regard to research integrity, researcher reflexivity and quality assurance of the investigation as a whole. The fact that all findings are consensually validated by all participants also provides some reassurance towards the authenticity of the study as a whole. Integration of findings from qualitative and quantitative analyses facilitated understanding and interpretation of apparent similarities and obvious differences between individuals with regard to their experiential descriptions. As the number of participants was relatively small, as well as linguistically and ethnically biased, interpretation of findings should obviously be treated with much caution. Larger, randomised controlled studies, involving on-going meditation practice, with various participant samples, including advanced practitioners, as well as integrated and differentiated research methods are needed to generalise findings and strengthen validity claims.

A strength of the present study was the randomised, experimental design. The latter enabled operational definition of and differentiation between independent variables in the form of the three meditation treatment conditions, while keeping other conditions constant and observing change in dependent variables. While this may have satisfied some principles of experimental

design established by such classic luminaries as Popper (1959) and Kerlinger (1978), two limitations regarding maximal differentiation of meditation conditions, which possibly created confounding effects, need to be acknowledged. Firstly, all three groups separately were associated with decreases in respiration. The ideal breath-ratio of five to seven breaths a minute, which may have further differentiated the groups, was not achieved in the Ratio-Breathing group. An objective breath-ratio counter could have given the Ratio Breathing group an undue biofeedback advantage. However, more initial training could have been done to both achieve the ideal six breaths a minute breathing rate and differentiate the meditation conditions. Secondly, although delta and gamma activity did not increase in the TM group, the general increases in EEG alpha, theta and beta band activity in both TM and ZM groups, were more consistent with evidential patterns of mindfulness meditation, which produces relatively

more slow delta and theta, as well as relatively more fast, alpha and beta activity than concentrative meditation (Dunn *et al.*, 1999).

These findings support the research of Horan (2009), who classifies TM as both a concentrative and mindfulness type of meditation. It also supports the findings of Tanner *et al*. (2009). These authors found that a three month TM program increased mindfulness skills significantly more than a waiting list control group. The neuro-physiological findings of meditation initially activating the middle bands of the EEG spectrum have also been reported in other studies (Edwards, 2012, 2013a, 2013b). As meditation deepens, Horan (2009) hypothesises that the transcendent observer, or witness, is associated with defocused, low alpha band activity. This integrates with the relative neural silence of delta activity in mirror-like, ground recognition and with gamma activity in binding integration of insights. Future research could control for this witnessing effect through the use of concentration or mindfulness measures, such as that of Wallach *et al*. (2006) and/or other standardised scales related to research hypotheses.

CONCLUSION

In conclusion, this study satisfied its main aim to record a small group of participants‟ experiences of three meditation conditions, Ratio Breathing, Transcendental Meditation and Zazen, with special reference to sport, health, neuro-physiology and sense of coherence. Integrative findings support the value of all three meditation conditions for health and to a lesser extent for sport. Larger, randomised controlled studies, involving on-going meditation practice, with various participant samples, including advanced practitioners, as well as integrated and differentiated research methods, are needed to generalise findings and to address the limitations of the present study.

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LEISURE CONSTRAINTS AND LEISURE SATISFACTION IN THE RECREATIONAL ACTIVITIES OF EMPLOYEES WITH DISABILITIES

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ABSTRACT

This study analysed leisure constraints and leisure satisfaction in the recreational activities of employees with disabilities. The sample (N=123) consisted of 91 men and 32 women with disabilities working in public institutions in Antalya, Turkey. Leisure constraints were measured using the Leisure Constraints Questionnaire developed by Alexandris and Carroll, and leisure satisfaction was measured using the Leisure Satisfaction Scale developed by Beard and Ragheb. The leisure constraints and leisure satisfaction of the respondents were compared according to gender, age and frequency of leisure participation, using the Mann-Whitney U-test. The results indicated no significant differences in mean scores for leisure constraints for either gender or age, although scores on the subscale for 'individual/ psychological factors' revealed significant differences in the frequency of leisure participation. The Leisure Satisfaction Scale revealed significant gender differences on the social subscale, as

well as age-related differences on the psychological subscale. The mean scores for individual/psychological constraints were higher for respondents who participated in leisure activities one day a week than for those who participated more days per week. To increase the participation in leisure activities and to enhance the satisfaction derived from participation, the planning and arrangement of recreational services should be designed specifically for employees with disabilities.

Key words: Leisure; Recreation; Constraints; Satisfaction; Employees with disabilities.

INTRODUCTION

According to the World Report on Disability of the World Health Organization, more than one billion people (15% of the world population) are living with some form of disability (World Health Organization, 2011). The number of people affected increases considerably when the families of individuals with disabilities are included in the calculation. Studies concerning people with disabilities have attracted the interest of both academics and public policy makers. This interest tends to focus on topics concerning education, health, housing, social services, legislation or other service-related issues and not on leisure (Aitchison, 2000). Many theorists have tended to underestimate the potential positive effects of leisure, concentrating instead on the access of people with disabilities to employment or education (Tregaskis, 2003). Although these efforts are very valuable, there is a lack of research within the sphere of leisure, which has been identified as an important life domain, alongside

marriage, work, standard of living, friendship and health (Headey *et al*., 1991). As such, leisure contributes physiologically and psychologically to the well-being of all individuals, regardless of whether they have any disabilities. Leisure has been shown to increase self-esteem and psychological well-being, to enhance physical health and fitness and to decrease the risk of various illnesses (Aitchison, 2003).

Although the amount and patterns of leisure participation by people with disabilities are likely to differ from those of people without disabilities, both groups are subject to leisure constraints that prevent them from participating in leisure activities or from achieving the desired level of satisfaction from these activities. Given the importance of leisure activities, leisure constraints constitute a predominant subject in leisure literature (Alexandris & Carroll, 1999). As defined by Jackson (2000:62), leisure constraints are "the factors that are assumed by researchers and perceived by individuals to inhibit or prohibit participation and enjoyment in leisure". It is nevertheless possible for people to participate in leisure despite the presence of constraints.

Particularly since the 1980s, this subject has been examined more systematically and has proven useful in drawing conceptual connections among the various aspects of leisure behaviour (Jackson, 1988). In an important contribution to literature, Crawford and Godbey (1987) state that, in addition to affecting participation and non-participation, leisure constraints influence the level of desire for and awareness of leisure activities.

Leisure constraints have also been shown to affect leisure behaviour (Hinch *et al*., 2005). Crawford *et al*. (1991) use a hierarchical model to explain leisure constraints, classifying them into three dimensions: intrapersonal, interpersonal and structural. In addition to these concepts, Jackson *et al*. (1993) highlight the notion of negotiation, arguing that individuals seek ways to

participate in leisure, despite being confronted with constraints. Leisure participation thus does not depend upon a lack of constraints, but rather on how these constraints are negotiated. In a study of 363 high school students, Raymore *et al*. (1993) conclude that intrapersonal, interpersonal and structural constraints play a decisive role in determining the decision-making processes of individuals with regard to leisure participation. Alexandris and Carroll (1997a) developed a scale with seven dimensions (individual psychological, lack of knowledge, facilities/services, accessibility/financial factors, lack of partners, time, lack of interest), although they acknowledge the lack of empirical verification for their model. Upon publication of the scale, the constraints had yet to be investigated in relation to actual participation, having been tested within a sample drawn from a population of students, whose perceptions regarding leisure constraints might not reflect those of the general population. In a comparison of three baseline models of leisure constraints, Casper *et al*. (2011) identified the scale with seven dimensions as the most appropriate measurement model according to the goodness-of-fit indices.

Research concerning leisure constraints is not restricted to the studies mentioned here. In an effort to represent the operation of constraints in the lives of individuals, Hubbard and Mannell (2001) used structural equation modelling to chart the leisure-constraint negotiation process. Since 2007, models developed by Hubbard and Mannell (2001) have been tested by various authors (Loucks-Atkinson & Mannell, 2007; Son *et al*., 2008; Stanis *et al*., 2009). Loucks-Atkinson and Mannell (2007) indicate that individuals who are more motivated to

participate are likely to exert greater effort to negotiate constraints. As reported in a study by Son *et al*. (2008), the negative effects of constraints on participation are almost completely compensated for by the positive effects of negotiation strategies, and the effect of motivation on participation is fully mediated by leisure negotiation. Stanis *et al*. (2009) conclude that negotiation partly mediates the constraint-participation and motivation-participation relationships that support the model developed by Hubbard and Mannell (2001).

Despite a considerable body of research pertaining to leisure constraints, few studies have focused on the leisure constraints of people with disabilities. This gap might be due to a lack of research collaboration between the academic field of leisure and that of disabilities (Aitchison, 2000). Very few studies refer to the barriers faced by people with disabilities or provide recommendations for promoting leisure participation within this population (Tregaskis, 2003; Burns *et al*., 2009).

Leisure satisfaction is another important aspect in leisure literature. The significance of leisure participation has been well documented. In addition, the ways in which individuals evaluate their own leisure experiences play an important role in their ability to realise the desired physical and psychological effects of these experiences and in their decisions regarding further participation in leisure activities. Leisure satisfaction is one criterion for evaluating leisure experiences that has been extensively examined in leisure literature. Beard and Ragheb (1980) define leisure satisfaction as the positive sensations and feelings that are expressed, achieved and realised by individuals during participation in leisure activities. Leisure satisfaction has been identified as an important domain of human life and has been shown to have a positive impact on life satisfaction (Brown & Frankel, 1993; Nimrod, 2007; Wang *et al*., 2008). Other concepts that are positively associated with leisure satisfaction include quality of life (Ngai, 2005; Spiers & Walker, 2009), well-being (Broughton & Beggs, 2007), and perceived freedom in leisure (Siegenthaler & O"Dell, 2000; Munchua *et al*., 2003). In a study involving

employed women, leisure satisfaction contributed positively to psychological health (Pearson, 2008). The psychological benefits of participating in recreational activities, especially sport, have also been documented in the literature, albeit without addressing the relationship between leisure and leisure satisfaction (Edwards *et al*., 2005). Other scholars have examined leisure satisfaction in relation to psychiatric morbidity (Raj *et al*., 2006), and some studies refer to its positive affect on partner relationships (Berg *et al*., 2001), and its contribution to marriage satisfaction (Johnson *et al*., 2006).

One of the most widely used instruments for measuring leisure satisfaction is the Leisure Satisfaction Scale developed by Beard and Ragheb (1980). The instrument consists of subscales for psychological, educational, social, relaxation, physiological and aesthetic factors. The psychological subscale covers the psychological benefits of leisure, addressing such feelings as freedom of choice, self-accomplishment and self-actualisation. The educational subscale examines the extent to which individuals learn about themselves, others and the environment, in addition to their likelihood to try new things. The social subscale covers social interaction, social communication and a sense of belonging, and the relaxation subscale concerns relief from the stress generated from work and everyday life. Issues addressed by the physiological subscale include physical fitness, general health, weight control and increasing energy, and the aesthetic dimension covers aspects relating to the attractiveness and design of environments for leisure activities.

The Leisure Satisfaction Scale (Beard & Ragheb, 1980) has been applied to a variety of populations in various environments. For example, it has been used in a study examining the leisure satisfaction of elderly people, considering variables such as gender, age, marital status, perceived health, ability to drive, type of accommodation and living arrangements (Broughton & Beggs, 2007). Leisure satisfaction and life satisfaction have also been studied with regard to people in the transition period to retirement (Pinquart & Schindler, 2009). In another study on the elderly, the Leisure Satisfaction Scale was used to measure the impact of Internet usage on leisure perceptions (Heo *et al*., 2011). In a study involving adults with physical disabilities, Kinney and Coyle (1992) identify leisure satisfaction as the most significant predictor of life satisfaction, explaining 42% of the variance in the mean scores for life satisfaction within their sample. Although the Leisure Satisfaction Scale was originally applied to groups other than the population of people with disabilities, it was later applied in a study involving a group of 100 adults with mental illness in an Australian community mental health rehabilitation centre (Lloyd *et al*., 2001). As recommended by Beard and Ragheb (1980), further tests on the validity of the scale were conducted, finding that participants reported receiving more satisfaction from their leisure activities than was the case with the normative population (Lloyd *et al*., 2001).

PURPOSE OF THE STUDY

In the past two decades, disability studies have attracted increasing interest in the literature, although few scholars conducting research on people with disabilities have examined leisure experiences within this population (Aitchison, 2000). The investigation of leisure experiences in disadvantaged groups could enhance effectiveness in the planning, provision and management of recreational services (Jackson, 1988). The present study, therefore, examines the leisure constraints and leisure satisfaction experienced by employees with disabilities working in public institutions.

The definition of leisure for people with disabilities differs in some respects from its definition in the context of those without disabilities. First, individuals with disabilities might not have as much freedom as their counterparts without disabilities, given that they sometimes need assistance and care from others during leisure participation. Second, individuals with disabilities are less likely to be employed on a full-time basis than members of the general population, and this obviously has implications for several aspects of the leisure experience. To minimise the differences between people with and without disabilities, the present study concerns people with disabilities who were employed full-time at the time of the research.

METHODOLOGY

Participants

The research population of the study comprised of employees (N=176) with disabilities working full-time in 12 public institutions in the inner city of Antalya, Turkey. With regard to the nature of disability, the composition of the population was as follows: amputated leg (n=22), polio (n=19), multiple sclerosis (n=6), hearing impairments (n=15) and other disabilities (n=38). The entire population was included in the study, and the response rate was

70%. The final sample of respondents (N=123) consisted of 91 men (age: 38.66±8.56) and 32 women (age: 32.84±6.72).

Ethical clearance

The required applications were submitted to the public institutions in which the members of the study population were working, and the necessary permission was obtained. Before the study was conducted, a brief explanation was provided to the entire population of 176 employees with disabilities.

Measures

The questionnaire used in this study comprised 4 parts. The first part was used to collect demographic data on the participants. The second part of the questionnaire concerned the leisure participation of the employees with disabilities. Leisure participation was measured as the frequency of participation in leisure activities per week. The third part of the questionnaire measured leisure constraints according to the Leisure Constraints Questionnaire, developed by Alexandris and Carroll (1997a), and adapted to the Turkish context through back-to-back translation (Karaküçük & Gürbüz, 2006). The adapted tool was further validated by Gürbüz *et al*. (2010). Items were measured along a 4-point Likert scale ranging from 1 (not important) to 4 (very important). The original 29-item scale contained the following subscales: (1) individual psychological factors; (2) lack of knowledge; (3) facilities/services; (4) accessibility/financial factors; (5) lack of partners; (6) time; and (7) lack of interest. The Turkish version of the scale was analysed for reliability and validity. Principal component analysis with varimax rotation revealed 27 items loaded with weights exceeding 0.40. Two items were deleted due to low factor loadings. The final Turkish version of the scale thus consisted of 27 items, distributed across the following 6 subscales: (a) facilities/services and accessibility [8 items]; (b) social environment and lack of knowledge [5 items]; (c) individual psychological factors [4 items]; (d) lack of partners [3 items]; (e) time [4 items]; and (f) lack of interest [3 items]. Taken together, the items in this scale explained 55% of the variance. The internal consistency (Cronbach‟s alpha scores) of the subscales ranged from 0.67 (time) to 0.82 (lack of

knowledge), and an internal consistency score of
0.84 was achieved for the entire Leisure Constraints Questionnaire (Karaküçük & Gürbüz, 2006). In this study of employees with disabilities, the internal consistency values of the subscales were 0.73, 0.77, 0.80, 0.81, 0.50 and 0.80 respectively, with an internal consistency score of 0.87 for the entire questionnaire. To determine the suitability of factor analysis for the dataset, the sample was first checked by computing the Kaiser-Meyer-Olkin (KMO) and Bartlett‟s tests of sphericity. According to the explanatory factor analysis with principal components procedure, the items were distributed around 6 factors, with an explained variance of 60.32%.

In the fourth part of the questionnaire, the leisure satisfaction of the participants was measured using the Leisure Satisfaction Scale, which was developed by Beard and Ragheb (1980) and adapted to Turkish by Karlı *et al*. (2008). The original scale consisted of 51 items, distributed across the following 6 subscales: psychological; educational; social; relaxation; physiological; and aesthetic factors. The items were measured along a 5-point Likert scale: 1 (almost never true for me); 2 (seldom true for me); 3 (sometimes true for me); 4 (often true for me); and 5 (almost always true for me). After factor analyses, the Turkish version of the

scale consisted of 6 factors and 39 items, explaining 45.27% of the variance. The subscales were as follows: (a) psychological factors [8 items]; (b) educational factors [9 items]; (c) social factors [8 items]; (d) relaxation factors [4 items]; (e) physiological factors [6 items]; and (f) aesthetic factors [4 items] (Karlı *et al*., 2008). The internal consistency (Cronbach‟s alpha) scores for the subscales of the Turkish version were 0.86, 0.84, 0.82, 0.79, 0.82 and
0.79 respectively; with an internal consistency score of 0.92 for the entire satisfaction scale (Karlı *et al*., 2008). In this study of employees with disabilities, the internal consistency (Cronbach‟s alpha) values of the subscales were 0.87, 0.89, 0.85, 0.88, 0.87 and 0.81 respectively, with an internal consistency score of 0.96 for the entire scale. According to the explanatory factor analysis with principal component procedure, the items were distributed around 6 factors, with an explained variance of 66.59%.

Statistical analysis

Descriptive data analysis was conducted using means (M) and standard deviations (SD). Before comparing the leisure constraints and leisure satisfaction levels of participants according to gender, age and leisure-participation frequency, the assumptions of normal distribution and homogeneity were tested. Because these assumptions were not met, the non-parametric Mann-Whitney U-test was used. The results were evaluated based on a significance level of $p<0.05$.

RESULTS

***TABLE 1*: GENDER: MEANS AND STANDARD DEVIATIONS OF VARIABLES**

Variables	Women M±SD	Men M±SD	Total Group M±SD	z	p
Leisure constraints					
Individual/Psychological	2.80±0.53	2.77±0.70	2.78±0.66	-0.57	0.57
Social environm. & lack of knowl.	3.13±0.55	3.05±0.57	3.07±0.56	-0.79	0.42
Facilities/Services & accessibility	3.08±0.36	3.03±0.45	3.04±0.43	-0.05	0.96

Lack of partners	2.82±0.65	2.74±0.71	2.76±0.69	-0.67	0.50
Time	2.93±0.24	2.99±0.41	2.97±0.37	-1.20	0.23
Lack of interest	2.67±0.53	2.62±0.71	2.63±0.66	-0.74	0.46
Leisure satisfaction					
Psychological	2.24±0.74	2.51±0.92	2.44±0.89	-1.31	0.19
Educational	2.22±1.00	2.52±0.88	2.44±0.92	-1.62	0.11
Social	2.38±0.95	2.84±1.00	2.72±1.01	-2.18	0.03*
Relaxation	2.17±1.03	2.53±1.10	2.43±1.09	-1.55	0.12
Physiological	2.56±0.96	2.76±1.06	2.71±1.04	-0.79	0.43
Aesthetic	2.43±0.98	2.73±0.99	2.65±0.99	-1.32	0.19

*p<0.05

The highest mean scores for leisure constraints were obtained for the subscales „social environment and lack of knowledge" and „facilities and accessibility" (Table 1). The lowest mean scores were obtained for the „lack of interest" subscale of the leisure constraints scale.

The highest mean scores for leisure satisfaction were obtained on the „social" subscale, and the lowest mean scores were obtained on the subscales for „psychological factors" and „educational factors". The Mann-Whitney U-test was applied to compare the mean scores of the leisure constraints and leisure satisfaction scales according to gender. No significant differences were noted ($p>0.05$). When the leisure satisfaction subscales were compared according to gender, men were found to have higher mean scores on the „social factors" sub-dimension ($U=1065$, $p=0.029$, $z= -2.183$, $r= -0.19$), where r=z/square root of N, N=total number of cases.

The subscales of leisure-constraints and leisure-satisfaction scales were compared according to age (Table 2). No significant differences were noted in the subscales of leisure constraints ($p>0.05$).With regard to leisure satisfaction, the mean scores of employees aged 36 years and older were significantly higher than were those of employees younger than 36 on the subscale for „psychological factors" ($U=1456$, $p=0.040$, $z= -2.054$, $r= -0.18$).

***TABLE 2*: AGE: MEANS AND STANDARD DEVIATIONS OF VARIABLES**

Variables	**Below 36 yrs.** M±SD	**36 yrs. +** M±SD	**z**	**p**
Leisure constraints				
Individual/Psychological	2.75±0.61	2.81±0.71	-0.47	0.64
Social environm. & lack of knowl.	3.03±0.64	3.10±0.47	-0.04	0.96
Facilities/Services & accessibility	3.05±0.45	3.04±0.41	-0.51	0.61
Lack of partners	2.80±0.65	2.72±0.73	-0.44	0.66
Time	2.93±0.39	3.01±0.35	-1.55	0.12
Lack of interest	2.59±0.64	2.68±0.69	-0.49	0.78
Leisure satisfaction				
Psychological	2.26±0.75	2.60±0.97	-2.05	0.40*
Educational	2.29±0.88	2.59±0.93	-1.77	0.77
Social	2.59±0.94	2.83±1.05	-1.20	0.22

Relaxation	2.26±1.05	2.59±1.11	-1.58	0.11
Physiological	2.65±0.88	2.76±1.17	-0.24	0.81
Aesthetic	2.60±0.92	2.70±1.05	-0.50	0.62

*p<0.05

The Mann-Whitney U-test was applied to compare the mean scores of the leisure-constraints and leisure-satisfaction subscales according to the frequency of leisure participation per week. Respondents who participated in leisure activities 1 day a week had higher mean scores on the „individual psychological factors" subscale than those who participated in such activities 2 or more days per week (U=1372, p=0.009, z= −2.624, r= −0.23) (Table 3). The subscales of leisure satisfaction yielded no significant differences with regard to participation frequency (p>0.05).

***TABLE 3*: WEEKLY LEISURE PARTICIPATION: MEANS AND STANDARD DEVIATIONS OF VARIABLES**

Variables	**1 Day pw.** M±SD	**2 Days + pw.** M±SD	**z**	**p**
Leisure constraints				
Individual/Psychological	2.93±0.60	2.62±0.69	-1.15	0.25
Social environm. & lack of knowl.	3.12±0.52	3.02±0.60	-0.93	0.32
Facilities/Services & accessibility	3.09±0.43	2.99±0.43	-2.62	0.01*
Lack of partners	2.81±0.68	2.71±0.71	-0.68	0.50
Time	3.01±0.37	2.93±0.37	-1.35	0.18
Lack of interest	2.73±0.62	2.52±0.70	-1.23	0.22
Leisure satisfaction				
Psychological	2.51±0.93	2.36±0.83	-0.91	0.36
Educational	2.48±0.95	2.40±0.88	-0.45	0.65
Social	2.66±1.07	2.78±0.93	-0.55	0.58
Relaxation	2.46±1.03	2.40±1.15	-0.52	0.60
Physiological	2.75±1.04	2.66±1.04	-0.35	0.72
Aesthetic	2.72±0.91	2.58±1.07	-1.24	0.21

*p<0.05

DISCUSSION AND CONCLUSION

Based on the results presented above, factors related to the „social environment and lack of knowledge" and to „facilities/services and accessibility" pose the strongest constraints to the participation of employees with disabilities in leisure activities. Of the factors investigated, „lack of interest" appears to play the least important role. These results are similar to those reported by Gürbüz *et al*. (2010), in which volunteer participants aged between 18 and 54 years were most constrained by issues related to „facilities/services and accessibility". Similarly, in a study involving individuals with learning disabilities (Reynolds, 2008), the primary barriers to leisure participation were related to expenses, the inability of staff to accommodate personal interests, transport problems and unwelcoming community resources/attitudes. The results of the current study also correspond to those of Alexandris and

Carroll (1997b) on a sample from the Greek population, in which „lack of interest" appeared relatively unimportant, with factors relating to „time" as the strongest constraint.

The fact that expenses did not pose a strong restraint to leisure participation in the current study is likely to be related to the fact that the participants were employed full-time, and thus more likely to be able to afford the expenses associated with such activities than would be the case for unemployed individuals. For this sample, the strongest constraints were related to the „social environment and lack of knowledge", the operationalization of which included such items as „not feeling himself safe", „not being happy in social environments", „not knowing where to learn", „not knowing where to participate" and „lack of teaching staff". This result

underscores the necessity of expert staff and a social environment in which people with disabilities can feel safe and welcomed by participants without disabilities.

With regard to leisure satisfaction, „social" factors played the most important role, while „relaxation", „psychological" and „educational" factors had the least pronounced effects. The results derived from the „relaxation" subscale are not consistent with those of other studies involving different populations. For example, Yang *et al*. (2008) observed the highest mean scores with regard to the „relaxation" subscale. In addition, Ardahan and Yerlisu-Lapa (2010) reported that among university students, the „physiological" subscale yielded the highest mean, with the lowest mean obtained from the „social" subscale. The differences between the results of this study and those of studies conducted on individuals without disabilities might reflect a situation in which leisure activities offer an important means through which people with disabilities can seek inclusion in society. Hence, they might place more emphasis on the social aspects of leisure activities, as reflected in the following subscale items: „During leisure activities, I can have social interaction with other people"; „The people I meet during leisure activities are friendly".

Another aspect in which the results of the current study differ from those of other studies is gender. The current analysis revealed few gender influences with regard to the leisure participation of employees with disabilities. In contrast, Brown *et al*. (2001) reported that the majority of women with children expressed a desire to be more active, but were restricted by a combination of structural barriers (lack of time, money, energy) and ideological obstacles (sense of commitment to others). In the same study, women who received social support were better able to negotiate their constraints, as compared to their counterparts who lacked such support (Brown *et al*., 2001). Other research has indicated that the participation of women in recreational activities is constrained by rigid scheduling, guilt and narrow programming, while social support and the ability to cope with rigid scheduling facilitate the negotiation of such constraints (Dixon, 2009). Henderson (1993) has studied several leisure constraints that are apparently more specific to women, including „perceived lack of entitlement", „ethic of care" and „health and safety constraints". The ethic of care becomes a constraint as women focus on responsibility and commitment to others. Issues of health and safety might pose a greater constraint on the leisure activities of women than those of men, particularly in light of such issues as sexual assault, crime and violence. In the leisure literature, the importance of negotiating constraints has been highlighted frequently, with many scholars claiming that in some cases, responsibilities associated with children might encourage leisure participation rather than restricting it (Irving & Giles, 2011).

The lack of gender effects in the current results calls for further investigation. Alexandris and

Carroll (1997b) reported that for an urban population, the mean scores of women exceeded those of men for the subscales addressing „individual/psychological factors", „accessibility/ financial factors" and „lack of knowledge". In Malaysia, the mean scores of female university students exceeded those of their male counterparts with regard to „structural" constraints and „individual psychological" constraints to participation in recreational sport activities (Yusof & Shah, 2007).

The contrast between the current results and those reported in literature might be related to several characteristics specific to the context of Turkey. In Turkish society, the primary duty

of women whether traditional and unliberated or those with open, western ideals, is to be a good wife and a good mother (Koca *et al*., 2009). Because of these norms, Turkish women (particularly married women) are likely to assign priority to their families, possibly neglecting their own needs, including with regard to leisure activities. More than half of the women employees in our sample were single. This might have decreased constraints that might otherwise be associated with being a woman. For the employees in this sample, disabilities are likely to have been a more important source of constraints than gender. When controlling for gender, the only significant difference in leisure satisfaction was that men had higher mean scores than women on the „social" subscale. The men in this sample might have placed more emphasis on social inclusion through the support of leisure activities. The literature also contains other studies that report no significant gender differences in leisure satisfaction (Broughton & Beggs, 2007; Ateca-Amestoy *et al*., 2008; Ardahan & Yerlisu- Lapa, 2010).

The results of the current study also yield no age-related differences in leisure constraints. In contrast, Alexandris and Carroll (1997b) report differences between age groups with regard to the „time", „individual psychological" and „lack of knowledge" subscales, with the highest mean scores observed among the oldest age group (46 to 65 years). In another study, Kleiber and McGuire (2008) conclude that, as individual"s age, they might need to restrict their activities to those that are more meaningful. Rather than negotiating constraints, therefore, elderly people can accept the limitations emerging from their constraints and obtain more leisure satisfaction than other people by devoting more effort to leisure participation.

The current results suggest age-related differences with regard to leisure satisfaction, with respondents aged 36 years and older having significantly higher levels of psychological satisfaction. In a study on factors determining leisure satisfaction, Ateca-Amestoy *et al*. (2008) report a U-shaped relationship between age and satisfaction. Instead of a linear relationship between age and leisure satisfaction, a non-linear relationship between these variables were obtained, with leisure satisfaction reaching a minimum mean score at the age of 45. In a study on the elderly, Broughton and Beggs (2007) report no differences in leisure satisfaction when making overall comparisons between age groups, although significant differences were observed between the scores of participants aged 70 to74 years and those aged 80 years and above with regard to the „physiological" subscale.

In the comparison of leisure constraints according to the frequency of leisure participation per week, mean scores for „individual/psychological" factors were lower for the group with less frequent participation (one day per week) than they were for the group with more frequent participation (two or more days per week). The mean scores for leisure satisfaction revealed no significant differences according to the frequency of leisure participation. These results are in contrast to those reported in a study involving university students, in which there was a

significant positive relationship between leisure participation and leisure satisfaction (Huang & Carleton, 2003). Similarly, in an examination of the leisure behaviour model, including leisure participation and leisure satisfaction, Ragheb and Tate (1993) reported that leisure participation had a positive effect on leisure satisfaction, thus indicating that greater participation in leisure activities increases leisure satisfaction.

In a study on people with lower-limb amputations, Couture *et al*. (2010) report that leisure participation decreased during the post-operative period, although leisure satisfaction remained at a high level. In another study involving people with physical disabilities, leisure satisfaction was identified as having the greatest effect (of all variables investigated) on life satisfaction (Kinney & Coyle, 1992). In the current study, the level of leisure satisfaction was relatively low. Given that leisure satisfaction is presumed to be an important aspect of human life due to its positive relationship with life satisfaction (Brown & Frankel, 1993; Nimrod, 2007; Wang *et al*., 2008), efforts should be made to increase the leisure satisfaction of people with disabilities.

Increased leisure satisfaction is presumed to encourage people with disabilities to participate more in leisure activities, which are subsequently expected to have a positive effect on leisure satisfaction and, ultimately, life satisfaction. The planning and arrangement of recreational services specifically for people with disabilities and other groups that are at a disadvantage in terms of leisure participation is likely to encourage their ability to cope with leisure constraints and increase their leisure satisfaction. Policymakers and practitioners in this area should not see the impairments of these individuals as constraining their participation in leisure activities. Instead, they should focus on constraints resulting from the inappropriate designation of leisure environments and services for people with disabilities. Ideally, people with disabilities should receive leisure services in a safe and relaxing environment. To maximise social inclusion, services for people with disabilities should be provided in contexts that also include people without disabilities, whenever possible. Improvements should be made to ensure physical access, and staff members working in the leisure services should be educated with regard to the needs of people with disabilities.

Future research should devote greater attention to evaluating the leisure experiences of people with disabilities, and scales should be developed specifically to measure their evaluations of leisure experiences. Finally, the definition of leisure as „free time" might be less applicable for people with disabilities, as the „freedom" of their time is likely to be limited by the fact that they sometimes need help and care from others. The integration of leisure studies and disability studies could, therefore, help to develop a more accurate representation of the actual leisure participation of people with disabilities.

As a last remark, it is important to note that the results reported here refer to people with disabilities who were working full-time. It is possible that their experiences could differ from those of people with disabilities who are either unemployed or working only part-time. For this reason, and because of other context-specific factors, caution is advised when generalising these results to other populations.

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USING COLLECTIVE METRICS TO INSPECT SPATIO-TEMPORAL RELATIONSHIPS BETWEEN FOOTBALL PLAYERS

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ABSTRACT

The aim of this study was to analyse the influence of score status on the spatio-temporal relationships between team mates. Four collective metrics (weighted Centroid, weighted Stretch Index, Surface Area and Effective Area of Play) were computed based on the location of the players at each second of a match. Three matches of a team were analysed and 9218 position instants of 22 players and the ball were collected. Statistically significant differences with small effects were discovered in three possible scores in all dependent variables: Weighted Centroid y ($F_{(2,\ 9215)}$=236.627; p<0.001; η^2=0.049; Power=1.00); Weighted Centroid x ($F_{(2,\ 9215)}$=126.985; p<0.001; η^2=0.027; Power=1.00); weighted stretch index ($F_{(2,\ 9215)}$=190.005; p<0.001; η^2=0.040; Power=1.00); Surface Area ($F_{(2,\ 9215)}$=322.809; p<0.001; η^2=0.065; Power=1.00); and Effective Area of Play ($F_{(2,\ 9215)}$=139.352; p<0.001; η^2=0.029; Power=1.00). The present study showed that score status influenced the collective organisation. This is in line with previous findings which, after performing notational analysis, suggest that a team's strategies are also influenced by the score status.

Key words: Collective behaviour; Match analysis; Metrics; Football Tactics.

INTRODUCTION

Special attention has been given to the analysis of collective behaviour in team sport in recent years (Duarte *et al*., 2012). One explanation for this can be the holistic viewpoint on the complex behaviour supported by chaos theory and dynamical systems (Kauffmann, 1993; Kelso, 1995; Davids *et al*., 2005). In addition, recent advances in technology allow for a more thorough analysis of the information about the players' position on the field (Carling *et al*., 2008). This information makes is possible to develop and apply a set of individual and collective metrics which would improve the understanding about player, and thus, team behaviour. Until now several metrics have been proposed in order to build a systemic understanding about the collective behaviour of teams (Bourbousson *et al*., 2010b; Frencken *et al*., 2011). The main metrics proposed in the literature until now are: (a) Centroid (Yue *et al*., 2008); (b) Stretch Index (Bourbousson *et al*., 2010b; Moura *et al*., 2012); (c) Surface Area (Okihara *et al*., 2004; Frencken *et al*., 2011); (d) Effective Area of Play (Clemente *et al*., 2013); (e) Territorial Domain (Vilar *et al*., 2013); (f) Networks (Bourbousson *et al*., 2010a);

and (g) Dominant Region (Taki *et al*., 1996).

The complexity of team sports promotes a high interest in their comprehension. Thus, match analysis is one of the most important areas to have been improved recently in scientific sport fields in order to assist with improvement of team performance (Reilly & Gilbourne, 2003). Recently, the action range has been increasing from the individual notational analysis to the tactical analysis, crossing the kinematic analysis (Yue *et al*., 2008). Nevertheless, due to their technological complexity, the tactical and collective behaviours have been under explored until now (Passos *et al*., 2011). Thus, there remains much to explore and understand about the way collective behaviour influences sport performance.

In professional team sport the main objective is the final score. Thus, during the match many strategies are performed to achieve the best possible score. Strategies are different depending on the team's score status (losing, winning or drawing). Most teams usually have a higher attacking intensity during unfavourable events (drawing or losing), in order to reverse their score status. Nevertheless, the collective behaviour of the team has not been studied thoroughly enough based on the team's score status. The collective behaviour value variation should in fact be further examined in order to improve the understanding about a teams' interaction. Inspecting different behaviours in relation to the score status makes it possible to characterise the team's process, thus helping to improve the players' interaction within their own team or to explore the opposing team's weaknesses.

PURPOSE OF THE STUDY

The aim of this study was to analyse the team's collective behaviour in the three possible match scores (winning, drawing and losing), in order to identify the differences in the collective behaviour related to score status. Score status was defined as the period of time that a given team had one of three possible scores during the match, thus score status can change during the match. A professional football team from the official Portuguese first league championship was analysed during different home matches. Statistically significant differences were expected in the collective behaviour among the three different score statuses.

METHODOLOGY

Sample

Three home matches of a professional team were analysed. Each match had a different final score (winning, losing or drawing). Thus, 1 match was considered for each final score. Overall, 9218 instances of time were considered and obtained from the 3 matches. All of the collected data complies with the American Psychological Association ethical standards for treatment of human or animal subjects.

Data collected

The teams' actions were captured using a digital camera (*GoPro Hero* with 1280 x 960 resolution), with the capacity to process images at 30Hz (30 frames per second). The camera was placed on an elevated position above the ground (from 10m to the field lateral line and in an elevation of 15m) in order to capture the whole field. The field dimensions were 104 x 68m.

The field was calibrated using special markers allowing recognition of them on the images.

The first step in the collection of the data was to record the players' behaviour using the digital camera as described. The camera was placed facing the middle line of the field. Considering that this digital camera can record with 180º, it was possible not to move the digital camera, thus ensuring the same marker positions were captured on the digital image. The field was calibrated using 19 markers positioned on the referential field lines. These markers were metrically identified from point zero, which was the inferior vertex of the field (Figure 1).

***FIGURE 1*: INITIAL CALIBRATION TO EXTRACT THE DIRECT LINEAR TRANSFORMATION**

***TABLE 1*: POSITIONING OF MARKERS IN LONGITUDINAL AND LATERAL AXES FOR INITIAL CALIBRATION**

Space	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
x (m)	0	52	104	104	104	104	104	104	52	0
y (m)	0	0	0	13.9	30.4	37.9	54.4	68	68	68

Space	#11	#12	#13	#14	#15	#16	#17	#18	#19
x (m)	0	0	0	0	87.7	87.7	16.3	16.3	52
y (m)	54.4	37.9	30.4	13.9	13.9	54.4	54.4	13.9	34

x= Marker longitudinal axis (metres) y= Marker lateral axis (metres) #= Marker

After capturing the football match, the physical space was calibrated using Direct Linear Transformation (DLT), which transforms the elements' position (players and ball) in pixels to the metric space (Abdel-Aziz & Karara, 1971). This method consists of a proportional equivalence of virtual space on real physical space. This calibration is based on the identification of field markers (real coordinates) on virtual images (virtual coordinates) (Fernandes *et al*., 2010). This procedure was performed using the software MATLAB.

First, a calibration based on the first frame of each half of each match was performed. The initial calibration aimed to extract the DLT coefficients provided from 19 bi-dimensional markers on virtual space (pixels) for the real physical space (metres), following the correspondence between Figure 1 and Table 1.

A graphical interface allowing for the visualisation of 1 frame of the match per second was

developed. During each frame the operator was requested to identify the locations of all players and the ball following the typical approach point and click. That identification corresponded to 1 point in the centre of the player's feet. Each point on the virtual space (pixels) of the image was converted using an algorithm[1] based on the relationship between virtual coordinates and real coordinates defined by Figure 1 and Table 1.

In order to ensure that the reliability of such a conversion was defined, experimental tests with random points on the field collected previously were mapped with real coordinates and the space measured metrically. On the toolbox developed through MATLAB, those points and the results were identified to allow for the identification of the higher standard deviation that was 5cm in relation to the real coordinates. This border was considered viable to perform the study because it did not compromise the main goal of study, which was to identify the spatio-temporal relationship between players. For a detailed description of this tracking process (DLT) consult Woltring and Huiskes (1990).

For the purpose of efficiency, only play moments were used, that is all moments in which the ball was not in the field (ball out of play) were excluded from the analysis. The methodology herein proposed has a computational complexity inherent to it, meaning each second will correspond to each analysed instant.

Computing the tactical behaviour

Five collective metrics were computed for the match analysis: (a) Weighted Centroid; (b) Weighted Stretch Index; (c) Surface Area; and (d) Effective Area of Play. A summary explanation about each metric will be presented below.

Weighted Centroid (wC)

The Centroid is the geometric centre calculation of the team. The usefulness of the team's centroid may be the potential to compute the in-phase relation between the 2 opposing teams in longitudinal and lateral directions (Bourbousson *et al*., 2010b). Moreover, it can be a useful metric to analyse the equilibrium point of the team, with regards to their distribution.

[1] The script that allow the remapping of virtual coordinates in real coordinates having as input the DLT coefficients can be seen at http://isbweb.org/software/movanal/reconfu2.m

The Centroid calculation has been proposed without considering the ball and the player's proximity to it. Nevertheless, the proximity to the ball is an important indicator that should be considered. The approach of Clemente *et al*. (2013) was used, considering that the proximity of the players to the ball would assign different weights to the centroid position. The relevance of each player to the team's Centroid, w_i weight, was based on the Euclidean distance of each player to the ball,

$$\sqrt{(x - x)^2 + (y - y^{2}}$$

$$w_i = 1 -$$

$i \quad b \qquad i \quad b)$

d_{max}

(1)

where (x_b, y_b) corresponds to the position of the ball and d_{max} is the Euclidean distance of the farthest player to the ball at each iteration (Clemente *et al*., 2013).

Weighted Stretch Index (wSI):

The Stretch Index measures the space expansion or contraction of the team on the longitudinal and lateral directions (Boubousson *et al*., 2010a). The Stretch Index is measured based on the centroid position, thus it is the sum of each player's dispersion on both axes. Similarly to the team's Centroid, a Weighted Stretch Index metric for the team may then be calculated as (Clemente *et al*., 2013),

$$s_{ind} =$$

$\sum_{i=1}^{N}$ $\underline{\sum}$

$$\frac{w_i d_i}{w_i}$$

(2)

$i=1$

where d_i is the Euclidean distance between player i and the team's Centroid.

$$d_i = \sqrt{(x_i - \bar{x})^2 + (y_i - \bar{y})^2} \quad (3)$$

Within this context, the Stretch Index can be obtained by computing the mean of the distances between each player and the Centroid of the team.

Surface Area (SA)

The Surface Area is based on the calculation of the entire area covered and the sum of triangulations emerging from the match (Frencken *et al*., 2011). Therefore, the sum of emerging triangulations is the value of all possible triangular combinations of N players, in which N is the total number of players within a team (Clemente *et al*., 2013). In the particular case of football, a maximum of 11 players (for each team) could be on the field at the same time. Hence, all possible combinations of 3 out of 11 players, is a total of 165 cumulatively formed triangles (Clemente *et al*., 2013). Consequently, the sum and area of the triangulations are computed at every instant.

Effective Area of Play (EAP)

The Effective Area of Play metric is based on the Surface Area. It is one more parameter related to ball possession. This parameter is used to analyse the overlapping occurring between opposite triangulations. When a defensive triangulation has an area of more than 36m, the offensive triangulation will be considered instead of the defensive one (Clemente *et*

al., 2013). A greater amount of open space between the defensive players decreases the difficulty for the offensive players to overcome the opposition (Dooley & Titz, 2011).

Statistical procedures

The one-way ANOVA was used to analyse the statistically significant differences between teams with and without ball possession. The assumption of normality distribution of one-way ANOVA in the 2 conditions (with or without ball possession) was assessed using the correction of the Kolmogorov-Smirnov test by Lilliefors. Although the distributions are not normal in the dependent variable, (since n>30), and because of the use of the Central Limit Theorem, normality was assumed (Maroco, 2010). The analysis of homogeneity was carried out using the Levene test. It was found that there is no uniformity of practice under the previously mentioned conditions. However, despite the lack of homogeneity, the F-test (ANOVA) is robust to homogeneity violations when the number of observations in each group is equal or approximately equal (Pallant, 2011), which was the case in this study. The violation of the assumption of normality does not radically change the F-value (Pallant, 2011). The classification of the size effect (measure of the proportion of the total variation in the dependent variable explained by the independent variable), and the power of the test were done according to Hopkins *et al*. (1996). The statistical analyses were performed using IBM SPSS Statistics (version 21) with a significance level of 5%.

RESULTS

***TABLE 2*: DESCRIPTIVE STATISTICS FOR EACH DEPENDENT VARIABLE DURING THE SCORE STATUS**

Variables		**Mean**	**Std. Deviation**
Centroid *y*	Loss	37.31	10.32
	Draw	33.36	9.14
	Win	32.09	10.35
	Total	34.38	10.22
Centroid *x*	Loss	49.81	13.82
	Draw	47.77	13.54
	Win	44.25	14.20
	Total	47.39	14.04
Weighted Stretch Index [m]	Loss	15.85	3.76
	Draw	17.44	3.48
	Win	15.91	3.54
	Total	16.38	3.68
Surface Area [m^2]	Loss	14403.85	5707.70
	Draw	17356.31	5119.86
	Win	14401.03	4684.26
	Total	15350.38	5389.11
Effective Area of Play [m^2]	Loss	7445.19	6071.68
	Draw	9674.15	6634.92
	Win	7292.82	5837.39
	Total	8111.91	6278.68

The collective behaviour was examined considering the team's score status (Table 1). From this analysis it was possible to identify that teams increase their average longitudinal (*x*-axis) position when the score status is unfavourable. Moreover, when teams have a losing score, they increase their average lateral position (*y*-axis) turning to the left side of the field. The dispersion metrics (Stretch Index and Surface Area) increase their values during score status of drawing a match. A similar situation can be observed in the effective area metric.

The *one-way* ANOVA was performed to inspect the collective behaviour variance between the 3 different score statuses during the matches. Statistically significant differences with small effects were found between the 3 possible score statuses in all dependent variables:

Weighted Centroid *y* ($F_{(2, 9215)}$=236.627; p<0.001; η^2=0.049; Power=1.00);
Weighted Centroid *x* ($F_{(2, 9215)}$=126.985; p<0.001; η^2=0.027; Power=1.00);
Weighted Stretch Index ($F_{(2, 9215)}$=190.005; p<0.001; η^2=0.040; Power=1.00);
Surface Area ($F_{(2, 9215)}$=322.809; p< 0.001; η^2=0.065; Power=1.00); and Effective Area of Play ($F_{(2, 9215)}$=139.352; p<0.001; η^2=0.029; Power=1.00).

In order to inspect the differences between the 3 possible score statuses, the Tukey's HD post hoc test was applied (Table 3).

***TABLE 3*: MEAN DIFFERENCE BETWEEN THREE SCORE STATUSES FOR ALL DEPENDENT VARIABLES**

Dependent variables	Match	Losing	Drawing	Winning
Centroid *y*	Losing	-	3.946*	5.221*
	Drawing		-	1.275*
	Winning			-
Centroid *x*	Losing	-	2.035*	5.555*
	Drawing		-	3.520*
	Winning			-
Weighted Stretch Index	Losing	-	–1.594*	–0.057
	Drawing		-	1.537*
	Winning			-
Surface Area	Losing	-	–2952.469*	2.810
	Drawing		-	2955.279*
	Winning			-
Effective Area of Play	Losing	-	–2228.956*	152.369
	Drawing		-	2381.325*
	Winning			-

*Mean difference is significant at the 0.01 level

It can be observed that only between the losing and winning statuses no differences for the Weighted Stretch Index, Surface Area and Effective Area of Play metrics were detected. For all remaining situations there were statistically significant differences.

DISCUSSION

The importance of the synchronisation among players is unquestionable (Travassos *et al*., 2012). This inter-player relationship should be analysed in order to understand if it really depends on the score status. The inter-player relationships in football follow some fundamental rules that are general for all teams (Gréhaigne *et al*., 2005). They are usually depicted as fundamental tactical principles of play (Costa *et al*., 2010). Despite these natural and useful principles, several changes become evident in the team's organisation during the game. The score status of a team is usually one of the main factors for increasing the emergence of new organisations and collective adjustments. Therefore, four collective metrics were applied during three different matches of a team where the score status varied during the match.

The Weighted Centroid metric was applied to measure the team's central point in the course of the match. In previous studies it was observed that the centroids of both teams are in-phase (synchronised) during the majority of the match, mainly on the longitudinal axis (Bourbousson *et al*., 2010b). It was also found that the majority of goals scored in open play resulted from an imbalance in the centroids, where the attacking team's Centroid overcame the opponent defensive team (Bourbousson *et al*., 2010b; Bartlett *et al*., 2012). In the present study the Weighted Centroid on the longitudinal axis was closer to the opponent's goal in the moments of disadvantage in the score (losing and drawing). This collective adjustment was statistically significant. This can be explained by the team's strategy to increase the opportunities to score (Bate, 1988). Thus, players increased their dispersion on the field with a higher frequency in order to invert the unfavourable situation. This advance in the field can be related to more ball possession and continuous attacks in order to increase the chance of scoring (Bate, 1988). In fact, previous studies suggested that there is a connection between the losing status and the increase in ball possession (Lago, 2009).

A significant decrease in the centroid location was observed during the winning status. These results are related to the strategy of the team to reduce their defensive pressure to the first third of the field in order to protect their own goal and revert to the disadvantage against the opponent's pressure to score. Thus, players in advantage opted to protect their goal, thus increasing the number of defensive players and at the same time they also tried to counter-attack in order to interrupt the opponent's advance (Lago, 2009). This strategy makes it possible to explore the possible ways to unbalance the opponent in the transition phase (the moment the opponent loses ball possession). This kind of behaviour was observed in previous studies which identified that ball possession was greater in the losing moments than it was in the winning ones (Lago-Peñas & Dellal, 2010).

Regarding the Weighted Centroid y, statistically significant differences depending on the score status were found. When a team is losing the match, they direct their exploration to the left side of the field, approaching the wing and away from the centre of the field. This can be associated with a greater tendency to attack continuously. During offensive playtime one of the most important tactical principles is to explore the width and length of the field (Costa *et al*., 2010). Therefore, it is expected that when a team increases their continued attack they mainly explore from the wings. On the other hand, a team reduces its distribution on the field during winning status, trying to explore more ways to counter-attack (Lago, 2009). This

option reduces the exploitation of the field wings, thus maintaining a higher centralisation on the field. This is logical since the direct play style and counter-attack explore more the central zone and the space behind opponent defenders.

Despite the important information obtained from the Weighted Centroid, it is not possible to fully understand the way players cover the field and move away from the team's central point (Clemente *et al*., 2013). Therefore, the Weighted Stretch Index and Surface Area are used to provide information about players' dispersion (Bourbousson *et al*., 2010b). It was possible to establish that the dispersion was significantly higher during the drawing status. Moreover, no significant differences were observed between losing and winning moments. Both observations can be discussed and implemented in the team's strategy in order to improve their approach to obtaining the main goal. During the winning and losing moments there are two different kinds of defensive and offensive strategies.

For instance, while losing, a team tries to increase their ball possession, thus increasing their dispersion on the field in order to come closer to the opponent's goal (Lago, 2009). Their defensive pressure is higher in order to recover the ball as soon as possible so as to counter the disadvantage and build offensive plays. While winning, a team tries to protect their own goal by increasing the number of players in defensive positions and counter-attacking with a smaller number of players, thus ensuring the compactness of the defensive moments (Clemente *et al*., 2012). In both cases (losing and winning moments), the teams exhibit a great compactness. This compactness results from the small distance between team mates, therefore, their dispersion is lower than in drawing moments. During drawing moments a team tries to retain the defensive security while attempting to score a goal to win the game. Therefore, a team's compactness is lower due to the necessity of exploring the offensive moments by width and length. In defensive moments a team may disperse more due to the need to cover wide spaces in order to counter the opponent's exploration, except for the forward players who need to maintain their position for continued attacks.

The team mates' triangulations were analysed considering the Effective Area of Play metric (Clemente *et al*., 2013). The importance of these triangulations lies in that they secure the support in both offensive and defensive moments. In defensive moments the triangulation is generated based on the proximity between team mates. This closeness decreases the opponent team's opportunity to penetrate their defence (Trapattoni, 1999). In offensive moments, triangulations secure certain attacking strategies by providing support to the player with ball possession (Dooley & Titz, 2011). Similar to dispersion metrics, Effective Area of Play is significantly higher during drawing moments. This metric has a high positive correlation with both Weighted Stretch Index and Surface Area (Clemente *et al*., 2013), thus these results are in line with previous findings. In defensive moments, the effective triangulation is determined by the proximity between team mates. Therefore, the compactness formed during the losing and winning statuses decreases the effective area covered. Regarding the drawing status, the width and length are better explored, thus increasing the triangulations area in defensive and offensive moments.

Using collective metrics made it possible to understand the importance of score status in order to change teams' strategy and organisation. The collective adjustment depends on many factors, however, mainly on the score status (Lago-Peñas & Dellal, 2010). Different relationships between team mates were observed depending on the score status, thus suggesting the existence of changes in team mates' synchronisation during the match. These findings may have important practical implementations in football match analysis. For instance, a team's properties can be detected by observing certain changes in the team's Centroid, dispersion values and triangulations formed during the match. These observations can be used by coaches to improve the synchronisation of team mates by adjusting certain relationships. At the same time, the opponent coach can detect certain weak and strong points about the spatio-temporal relationships of the other team's players, hence taking advantage of this information for the benefit of his or her team.

This study would be improved by using some notational information, such as the ball possession, shots performed or the type of passes used in each score status. This information could promote the discussion, complementing some players' spatio-temporal relationships analysed from the collective metrics. The present study showed that score status influences collective organisation. This is in line with previous findings where the use of notational analysis suggested that a team's strategies are influenced by score status, thus changing a team's play style during the match (Jones *et al*., 2004; Bloomfield *et al*., 2005; Lago & Martín, 2007). In further studies the information obtained from the collective metrics and notational analysis should be used to increase the team's understanding process and improve the football match analysis.

CONCLUSION

The interrelationships among football team mates depend on many contextual factors. One of the most important is the score status during the match. Therefore, the spatio-temporal relationships between team mates were analysed in three possible score statuses. The results showed that the losing status increased the longitudinal dispersion of the players in the field in order to advance towards the opponent's goal. The losing status reduced the space between team mates, thus increasing the compactness. The winning status significantly reduced the central point of the team, thus keeping it closer to the team's own goal. During the winning

moments, a team's compactness was similar to the one exhibited during the losing status. During the drawing moments the dispersion of team mates in the field was higher. Different score statuses constrain the collective behaviour, thus becoming an indicator for some adjustments in the team's organisation.

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A NEW APPROACH TO THE STUDY OF GOLF PUTTING

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ABSTRACT

The aim of this study was to apply non-linear techniques in the analysis of golf putting performance. How players adapt to the variability that emerges from the putting execution and how they self-organize their performance toward the task constraints was investigated. The sample consisted of 10 adult male golfers (33.80±11.89 years) who were volunteers, right-handed and experts (10.82±5.40 handicap), including the European champion of pitch and putting (season 2012/2013). The putting movement was analysed using auto tracking methodologies by autonomously comparing the current frame with the previous frame using a MatLab software program. The results indicated that golf putting performance can be described as a non-linear, stable and regular system in which each player discovers active solutions to overcome the constraints of the task. It was concluded that non-linear techniques, like approximate entropy and Lyapunov exponent are extremely useful for analysing human movement within a sport context.

Key words: Non-linearity; Variability; Golf putting; Motor control; Performance.

INTRODUCTION

The human body is seen as a non-linear system that is exposed to the instability and disturbances the environment offers (Araújo *et al*., 2004). In this sense, while non-linear systems perform continuous energy exchanges with their surroundings and use that same energy to self-organise, closed systems maintain their characteristics unchangeable and exchange nothing with their environment (Davids *et al*., 2008; Harbourne & Stergiou, 2009).

Non-linear techniques have been used in the field of human motor behaviour to explain the intrinsic variability of biological systems[1]. These techniques provide qualitative information on the tendency of the motor system by viewing different patterns of response. Unlike cognitive theories that support traditional motor control models, which consider variability to

[1] For a more detailed description refer to Harbourne and Stergiou (2009).

be a negative factor for learning, the non-linear perspective shows that 'noise'[2] and 'chaos' are necessary to establish new coordinative patterns (Stergiou *et al*., 2004; Harbourne & Stergiou, 2009).

To describe the variability of human motor behaviour in the context of sport performance, it has been established that non-linear techniques, such as the approximate entropy and Lyapunov exponent, allow unravelling of the structure of a mathematical representation of a given sport movement, like golf putting. In spite of non-linear techniques quantifying the motor performance of athletes through the mean, standard deviation and coefficient of variation, they take in consideration the individual characteristics of players and are mostly based upon statistical effects to characterise the learning and training of motor skills (Stergiou *et al*., 2004).

Faced with such arguments, it seems that the problem of 'individuality' in sport is not confined to ideal, linear or standardised techniques. In fact, it has to do with the implementation of a wide variety of exercises that contribute to the self-organisation of the motor system. As a result, similar to other researchers, human movement is seen as a non- linear system capable of producing solutions to solve motor problems (Schöllhorn *et al*., 2008).

With regards to golf skills, which support the main goal of this work, no study is known, where non-linear techniques are used to analyse this sport. Such confirmation deserves special attention and in-depth research, since each golf player has different morphological and functional characteristics that represent a determined performance profile, 'signature' or 'digital fingerprint' (Pelz, 2000; Couceiro *et al*., 2013; Dias *et al*., 2013). In that sense, it seems difficult to study the variability that characterises the motor performance of golfers in putting performance, based only upon traditional statistical results (mean, standard deviation and coefficient of variation), as is common procedure in most studies that have analysed this movement in laboratory context, as well as in training and competition (Schöllhorn *et al*., 2008).

The Professional Golf Association (PGA Tour) shows that golf putting[3] represents almost 40% of the total amount of strikes performed during a game (Pelz, 2000; Alexander & Kern, 2005; Dias *et al*., *in press*). However, there is no reference in the literature to an analysis of golf putting from the perspective of non-linear techniques (approximate entropy and Lyapunov exponent). This has motivated the scope of this research around golf putting which, although described as a simple motor execution movement, is quite complex and comprises of many variables.

[2] 'Noise' is considered as random fluctuations that incorporate a certain spectrum of action. Thus, several types of noise are well known in the literature (pink, white, brown and black). The pink noise is related to the study of the human heart rate while the white noise can be measured on electromyography signals (Stergiou *et al*., 2004).
[3]Short shot carried out in the green (Pelz, 2000).

PURPOSE OF THE STUDY

Considering that non-linear techniques allow for the tracking of the motor system in different behaviour patterns (regularity, stability, complexity or chaoticity), the present study aims to apply these techniques to the analysis of golf putting and, consequently, describe the performance of expert players. In order to do so, this study has as basis the studies conducted by Pincus *et al*. (1991), Stergiou *et al*. (2004) and Harbourne and Stergiou (2009), which show that approximate entropy and Lyapunov exponent are robust tools to analyse human movement within a sports context.

METHODOLOGY

Participants

Ten male golfers (age: 33.8±11.89) were tested over 3 experimental studies and they were volunteers, right-handed and experts (10.82±4.05 *handicap*), which included the European champion of *pitch* and *putting* (season 2012/2013). All participants signed a university-approved ethical consent form. All tests were conducted in accordance with the ethical guidelines established by the University of Coimbra, Portugal.

Task and apparatus

The participants executed the task on an indoor rectangular green carpet, replicating a fast putting surface able to provide a ball speed up to 10m/s. The carpet was 10m long and 2m wide with a thickness of 4mm (Dias *et al*., 2014). Four circles, the size of a golf ball, were drawn on the carpet to point the exact location for the execution of the putting trials, 1, 2, 3 and 4 metres away from the hole. For the second and third studies, a slope, where its legs measured respectively 1m and 100mm, was placed beneath the carpet. In that sense, the golf slope gradient was 20%. A platform with a length of 4m was placed attached to the slope. Finally, 2 circles were drawn on the left and right side of the carpet at 25° in relation to the hole (Figure 1).

Data recording

To perform this study, a digital Casio Exilim/High Speed EX-FH25 camera was used. It was shooting at 210fps (frames per second) with a resolution of 480x360 pixels and a focal length of 26mm. The digital camera was placed 550mm above the ground heading forward and 4m away from the experimental device, in front of the subject. As the digital camera's lens provides a considerable depth of field, a reference in the same plane of the analysed movement was necessary in order to perform the conversion to m/sec. This reference was the putt's metallic part length of 585mm. Note that this introduces some minor errors due to the declination angle of the putter that varies from player to player.

However, and since the motion of the putter's head is always confined to the same distance from the camera (defined by the ball's position), one can reduce the calibration inaccuracy.

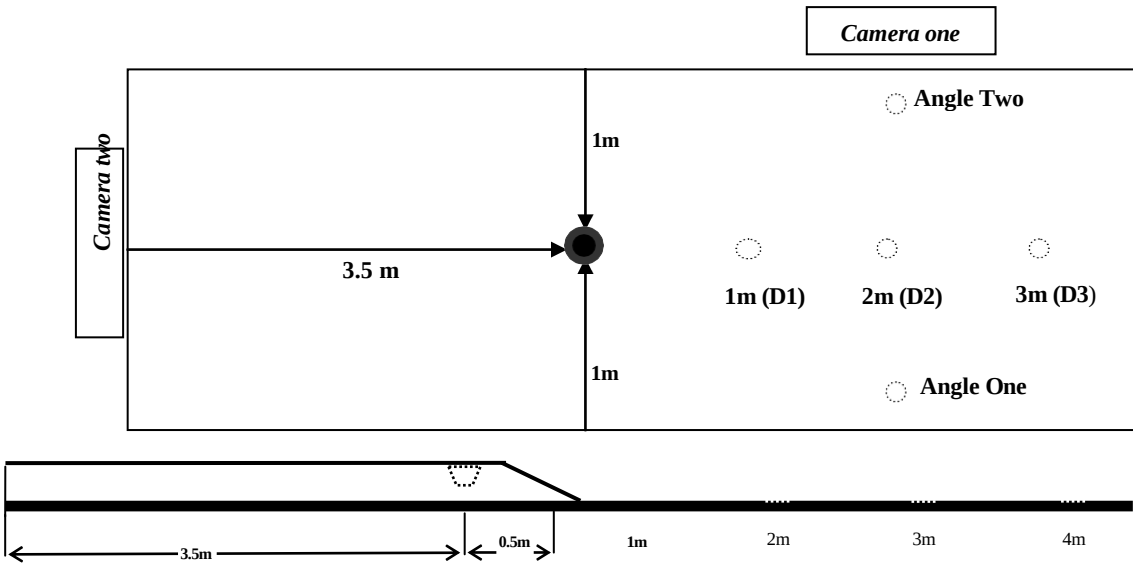


***FIGURE 1*: TOP AND SIDE VIEWS OF THE EXPERIMENTAL APPARATUS**

For a more detailed approach about the calibration and acquisition method, please refer to Dias *et al*. (2013) and Couceiro *et al*. (2013). Digital camera recordings provide information about golf putting movements in distinct stages: 1) *back swing*; 2) *down swing*; 3) *ball impact*; and 4) *follow-through*. The putting movement was analysed using auto tracking methodologies by autonomously comparing the current frame with the previous frame using a MatLab script (Couceiro *et al*., 2013; Dias *et al*., 2013).

Procedures

The following procedures were followed for studies one, two and three. All the experiments were performed in the same set-up (Figure 1).

1. In Study One, 4 circles were drawn to identify the spots where the ball should be at the beginning of the trials. The circles were aligned with the centre of the hole, 1m away from each lateral extremity of the device (centred).
2. In Study Two, the same experimental device from Study One was used, but a 1m long ramp (slope) was placed under the carpet to elevate the surface by 100mm. This ramp made the ball rise to the level of the hole entrance. Next to the ramp, there was a 4m long and 2m wide platform that worked as a source of additional variability of 'noise' in the

performance of a task.

3. In Study Three, the same experimental device from the 2 previous studies were used, and players carried out the putting 2m away, in an ascending trajectory with a 25º angle on the left side of the centre of the hole. Subsequently, the players carried out the putting with the same 25º angle, but on right side of the centre of the hole.
4. For the first practice condition, 30 trials were carried out at each distance of 1, 2, 3 and 4 metres from the hole in a no-slope condition (total of 120 trials). In the second practice condition, the participants performed 30 putts at a distance of 2, 3 and 4 metres from the hole under a slope constraint (total of 90 trials). Finally, the players performed 30 putts at a distance of 2m with 25° to the left of the hole (Angle 1) and 30 putts at a distance of 2m with 25° to the right of the hole (Angle 2), with a constraint imposed by a slope (total of 60 trials).

Detection algorithm

The methodology used to detect players' movements, as well as the data analysis techniques is described in this section. As it was a controlled environment, a simple colour detection algorithm, described in Figure 2, was used in order to detect the putter's head through the red marker according to the RGB (Red-Green-Blue components) range values defined (Couceiro *et al.*, 2013). The digital cameras' lenses provided a considerable depth of field, a reference on the same plane of the analysed movement. Such procedure was necessary to perform the conversion to m/sec. (Dias *et al.*, 2013).

The grey dots in the chart presented in Figure 3 represent an example of a point cloud that represents the detected position, in the horizontal plane, of a golf club during putting execution. Figure 3 shows that the detection algorithm's output have some missing data. This happens when the algorithm is unable to accurately identify the red colour of the marker. In such cases, the detection is skipped in the corresponding time instant to avoid the introduction of errors.

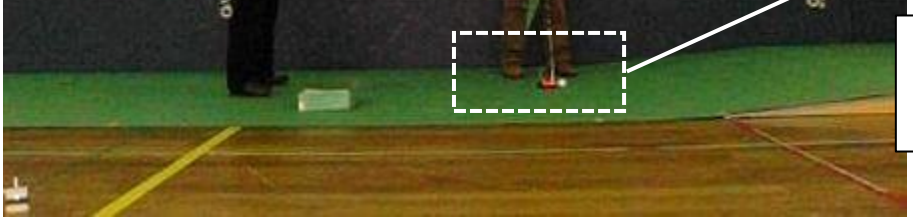


***FIGURE 2*:EXAMPLE OF A REGISTERED SCENE AND RANGE OF COLOUR INTENSITIES TRIGGERING THE DETECTION ALGORITHM** (adapted from Couceiro *et al*., 2013)

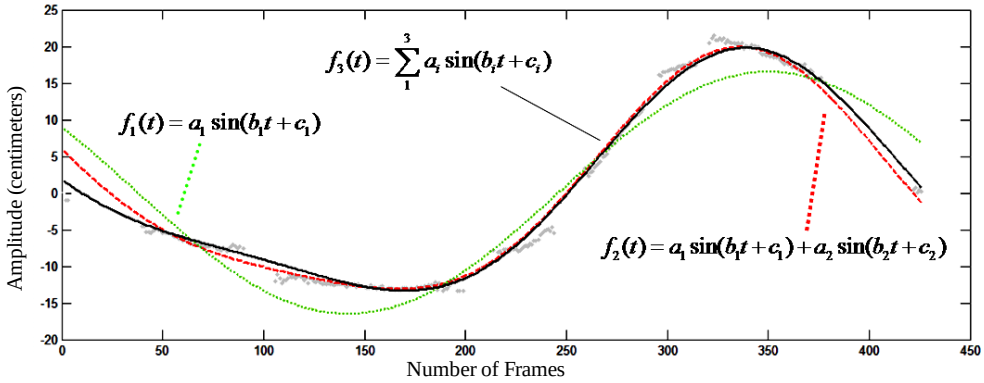


***FIGURE 3*: FITTING SINUSOIDAL FUNCTIONS TO POINT CLOUD REPRESENTS POSITION OF GOLF CLUB DURING PUTTING EXECUTION** (one trial) (adapted from Couceiro *et al*., 2013).

In order to classify the point cloud, linear and non-linear estimation techniques were studied to fit the acquired points of the cloud to a sinusoidal function, thus obtaining a mathematical model to describe the putter's position during the execution of the play. In the next section, the Particle Swarm Optimization (PSO) (Kennedy & Eberhart, 1995) and Darwinian Particle Swarm Optimization (DPSO) estimation techniques are discussed (Tillett *et al*., 2005).

Estimation algorithms

From the analysis of the shape of various point clouds given by the detection algorithm, it was clear that to model the putter's horizontal position in time, a sinusoidal-like function should be used (Figure 3). Nevertheless, a function composed of only 1 sinusoid was not precise enough to describe the movement, as it is clear in function f_1 of Figure 3, which in this case resulted in a mean squared error (MSE) of 2.6568 units. This is due to the amplitude, angular frequency and phase of the descending half-wave corresponding to the player's back swing and down swing, which is usually different than the ascending half-wave, which corresponds to the ball's impact and follow-through (Couceiro *et al*., 2013).

These disparities could not be represented using solely 1 sinusoidal wave. Hence, to obtain a more precise model a sum of sinusoidal waves was used. A compromise between precision and complexity of the problem had to be assumed, as each sinusoid adds 3 more dimensions to the estimation problem. These dimensions are amplitude, angular frequency and phase of the corresponding sine wave. In order not to let the complexity of the problem grow, a function composed of the sum of 3 sinusoids was used (function f_3 of Figure 3), due to its precision, with a MSE of 0.6926, when compared to using solely a sum of 2 sinusoids, with a MSE of 0.7124 (function f_2 of Figure 3). Although this may be considered a small difference for this particular case, in the course of the several trials function f_3 presented highly accurate

and more stable results than function f_2, without significantly increasing the computation complexity of the model.

The following mathematical model was used to represent golf putting (Couceiro *et al.*, 2013):

$$f(t) = a_1 sin(b_1 t + c_1) + a_2 sin(b_2 t + c_2) + a_3 sin(b_3 t + c_3) \quad (1)$$

Having the estimation function defined as a sum of 3 sine waves, each of the 3 parameters of each wave needs to be estimated, resulting in a 9-dimension estimation problem, which attempts to minimise the mean squared estimation error for every experiment in order to obtain a precise function that describes the horizontal position of the golf club during putting execution.

The *Darwinian Particle Swarm Optimization* (DPSO), first introduced by Tillett *et al*. (2005) and further evaluated in Couceiro *et al*. (2013) in the golf game context, was used. The DPSO extends the original *Particle Swarm Optimization* (PSO) presented by Kennedy and Eberhart (1995), to determine if natural selection (Darwinian principle of survival of the fittest) can enhance the ability to escape from local optima. The aim is to run many simultaneous parallel PSO algorithms, each one a different swarm, on the same test problem and a simple selection mechanism is applied. When a search tends to be a local optimum, the search in that area is simply discarded and another area is searched instead (Couceiro *et al*., 2013; Dias *et al*., 2013).

Data pre-processing

After obtaining the parameters of the mathematical model of each trial, it was necessary to generate a single model representing the planar trajectory of the putting over time in all the trials carried out. It would then be possible to numerically calculate the metrics of the non-linear analysis temporally by concatenating the putting trajectory of trials *T* (Figure 3) carried out in a practice condition (Figure 4).

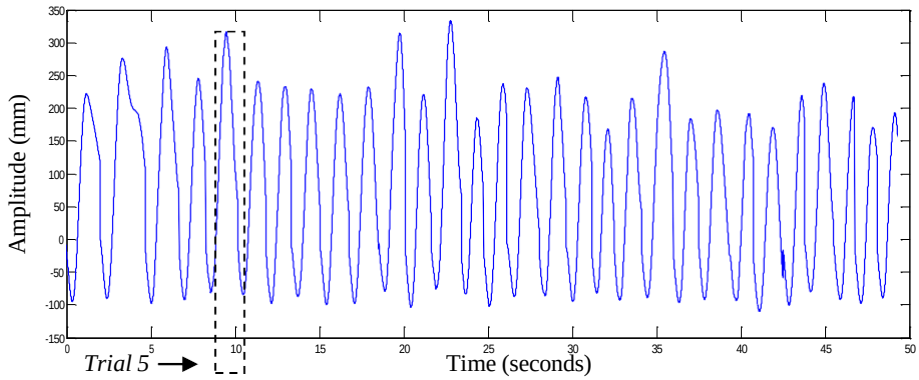


***FIGURE 4*: EXAMPLE OF THE CONCATENATION OF 30 TRIALS**

This mathematical model represents the time series characteristic of a player's movement in a determined practice condition. In the case represented in Figure 4, it is possible to confirm that the player presents some variability at the level of putting execution (the amplitude and duration of the movement diverge throughout the series). The representation between the golf

stick position at each instant and speed was used to better observe the movement (Figure 5).

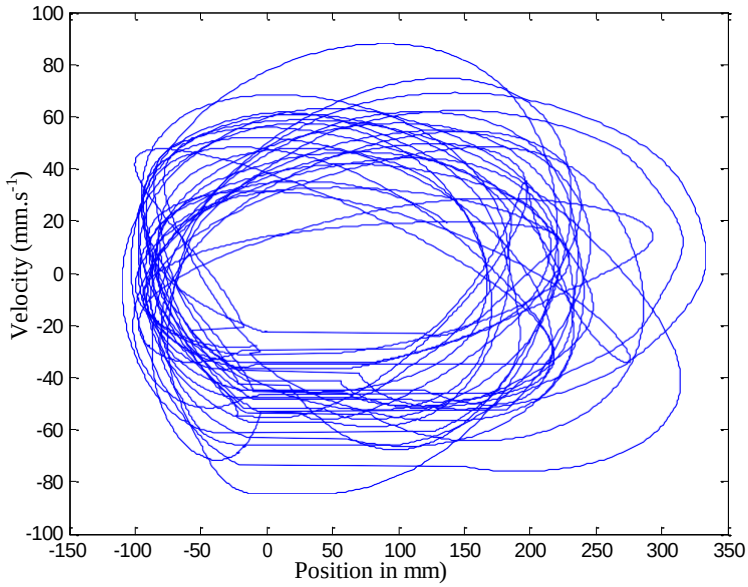


***FIGURE 5*: ATTRACTOR RESULTING FROM STRING CONCATENATION OF 30 TRIALS**

Figure 5 confirms that the movement is placed between the periodic (circular image around a point) and the chaotic (distortion in amplitude and shape of the image). However, it is difficult to quantify the variability of the player. Using non-linear methods that allow for the characterisation of the variability of the player in a determined practice condition becomes important (Harbourne & Stergiou, 2009).

Non-linear methods

Both the approximate entropy and the largest Lyapunov exponent will be used to further understand the variability of golf players. Throughout the years, several different methods were proposed to calculate both the approximate entropy and the largest Lyapunov exponent (Stergiou *et al*., 2004). The next sections present the chosen approaches based on a preliminary assessment of the related work applied to human movement.

Approximate entropy

Pincus *et al*. (1991) described the techniques for estimating the Kolmogorov entropy of a process represented by a time series and the related statistics approximate entropy. In this sense, consider that the whole data of the T trials is represented by a time-series as $u(1), u(2), \dots, u(N) \epsilon \mathbb{R}$, from measurements equally spaced in time, which form a sequence of vectors $x(1), x(2), \dots, x(N-m+1) \in \mathbb{R}^{1\times m}$, defined by:

$$x(i) = [u(i) \quad u(i+1) \quad \cdots \quad u(i+m-1)] \in \mathbb{R}^{1\times m}.$$

The parameters *N*, *m* and *r* must be fixed for each calculation. *N* is the length of the time series (number of data points of the whole series), *m* is the length of sequences to be compared and *r* is the tolerance for accepting matches. One can define:

$$C_i^m(r) = \frac{number\ \ of\ j\ such\ that \leq r}{N-m+1}, \quad (2)$$

for $1 \leq i \leq N - m + 1$. Defining $d(x(i), x(j))$ for vectors $x(i)$ and $x(j)$, and based on the work of Takens (1983), it results in:

$$d(x(i), x(j)) = \max_{k=1,2,\ldots,m} [|u(i + k - 1) - u(j + k - 1)|]. \quad (3)$$

From the $C_i^m(r)$, it is possible to define:

$$C^m(r) = (N - m + 1)^{-1} \sum^{N-m+1} C^m(r), \quad (4)$$

i

and

$i=1$ i

$\ln C^m(r)$

$$\beta_m = \lim_{n\to 0\ N\to\infty} \frac{i}{\ln r}. \quad (5)$$

The assertion is that for a sufficiently large m, β_m is the correlation dimension. Such a limiting slope has been shown to exist for the commonly studied chaotic attractors. This procedure has frequently been applied to experimental data. Researchers seek a 'scaling range' of *r* values for which $\frac{\ln C^m}{\ln r}$ is nearly constant for large m, and they infer that this ratio is the correlation dimension (Grassberger & Procaccia, 1983). Some researchers have concluded that this procedure establishes deterministic chaos (Pincus *et al*., 1991; Pincus & Singer, 1998; Stergiou *et al*., 2004).

The following relation is defined:

$$\phi^m(r) = (N - m + 1)^{-1} \sum_{i=1}^{N-m+1} \ln C_i^m(r). \quad (6)$$

One can define the approximate entropy as:

$$ApEn(m, r, N) = \Phi^m(r) - \Phi^{m+1}(r) \quad (7)$$

On the basis of calculations that included the theoretical analysis performed by Pincus *et al*. (1991), a preliminary estimate showed that choices of *r* ranging from 0.1 to 0.2 of the standard deviation of the data would produce reasonable statistical validity of $ApEn(m, r, N)$. As a consequence, values of approximate entropy close to zero characterise a periodical signal/system of high regularity, low variability and little complexity. Following this line of thought, values of approximate entropy equal to or above 1.5, qualify as a signal/system of high variability, low complexity and little regularity (Pincus *et al*., 1991; Pincus & Singer, 1998; Harbourne & Stergiou, 2009).

Lyapunov exponent

Using the Lyapunov exponent, it is possible to quantify the sensitivity of initial conditions of dynamical systems. Within the golf context, the spectrum of Lyapunov exponent can classify the divergence of putting trajectories. This concept relates to the spectrum of Lyapunov

exponent by considering a small n dimensional sphere of initial conditions, in which n^n is the number of equations used to describe the system (Rosenstein *et al*., 1993). The Lyapunov exponent may be arranged so that:

$$\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_n, \quad (8)$$

where λ_1 to λ_n correspond to the most rapidly expanding and contracting principal axes, respectively. Hence, one needs to recognise that the length of the first principal axis is proportional to $e^{\lambda_1 t}$, so that the area determined by the first 2 principal axes is proportional to $e^{(\lambda_1+\lambda_2)t}$ and the volume determined by the first k principal axes is proportional to $e^{(\lambda_1+\lambda_2+\cdots+\lambda_k)t}$. Therefore, the Lyapunov spectrum can be defined so that the exponential growth of a k-volume element is given by the sum of the k largest Lyapunov exponents. The largest Lyapunov exponent can then be defined by using the following equation, where $d(t)$

is the average divergence at time t and C is a constant that normalises the initial separation:

$$d(t) = Ce^{\lambda 1 t}. \quad (9)$$

In order to improve the convergence (with respect to i), Sato *et al.* (1987) proposed the following equation:

$$\lambda\ (i,k) = \quad 1 \quad \cdot \quad 1$$

$$\sum^{M-k} \ln(d_j\,(i+k)), \qquad (10)$$

$$\frac{1}{k\cdot\Delta t}$$

$\overline{M-k}$

$j=1$

$d_j\,(i)$

where M is the number of axes being analysed. The golf putt can be described by analysing only the horizontal axis, *x*-axis, $M = 1$. From the definition of λ_1 given in equation (10), we assume that the j^{th} pair of nearest neighbours diverges approximately at a rate given by the largest Lyapunov exponent:

$$d_j\,(i) \approx C_j\, e^{\lambda 1 (i \cdot \Delta t)}, \tag{11}$$

where C_j is the initial separation.

By taking the logarithm of both sides of Equation (12) the following is obtained:

$$\ln d_j\,(i) \approx \ln C_j + \lambda_1 (i \cdot \Delta t). \tag{12}$$

Equation (13) represents a set of approximately parallel lines (for $j = 1,2, \ldots, M$), each with a slope roughly proportional to λ_1. The largest Lyapunov exponent is easily and accurately calculated by using a least-squares fitting to the 'average' line defined by:

$$y(i) = \frac{1}{\Delta t\ \langle \ln d_j\,(i) \rangle}, \tag{13}$$

where $\langle ln\ d_j\ (i) \rangle$ denotes the average of $ln\ d_j\ (i)$ over all values of j. This process of averaging is the key to calculating accurate values of λ_1 using small, noisy data sets.

The calculus of the largest Lyapunov exponent included the values obtained in the study by Harbourne and Stergiou (2009). In this sense, values close or inferior to zero (0) characterise

a periodic signal/system with high periodicity and regularity. On the other hand, values close to 0.1 qualify chaotic signals/systems with high variability and complexity, where values equal to or above 0.4 characterise a system with low regularity and high variability.

Although being evaluated in the golf putting context, by applying the proposed methodology one can characterise any type of human movement in terms of regularity and stability. As such, this methodology can be used to assess the performance of an individual, by comparing it with the typical expected outcome provided by the approximate entropy and Lyapunov exponents. Moreover, as these measures allow classifying the chaos of a given human process, it may shed some light into a closer relationship between process and product variables.

RESULTS

This section presents the applicability of the previously presented non-linear methods after the detection, estimation and pre-processing steps.

Approximate entropy

Table 1 presents the average of approximate entropy for the motor execution of the putting of each player in the 3 studies.

***TABLE 1*: AVERAGE OF APPROXIMATE ENTROPY FOR MOTOR EXECUTION**

OF PUTTING OF EACH PLAYER IN THREE STUDIES

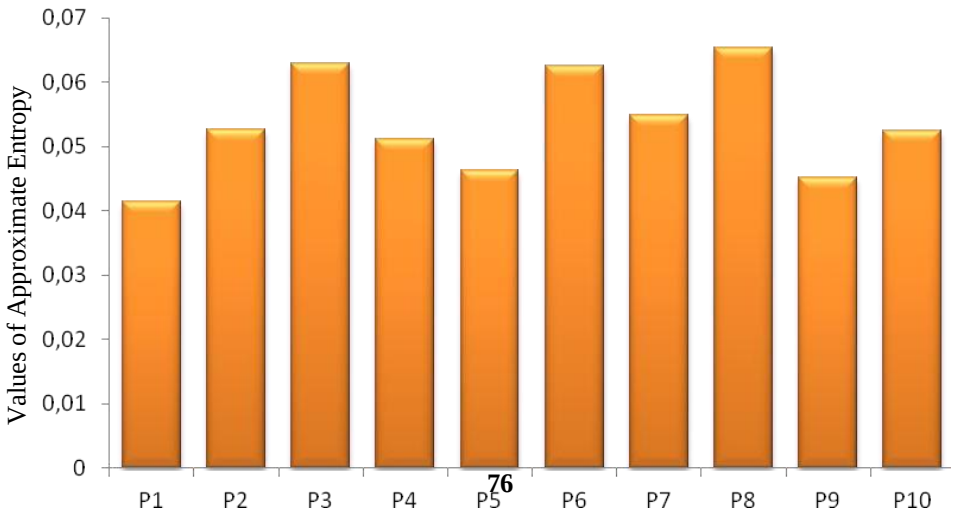
	Var	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Ave per St
Study 3	1m	0.042	0.056	0.071	0.055	0.056	0.068	0.057	0.073	0.047	0.057	0.042
	2m	0.042	0.056	0.068	0.053	0.052	0.071	0.048	0.065	0.044	0.051	0.042
	3m	0.046	0.053	0.068	0.043	0.043	0.055	0.047	0.061	0.041	0.046	0.046
	4m	0.044	0.045	0.060	0.037	0.041	0.052	0.056	0.056	0.043	0.049	0.044
	2m	0.040	0.053	0.062	0.062	0.040	0.058	0.051	0.069	0.043	0.065	0.040
	3m	0.033	0.048	0.064	0.054	0.039	0.066	0.064	0.058	0.044	0.048	0.033
	4m	0.036	0.041	0.064	0.044	0.040	0.051	0.049	0.054	0.036	0.046	0.036
	A1	0.040	0.055	0.056	0.051	0.042	0.059	0.053	0.075	0.054	0.055	0.040
	A2	0.050	0.066	0.054	0.061	0.065	0.083	0.070	0.076	0.053	0.056	0.050
	Ave. per P	0.041	0.053	0.063	0.051	0.046	0.063	0.055	0.065	0.045	0.052	0.053

P= Player A= Angle Ave= Average St= Study Var= Variable

The average of approximate entropy obtained by the 10 players in each study and respective distance of shot shows values that vary between 0.033 and 0.050. In distances of 3 to 4m (Study Two), entropy reached minimal values. On the other hand, the maximum value was reached in Study Three, more specifically in Angle Two. As a result, Players 1 and 9 proved to be the most consistent (present the lowest approximate entropy), whereas Players 3, 6 and 8 presented the highest levels of entropy. In addition, when calculating the average of all the

values of approximate entropy for each data set, the average value of approximate entropy for putting performance in expert players was 0.053. This is a very stable, regular and periodic value. Through the values obtained for the average of approximate entropy, Figure 6 shows a pattern of regularity and stability of players in the motor execution of putting throughout the 3 studies.

Players 1, 5 and 9 were found to be the most consistent, with player 1 being the most stable of all participants throughout the 9 practice conditions.



Players

***FIGURE 6*: AVERAGE OF APPROXIMATE ENTROPY FOR MOTOR EXECUTION OF PUTTING OF EACH PLAYER IN THREE STUDIES**

Lyapunov exponent

Table 2 presents the median of the Lyapunov exponent for the motor execution of the putting of each player in the 3 studies. The choice to analyse the data shown in Table 2 fell on the median, bearing in mind that the Lyapunov exponent can show extreme and negative values that influence the mean. Moreover, unlike the mean, which can disguise the results obtained, the median is a measure of central tendency that is more consistent and suitable to analyse the Lyapunov exponent. In other words, considering the central value of data distribution, it was concluded that 50% of the values are below to the median and the other 50% are above it (Stergiou *et al*., 2004).

***TABLE 2*: AVERAGE OF APPROXIMATE ENTROPY FOR MOTOR EXECUTION OF PUTTING OF EACH PLAYER IN THREE STUDIES**

	Var	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Med per St
Study 1	1m	0.000	-0.001	0.002	0.002	0.001	0.000	0.004	0.000	-0.002	0.002	0.001
	2m	0.000	-0.002	0.000	-0.002	-0.003	-0.001	0.003	0.000	-0.002	0.003	0.000
	3m	0.002	0.005	0.007	0.012	-0.007	0.007	0.000	-0.003	-0.002	0.004	0.003
	4m	-0.001	0.003	0.000	0.011	0.001	0.010	0.004	0.001	-0.008	0.010	0.002
Study 2	2m	0.002	-0.004	-0.002	0.000	0.002	0.007	-0.001	-0.002	-0.012	0.000	-0.001
	3m	0.002	0.003	0.011	0.003	-0.004	-0.010	-0.004	-0.002	-0.009	0.010	0.000
	4m	0.000	0.006	0.000	-0.002	0.001	0.009	0.004	0.003	0.001	0.004	0.002
Study 3	A1	0.002	0.000	0.001	0.004	0.004	0.008	0.000	-0.001	-0.006	0.002	0.002
	A2	0.002	0.000	0.000	0.000	0.001	0.000	0.001	0.000	-0.001	0.001	0.000
	Med per P	0.002	0.000	0.000	0.002	0.001	0.007	0.001	0.000	-0.002	0.003	0.001

P= Player A= Angle Med= Median St= Study Var= Variable

The median of the Lyapunov exponent per study and respective distance of shot revealed values that were between -0.001 and 0.003. It reached the maximum value in the 3m distance (Study One). In this sense, Player 9 presented a lower Lyapunov exponent, whilst Player 6 reached the highest value. Moreover, considering the median of all the values of the Lyapunov exponent for each set of data, the resulting value from this non-linear tool for putting performance in players was 0.001.

Lyapunov Exponent

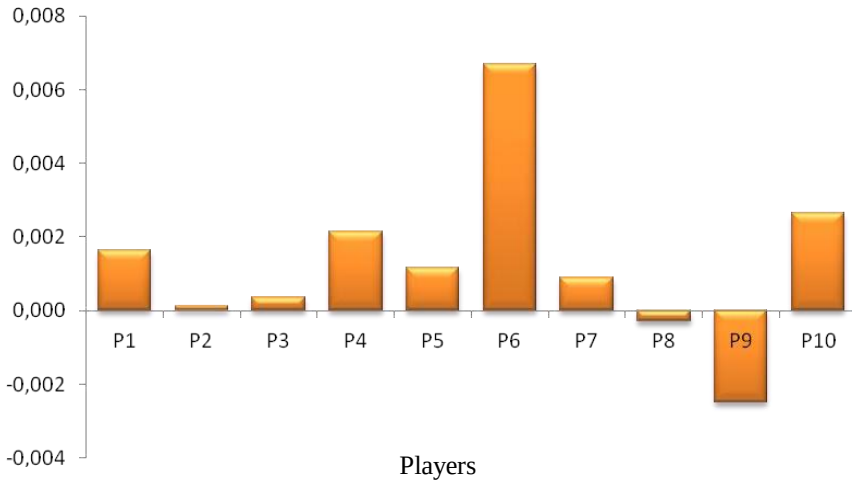


***FIGURE 7*: MEDIAN OF LYAPUNOV EXPONENT FOR MOTOR EXECUTION OF PUTTING OF EACH PLAYER IN THREE STUDIES**

Figure 7 presents the median of the Lyapunov exponent for the motor execution of each player's putting action throughout the 3 experimental studies. As with approximate entropy it was possible to identify a pattern of regularity and stability of the players throughout the entire research. Player 9 presented the lowest and most stable Lyapunov exponent throughout the 9 practice conditions in the 3 studies. Moreover, Player 8 also showed negative values of the Lyapunov exponent.

DISCUSSION

The main goal of this work was the application of non-linear techniques in the analysis of golf putting performance. The aim was to confirm if this movement can be described as a non-linear system in which each player discovers active solutions to realise the goals of the task. Knowing that non-linear techniques are extremely useful to study the variability of the systems of human movement, approximate entropy and the Lyapunov exponent were used throughout the three studies to analyse the variability of golf putting (Stergiou *et al.*, 2004; Harbourne & Stergiou, 2009).

The results showed that the approximate entropy values found throughout the three studies in the longest distances (4m: Study 1) reached minimal values. In addition, contrary to what was expected, the maximum value of approximate entropy was reached in Study Three (Angle 2), 2m away from the hole, when players had to apply a curvilinear trajectory in order for the ball to overcome the ramp, thus being under a large amount of 'noise' and variability. Moreover, the results confirmed that the values of the Lyapunov exponent found in putting performance were between -0.001 and 0.003 (Harbourne & Stergiou, 2009). Thus, unlike approximate entropy, the value with the most 'noise' and variability was reached 3m away (Study 1). However, the median of all the values of the Lyapunov exponent for each set of data (player-study) presented a putting performance value of 0.001, which was below the general approximate entropy of the three studies. Similarly to approximate entropy, it was also possible to follow the motor performance of players and confirm that the putting was an

extremely regular, periodic and stable movement (Pelz, 2000; Harbourne & Stergiou, 2009; Dias *et al*., 2013).

By tuning into a non-linear approach and crossing the border into dynamic and chaotic systems, it was possible to confirm that the players adapted to the variability and 'noise' that emerged from putting execution, and self-organised their performance towards the goal of the task (Davids *et al*., 2008). In this sense, the variability that results from motor performance can constitute a 'digital fingerprint' or 'putting signature' that is exclusive to each golfer (Couceiro *et al*., 2013; Dias *et al*., 2013).

PRACTICAL APPLICATION

Non-linear applications can be used in the study of the variability of systems of human movement by complementing classical linear techniques which are normally used to quantify the performance of motor skills. However, it should be highlighted that this is not about underrating the important role that linear techniques have in the research of systems of human movement, but rather about deepening their study in harmony with non-linear tools (Stergiou *et al*., 2004; Harbourne & Stergiou, 2009).

CONCLUSION

The variability caused by the manipulation of the task led to the emergence of solutions adjusted to each player within the context of the action. In this sense, the golfers that did not carry out the putting through linear trajectory facing the hole, had to adapt to the difficulties that the experimental device presented. As a result, the high values of approximate entropy obtained in Study Three are justified.

By drawing an analogy between this work and the model proposed by Schöllhorn *et al*. (2008), it is considered that the characteristics of the players (morphological and functional), their level of performance and the complexity inherent in putting execution are important to find substantial differences between the values of approximate entropy and Lyapunov exponent. Consequently, the authors believe that the problem with individuality is not limited to ideal or standardised techniques, but contemplates a wide variety of non-linear strategies that can be implemented according to the specificity of each player.

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STANDARDISATION OF BULL'S MENTAL SKILLS QUESTIONNAIRE IN SOUTH AFRICA AND THE UNITED KINGDOM

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ABSTRACT

The contemporary science of sport and exercise psychology requires the standardisation of mental skills questionnaires to facilitate accurate assessment of and intervention for individuals and groups in various health and sport related contexts. The study presents international research findings regarding the standardisation of a Mental Skills Scale with a sample of university students (N=420) from South Africa (n=211) and the United Kingdom (n=209) respectively. Although further international and national standardisation in both English and other languages is recommended, factor and reliability analyses indicated satisfactory validity and reliability of the current English version of the scale.

Key words: Standardisation; Mental Skills Questionnaire; South Africa; United Kingdom; Sport and Exercise Psychology.

INTRODUCTION

Mental skills (MS) are vital for contemporary life, health and well-being. Their accurate assessment is crucial for the development of health and sport in general and for the field of

Sport and Exercise Psychology in particular. As holistic, overlapping, naturally occurring, daily utilised, learned abilities, MS are interrelated and form a unique, composite, inseparable whole (Bull *et al.*, 1996; Weinberg & Gould, 2011). They can be conceptually divided into distinct, but arbitrary, categories for research, teaching, assessment, training and intervention purposes. In various academic and professional fields, such as Sport and Exercise Psychology, MS are measured individually and/or collectively using psychometric instruments for some of which local and/or international norms have been established. Although a great amount of research has been undertaken specifically in sport and exercise, MS assessment and training are also equally applicable in other settings and performance domains. For example, Talbot-Honeck and Orlick (1998) measured and developed MS in top classical musicians to enhance performance, while Murphy and Orlick (2006) focused on MS application in the drama profession.

PURPOSE OF THE STUDY

Bull‟s Mental Skills Questionnaire measures imagery ability, mental preparation (goal setting), self-confidence, anxiety and worry management, concentration ability, relaxation ability and motivation (Bull *et al*., 1996). As it was based on Nelson and Hardy‟s (1990) empirically validated Sport-Related Skill Questionnaire (SPSQ), and originally intended for practical purposes, no United Kingdom (UK) norms have been developed for the scale. However, a psychometric evaluation of Bull‟s scale has been undertaken with Flemish sportspersons (Snauwaert, 2001), and Edwards and Steyn (2011) have established preliminary South African (SA) norms for the seven mental skills subscales. The present international collaborative research was aimed at more comprehensive standardisation of Bull‟s scale in both SA and the UK.

METHODS

Design

In this positivistic study, a descriptive, purposeful sample design was used and quantitative data analysis methods were employed.

Ethical administrative procedures

Consent was obtained from the author of the questionnaire to undertake research on the scale and from the respective SA and UK Universities to conduct the research. The purpose of the study was explained to all participants. Consent was obtained from each participant. Confidentiality was guaranteed and participants were informed that they were free to withdraw from the study at any stage. Each participant completed the Bull‟s Mental Skills Questionnaire. All information was presented in a group format and kept confidential.

Sample

For the purpose of standardising and establishing international norms for the Bull‟s Mental Skills Questionnaire, a large sample group was required. The purposive sample was also chosen on the basis of their potential understanding of the concept of mental skills. All participants were undergraduate students studying Psychology and/or Sport Science, the two main fields which comprise Sport and Exercise Psychology. The total sample consisted of 420 participants, with a mean age of 20.81±4.12 years and an age range from 18 to 47 years.

There were 240 male and 180 female participants. Almost two thirds of the participants (n=272) listed their home language as English, whilst 148 listed various other languages, mainly African languages, as their home language.

The SA sample‟s mean age and standard deviation was 19.48±1.87 years, while the UK sample‟s mean age and standard deviation was 22.17±5.20 years. The SA sample (n=211) consisted of 87 males and 124 female participants, whereas the UK sample (n=209) included 153 male and 56 female participants. In the SA sample, there were 107 English speakers and 104 other home language speakers such as Afrikaans, Sotho, Xhosa and Zulu, whereas in the UK sample there were 165 English speakers and 44 other home language speakers, such as Spanish, Portuguese, Arabic, Lithuanian and Danish. In all cases the participants (SA and

UK) were completing a university degree delivered in English. In order to access their chosen course of study the participants had previously demonstrated an advanced level of English comprehension.

Bull's Mental Skills Questionnaire

The Bull‟s Mental Skills Questionnaire was developed in the UK to measure imagery ability (IA), mental preparation (MP), self-confidence (SC), anxiety and worry management (AWM), concentration ability (CA), relaxation ability (RA) and motivation (M) from which a total scale score is derived (Bull *et al*., 1996). The questionnaire consists of 28 items and assesses participants along a 6-point Likert scale, requiring item responses ranging from „strongly agree‟ to „strongly disagree‟.

The scale was based on Nelson and Hardy‟s (1990) SPSQ, which consists of the following categories: imagery skill; mental preparation; self-efficacy; cognitive anxiety; concentration skill; relaxation skill; and motivation. The SPSQ was initially completed by 100 participants with all 7 subscales yielding Cronbach alpha values above 0.78. Bull‟s scale has been translated into Dutch, where it was assessed with 219 sportspersons and shown to have generally high Cronbach alpha levels of 0.80, 0.64, 0.62, 0.61, 0.59, 0.72 and 0.72 respectively for the 7 subscales (Snauwaert, 2001).

***TABLE 1*: MEANS AND STANDARD DEVIATIONS OF PREVIOUS STUDIES IN SOUTH AFRICA USING BULL'S SCALE**

Study	N	Age	Stat	IA	MP	SC	AWM	CA	RA	M	Tot Sc
Danariah (2007)	60	17	M	18.60	20.20	18.90	16.10	17.40	18.40	20.50	130.10
			SD	-	-	-	-	-	-	-	-
Edwards (2007)	20	18	M	19.20	16.50	18.25	16.40	18.75	16.00	18.75	123.85
			SD	3.68	4.25	3.80	4.49	5.01	5.02	3.92	19.08
Edwards & Edwards (2007)	9	18	M	15.33	13.00	14.22	12.22	16.00	14.67	16.67	102.11
			SD	3.81	2.87	3.70	3.38	3.87	4.09	2.87	18.93
Edwards & Steyn (2011)	419	20	M	18.48	18.61	17.47	15.38	17.88	16.17	19.07	123.09
			SD	3.44	3.54	4.05	4.91	4.37	3.57	3.49	18.27
	Male 151	20	M	18.99	18.40	17.81	15.76	17.64	16.67	19.93	125.21
			SD	3.19	3.49	3.81	4.97	4.21	4.63	3.03	17.00
	Fem.	20	M	18.19	18.73	17.28	15.16	18.01	15.90	18.59	121.90

	268		SD	3.55	3.57	4.17	4.87	4.45	4.52	3.64	18.88
Kruger *et al*. (2013)	121	19	M	18.25	19.74	17.29	14.70	16.06	15.98	19.81	121.83
			SD	3.11	3.06	3.92	4.42	5.86	4.07	3.53	19.09

IA= Imagery Ability; MP= Mental Preparation; SC= Self-confidence; AWM= Anxiety & Worry Management; CA= Concentration Ability; RA= Relaxation Ability; M= Motivation
For Danariah‟s (2007) study, no data on standard deviations (SD) were reported. Age= Mean age

The scale has previously been used within the SA context (Danariah, 2007; Edwards, 2007; Edwards & Edwards, 2007; Edwards & Steyn, 2011; Kruger *et al.*, 2013). Table 1 provides a summary of the mean (±SD) subscale and total scale scores for each of the samples in the aforementioned studies. Edwards and Steyn‟s (2011) study established preliminary norms with a sample of 419 SA university students. Analysis of variance indicated significant differences between males and females on imagery ability ($F_{1, 419}$=5.36; p=0.02) and motivation ($F_{1, 419}$=14.65; p=0.00), with the males scoring higher than the females on these scales. In terms of study mean comparisons, results were varied based on age and context. However, motivation was the highest scoring subscale in all of these studies, except for the study by Edwards (2007).

Data analysis

The quantitative data were analysed using the computer based SPSS statistical software package with factor, reliability, multivariate and descriptive statistical analyses computed. Factor analysis was justified for the total sample, as well as the SA and UK sub-samples. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.85 for the total sample, 0.819 for the SA sample and 0.814 for the UK sample and in each case Bartlett‟s Test of Sphericity was significant (alpha=0.00). Because there had been no initial standardisation of the total scale, exploratory, rather than confirmatory, Principle Component Factor Analyses was indicated. Although Oblimin rotation was considered, Varimax rotation method for orthogonal factors was used as the correlation matrix indicated many correlations under 0.32 (Tabachnick & Fidell, 2007).

This was followed by Cronbach alpha Reliability Analyses, item analyses and multivariate analyses for subscale, age, sex and language differences. Initial descriptive Chi-square analyses comparing younger and older, male and female, English and other language category groups indicated significant demographic differences between the SA and UK samples. As these demographic differences, reported earlier, are obvious and their analysis is not essential to the study, this is simply mentioned in passing.

RESULTS AND DISCUSSION

Results are presented in the abovementioned format, namely factor analyses followed by reliability, item and multivariate analyses.

Factor analyses

Principal Component Factor Analysis for the total sample indicated 7 components accounting for 60.26% of the variance; for the SA sample indicated 8 components accounting for 64.65% of the variance; and for the UK sample indicated 7 components accounting for 61.83% of the variance.

From Table 2, it can be clearly observed that the factor structure of the total international sample exactly reflects the Bull‟s subscales of concentration ability (Factor 1), anxiety and worry management (Factor 2), mental preparation (Factor 3), relaxation ability (Factor 4), motivation (Factor 5), imagery ability (Factor 6) and self-confidence (Factor 7).

***TABLE 2*: ROTATED COMPONENT MATRIX OF TOTAL SAMPLE**

Question	Factor 1	2	3	4	5	6	7
Q01						0.755	
Q02						0.748	
Q03						0.482	
Q04						0.645	
Q05			0.823				
Q06			0.812				
Q07			0.561				
Q08			0.641				
Q09							0.694
Q10							0.701
Q11							0.628
Q12							0.487
Q13		0.806					
Q14		0.807					
Q15		0.777					
Q16		0.735					
Q17	0.748						
Q18	0.760						
Q19	0.805						
Q20	0.760						
Q21				0.701			
Q22				0.458			
Q23				0.757			
Q24				0.713			
Q25					0.519		
Q26					0.644		
Q27					0.684		
Q28					0.764		

N= 420

Reliability analyses

Full scale, 28-item reliability analyses yielded satisfactory Cronbach alpha coefficients of 0.88 for the total sample, 0.89 for the SA sample and 0.88 for the UK sample. The reliability

coefficients for the respective subscales are reported in Table 3.

***TABLE 3*: RELIABILITY COEFFICIENTS FOR TOTAL, SOUTH AFRICAN AND UNITED KINGDOM SAMPLES**

Items	**Total sample** (N=420)	**SA sample** (n=211)	**UK sample** (n=209)
Imagery ability	0.70	0.81	0.44
Mental preparation	0.71	0.72	0.69
Self-confidence	0.75	0.70	0.80
Anxiety and worry management	0.64	0.61	0.66
Concentration ability	0.73	0.73	0.75
Relaxation ability	0.83	0.81	0.83
Motivation	0.83	0.78	0.84

Item analyses

As can be observed from the rotated component matrix of Table 4, in the SA sample, clusters of factors preserved their original, integrated structure for Factor 1 (relaxation ability), Factor 2 anxiety and worry management, Factor 3 (concentration ability) and Factor 4 (mental preparation). Factor 5 contains 2 items from the motivation subscale Q27 ("I am good at motivating myself") and Q28 ("I usually feel that I try my hardest"), which are combined with Q12 ("Throughout competitions I keep a positive attitude") and Q7 ("I always analyse my performance after I complete my performance"). Thus, the scale factor of motivation appears to be associated with a positive attitude and performance analysis, which for this sample might be considered as motivating factors. Factor 6 retains 3 items from the original self-confidence scale, which are combined with Q25 ("At competitions I am usually psyched enough to compete well"). Factor 7 contains 3 of the items from the original imagery ability scale, which are combined with Q7 ("I always analyse my performance after I complete my performance").

Thus, it seems that the SA sample may have perceived question 7, post-performance analysis, as both an imagery and motivating factor. This interpretation is supported by the additional Factor 8, which contains 2 of the items from the original imagery ability subscale, as well as 2 items from the original motivation subscale. The particular items, Q25 ("At competitions I am usually psyched enough to compete well") and Q26 ("I really enjoy a tough competition") may reflect both perceptions of the motivating power of imagery, as well as competitive, competition and/or toughness images and/or fantasies. It may reflect social constructions, and/or fantasies, discourses and valuing of tough, competitive, winning and/or macho culture. It may also reflect the influence of linguistic interpretation of the items by almost half of the SA sample, who had home languages other than English.

***TABLE 4*: ROTATED COMPONENT MATRIX FOR SOUTH AFRICAN SAMPLE**

Question	Factor 1	2	3	4	5	6	7	8
Q01							0.789	
Q02							0.802	
Q03								0.657
Q04							0.376	0.645
Q05				0.864				
Q06				0.834				
Q07				0.391	0.484		0.302	
Q08				0.676				
Q09						0.752		
Q10						0.654		
Q11						0.655		
Q12					0.515			
Q13		0.789						
Q14		0.809						
Q15		0.693						
Q16		0.599						
Q17			0.660					
Q18			0.721					
Q19			0.778					
Q20			0.772					
Q21	0.693							
Q22	0.621							
Q23	0.769							
Q24	0.773							
Q25						0.347		0.412
Q26								0.598
Q27					0.702			
Q28					0.709			

From Table 5, it is clear that the factor structure of the UK sample reflected the Bull‟s subscales of concentration ability (Factor 1), motivation (Factor 2), anxiety and worry management (Factor 3), mental preparation (Factor 4), imagery ability (Factor 5), self-confidence (Factor 6) and relaxation ability (Factor 7), although in the latter case, only 3 items of Bull‟s scale were retained.

***TABLE 5*: ROTATED COMPONENT MATRIX FOR UNITED KINGDOM SAMPLE**

Question	Factor 1	2	3	4	5	6	7
Q01					0.703		

Q02				0.727			
Q03				0.535			
Q04				0.642			
Q05			0.774				
Q06			0.791				
Q07			0.655				
Q08			0.613				
Q09					0.486		
Q10					0.639		
Q11					0.583		
Q12					0.626		
Q13		0.800					
Q14		0.788					
Q15		0.747					
Q16		0.798					
Q17	0.775						
Q18	0.795						
Q19	0.720						
Q20	0.684						
Q21							0.748
Q22							
Q23							0.749
Q24							0.604
Q25		0.647					0.269
Q26		0.666					
Q27		0.701					
Q28		0.758					

It is usual convention not to accept items which have factor loadings of less than 0.30. Item Q25 ("At competitions I am usually psyched enough to compete well"), was the only other factor item that approximates a 0.30 loading. This indicates a slight merging of the motivation and relaxation ability factors in this sample, which is understandable and reasonable in terms of the particular wording of Q25.

Means and standard deviations

Descriptive demographic aspects of the present sample have been reported earlier. Means and standard deviations (SD) for the various subscales are reported in Table 6.

***TABLE 6*: MEANS AND STANDARD DEVIATIONS FOR SUBSCALES**

Sample	N	Stat	IA	MP	SC	AWM	CA	RA	M
Total	420	M	18.65	17.67	16.81	17.10	16.95	15.81	19.29
		SD	3.42	3.62	3.87	4.84	4.91	3.74	3.30

SA	211	M	18.73	18.04	17.23	18.42	15.69	16.03	19.12
		SD	3.49	3.46	3.96	4.25	4.90	4.42	3.27
UK	209	M	18.57	17.31	16.38	15.78	18.23	15.58	19.46
		SD	3.36	3.75	3.75	5.05	4.58	2.89	3.33

IA= Imagery Ability; MP= Mental Preparation; SC= Self-confidence; AWM= Anxiety & Worry Management; CA= Concentration Ability; RA= Relaxation Ability; M= Motivation

Multivariate analysis for the different university samples revealed significant differences for mental preparation ($F=4.38$; $p<0.037$; $\eta^2 =0.010$), self-confidence ($F=5.15$; $p<0.024$); $\eta^2 =0.012$), anxiety and worry management ($F=33.79$; $p <0.00$; $\eta^2 =0.075$), and concentration ability ($F=30.14$; $p<0.00$; $\eta^2 =0.067$). In each case the direction of these differences can be noted above, with the SA sample scoring higher for mental preparation, self-confidence, and anxiety and worry management, and the UK sample scoring higher for concentration. However, effect sizes are small in all comparisons.

Multivariate analysis for age, sex and language, revealed very few significant findings, with small effect sizes for all comparisons except for older students scoring significantly higher for anxiety and worry management than younger students ($F=1.79$; $p<0.013$; $\eta^2 =0.098$). Women scored significantly higher than men for mental preparation ($F=4.12$; $p<0.043$; $\eta^2 =0.010$), while men scored significantly higher for motivation ($F=10.64$; $p<0.001$; $\eta^2 =0.025$). There were no significant differences for language influences on the respective subscales.

CONCLUSION AND RECOMMENDATIONS

This study is the first standardisation of the English version of the Bull‟s Mental Skills Questionnaire, which was found to exactly retain its original hypothesised factor structure with an international large sample of university students from two countries, SA and the UK. This is a strong endorsement of this version of the scale, as were the very satisfactory reliability analyses for the total international sample, as well as the two national samples. This provides a general argument for the validity and reliability of the English version of the scale for future international research. There is some indication from the two countries that the findings can be generalised. The provisional recommendation is that the scale be retained in its current form for future international research unless other studies provide contrary evidence.

Obviously, further research and standardisation of the scale is needed in both SA and the UK for the validity and reliability to be asserted with any degree of confidence. In particular, further psychometric evaluation and standardisation is warranted for samples with home languages other than English. Although the scale has value with English-speaking populations in other countries, diverse languages and cultures inevitably present alternative interpretations of items. As was the case in the standardisation of the scale for Flemish sportspersons, research developing other language versions of the scale seems required, relevant and recommended.

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WHO IS THE SCUBA DIVER THAT VISITS SODWANA BAY AND WHY?

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ABSTRACT

In South Africa, scuba diving as a sport is growing significantly. One of the most sought after scuba diving destinations is Sodwana Bay, situated on the northern coast of KwaZulu-Natal (South Africa). The market is rapidly expanding, thus creating competition among the different dive operations. Understanding the travel motives of scuba divers will benefit dive operations and destinations in developing the most appropriate product, improving the services offered and creating more

effective promotional activities that will ultimately lead to a competitive advantage. The purpose of this research was to understand the profile and travel motives of scuba divers to Sodwana Bay. Four hundred and two questionnaires were handed out over a 10-day period at Sodwana Bay by six fieldworkers. Availability sampling (non-probability sampling) was implemented in the distribution of the self-administered questionnaire. The results indicated that the profile of scuba divers to Sodwana Bay tend to be younger adults (mean age=34 years) with more male than female participants. The factor analysis identified four motives for diving at Sodwana Bay: personal challenge; devotion; relaxation; and escape and exploration and discovery. The research contributes to current literature regarding travel motives, as well as the scuba diving market in the South African context.

Key words: Marine tourism; Travel motives; Sodwana Bay; Scuba diving; Factor analyses.

INTRODUCTION

Marine tourism is one of the tourism industry‟s fastest expanding markets across the world (Moskwa, 2012). According to Orams (1995:2), marine tourism can be defined as "those recreational activities that involve travelling away from one‟s place of residence and have as their host or focus the marine environment (where the marine environment is defined as those waters which are saline and tide-affected)". Over the years, marine tourism has evolved into a multi-dimensional market with a wide variety of activities to offer, such as surfing, snorkelling, kayaking, deep sea fishing and boating (Garrod & Wilson, 2003).

Marine tourism is also popular in South Africa, which offers a vast number of marine activities and products (Tinley, 1985). One marine activity that has expanded immensely over the last decade is scuba diving. Scuba (Self-contained underwater breathing apparatus) is one of the most popular marine activities enjoyed along the coastline of South Africa. In 2005, 48 398 new divers in South Africa obtained their qualifications as scuba divers (Skaare,

2013). Globally, there are more than 28 million active divers who participate in this activity (Garrod & Gössling, 2008).

South Africa‟s coastline is rich in coral reefs and has some of the most diverse and best diving sites around (Scuba diving in South Africa, 2013). What makes South Africa even more appealing is the fact that scuba diving can be practised year-round because of generally good weather and ocean conditions (Scuba diving in South Africa, 2013), as well as the variety of marine life ranging from the whale shark to nudibranchs.

Sodwana Bay is one of South Africa‟s most popular diving sites situated on the northern coast of KwaZulu-Natal in the Greater St. Lucia Wetland Park and Isimangaliso World Heritage Site. The town (Figure 1) is small and reliant on the income of tourists and scuba divers (SodwanaBay.com, 2013). The reef complex of approximately 50km in length is home to the southern most tropical coral reefs in the world, with 95 species of hard and soft coral and a fish population constituting more than 1 200 species, including the whale shark and manta ray (SodwanaBay.com, 2013). The map below (Figure 1) indicates the location of Sodwana Bay.

***FIGURE 1*: MAP OF SODWANA BAY, SOUTH AFRICA** (Ray, 2013)

PURPOSE OF THE STUDY

Scuba divers flock to Sodwana Bay for various reasons. Saayman (2006) stated that as with all other tourism products and activities, scuba divers have certain motives or reasons for taking part in the activity and travel significant distances to practise scuba diving at a specific destination, such as Sodwana Bay. Even though travel motives have been well researched, these motives differ for various products and markets (Van der Merwe *et al*., 2007). The identification of travel motives for scuba divers can be beneficial for scuba diving operations and marine tourism product developers. Establishing the travel motives of divers at Sodwana Bay specifically will help owners of dive operations to understand the behaviour of tourists visiting Sodwana Bay better and adapt the product according to their specific needs.

Therefore, the purpose of this study is to understand who the scuba diver is that dives at Sodwana Bay and why.

LITERATURE REVIEW

Marketing of a service (scuba diving in this case) cannot be effective without understanding the behaviour of consumers. Fodness (1994) states that behaviour can be viewed as a process of internal psychological factors, such as needs, desires and objectives, which can cause some tension. The natural outcome resulting from pent up tension is a need to release it through certain types of behavioural escapes. Lubbe (1998) states it differently by suggesting that an individual"s motivation for travelling begins when that individual becomes aware of certain needs which specific destinations or activities are perceived to be able to fulfil. Iso-Ahola (1999), on the contrary, defines motives as understanding the underlying forces which arouse and direct behaviours. Swanson and Horridge (2006) take it further and define travel motives as a set of needs which can cause a tourist to take part in certain activities and make certain decisions. According to Kruger *et al*. (2011), motivations can induce the tourist to make certain decisions and display certain behavioural characteristics and it can, therefore, be deduced that motivations can give direction to behaviour, as well as strengthen and intensify behaviours. Travel motives, therefore, play an important role in understanding the target

market.

Two types of travel motives, which form the central defining elements of any leisure activity, can be identified in the literature (Meisel & Cotrell, 2003; Kruger *et al.*, 2011). Firstly, perceived freedom, or self-determination, is defined as the feeling gained from knowing that what is being done is done so by choice and because there is a desire for it (Neulinger, 1974). Secondly, intrinsic motives are based on innate psychological needs, for example to know, to accomplish and to be physically active (Kruger *et al.*, 2011). Research conducted by Oh *et al.* (1995) found that in order for any country or establishment to increase visitor numbers, an understanding of why people travel or choose a specific destination becomes vital. Understanding the travel motives of tourists encompasses the following advantages:

- A deeper understanding of travel motives leads to more effective marketing strategies and the creation of a sustainable management plan for destinations (Pan & Ryan, 2007).
- Ultimately, understanding the motives of tourists to visit a place (in this case Sodwana Bay, South Africa) assists in creating awareness through marketing campaigns which consequently lead to attracting more visitors by providing products that meet the needs of the customer (Fodness, 1994).
- It helps to identify the desires and needs of this niche market in the tourism industry (Beh & Bruyere, 2007). According to Lubbe (1998), tourists, specifically scuba divers, will travel to a destination and take part in activities which they feel will serve their needs. Burns and Holden (1995) justify this argument by suggesting that in order to correctly identify the needs of tourists, it is imperative to look at the destinations tourists choose to visit, as well as the activities in which they engage.
- Knowledge regarding the travel motives of scuba divers can improve marketing efforts and hence, certain critical factors in the industry can be taken into account when developing marketing strategies (Saayman, 2006).

- A competitive advantage would be gained with regard to the offerings of other scuba diving destinations, which is vital to this growing competitive market (Kruger & Saayman, 2009).
- Sufficient knowledge of the travel motives of scuba divers to Sodwana Bay will aid scuba diving establishments in Sodwana Bay in serving a specific market, rather than the total market (Saayman & Slabbert, 2004).
- Market efforts, which are focused on specific segments of an industry, establish the product or service more effectively; consequently product development takes place (Wu *et al.*, 2000).

Already in 1994, Fodness (1994) stated that a deeper insight into the travel motives of tourists can benefit tourism marketing in the areas of product development, service quality, image development and promotional activities. The motives of tourists travelling to certain destinations can also be translated into reasons for travelling.

Various reasons have been developed in order to understand travel motives. Maslow developed a theory based on five stages of basic human needs. The theory holds that human needs comprise different sets of goals, each of which must be satisfied in turn. These sets of needs include psychological needs, safety and security needs, social needs, self-esteem and self-actualisation (Tikkanen, 2007). Furthermore, Crompton (1977) established seven general reasons why people will travel: to escape from their everyday life; discovery and self-

evaluation; relaxation and recreation; prestige; regression; strengthening of family ties; and the facilitation of social interaction. According to Crompton (1977), these can be regarded as the main reasons why people travel, which also result in the motivations being shaped for embarking on a trip.

Saayman (2006) maintains that while people cannot be motivated without a reason, they cannot have a reason without being motivated. In the early years, Gray (1980) developed the concepts of "Sunlust" and "Wanderlust" which form the basic reasons why people travel. Gray (1980) defines "Sunlust" as being dependent on the existence of better and different attractions than those to which the tourist is accustomed because it delivers another specific experience or service to that which is locally available to the tourist (Saayman, 2006). "Wanderlust", on the other hand, is defined as the inner motivation human beings possess for leaving all that is known and familiar to them in order to explore new cultures and experiences that are out of the ordinary (Gray, 1980). While there is a fine and complex line drawn between these concepts, both play an important role in people"s reasons for travelling.

Analyses of literature regarding travel motives yielded numerous studies that have been conducted on the travel motives of different market segments in the tourism industry (Kozak, 2002; Meyer *et al*., 2002; Meisel & Cottrell, 2003; Bansal & Eislet, 2004; Yoon & Uysal, 2005; Molera & Albaladejo, 2007; Kruger & Saayman, 2009; Saayman *et al*., 2009; Van Vuuren & Slabbert, 2011). Segments such as the leisure tourism market, the adventure tourism market, and the beach tourism market, as well as the scuba diving market in particular, have been researched across the world and travel motives for each of these markets have been established (Table 1).

***TABLE 1*: TRAVEL MOTIVES ACROSS SECTORS OF THE TOURISM INDUSTRY**

Authors of studies	**Leisure tourism market**	
Crompton (1977) Loker & Perdue (1992) Oh *et al*. (1995) Bansal & Eislet (2004) Jang & Wu (2006)	Escape everyday life Self-discovery Recreation & travelling Status Regression Friends & family	Adrenaline-seeking Excitement Knowledge-seeking Relaxation Self-esteem Social interaction
	Beach tourism market	
Yoon & Uysal (2005) Molera & Albaladejo (2007) Saayman *et al*. (2009)	Relaxation Excitement Adventure Education	Escape Fun Family togetherness
	Adventure tourism market	
Sung *et al*. (2000) Meyer *et al*. (2002) Meisel & Cottrill (2003)	Stature Learning Escaping Personal challenge Family togetherness	Risk involvement Exploration & discovery Perceived freedom Social interaction

	Scuba diving market	
Ditton *et al*. (2002) Meyer *et al*. (2002) Todd *et al*. (2002)	Experience adventure Excitement Relaxation Learning	Social interaction Personal challenge Escape

It can be deduced from Table 1 that the motives which are evident in all these markets are to escape and relax. It is thus important for tourists to escape from everyday life and enjoy the relaxation offered by such a trip. It is also clear that the travel motives, as established by Crompton (1977), are relevant to most tourism markets: social interaction; escaping; rest and relaxation; family togetherness; prestige and stature; self-discovery; and regression.

Very few research studies pertaining to the travel motives of scuba divers were found. Those that were found are mentioned below. Travel motives for scuba divers visiting north central Florida were determined by Meyer *et al*. (2002) as the desire to seek a personal challenge, learning and escape. On the other hand, Meisel and Cottrell (2003) found perceived freedom to be very important for scuba divers visiting the Florida Keys. Todd *et al*. (2002) also conducted research on scuba divers across New York‟s Great Lakes Region. They identified six motives that are important to divers namely, adventure, learning, escape, social interaction, stature and personal challenge. Tschapka and Kern (2012) conducted a study regarding the motivations of scuba divers in Australia. Tschapka and Kern (2012:9) found seven motives to be of importance to scuba divers, namely personal challenge, adventure, relaxation, novelty, stature, learn and hunt. From these motives it was found that scuba divers participate in the activity primarily for personal challenge. It can thus be derived from the studies above that the primary motives for scuba divers are to seek personal challenge and escape.

However, drawing from the analyses of the travel motives of the different tourism markets, it is clear that tourists have different motives when visiting different places or taking part in different activities (Saayman *et al*., 2009). It is thus important to conduct continuous research on travel motives and keep abreast of the new trends and behaviour of tourists, such as scuba divers. Once the travel motives of tourists have been established, it is less complex to serve the needs of that specific market.

MOTIVATION FOR THE STUDY

The market for scuba diving across South Africa is expanding while competition is also growing. As Sodwana Bay is not the only dive site in South Africa, it is in competition with other well-known sites, such as Cape Town, Gansbaai, Mossel Bay and Umkomaas/Aliwal Shoal in Durban, with the largest concentration of operators in KwaZulu-Natal (Dive Advisor, 2013). Therefore, there are two reasons for conducting travel motive research at Sodwana Bay. Firstly, owing to strong competition in this market, dive operations need to understand their clients who will in return assist in providing better scuba diving products in order to gain an advantage over their competitors. The determination of a profile and travel motives of divers will assist in this regard. Secondly, no research has been conducted regarding the travel motives of scuba divers in South Africa; one cannot assume that it would be similar to the other foreign dive destinations where research has been conducted. This

research can, therefore, aid Sodwana Bay in becoming a leading scuba diving destination in South Africa, thereby rising above the competition and attracting more divers from across South Africa and the world.

METHODOLOGY

Ethical clearance

An application was submitted to the ethical clearance committee of the Faculty of Economic and Management Sciences at the North-West University, Potchefstroom campus, who approved the study. The North-West University is subject to the National Health Research Ethic Council (NHREC).

Research plan

To identify the travel motives of scuba divers, a destination-based visitor survey was undertaken at Sodwana Bay in KwaZulu-Natal (South Africa) from 29 March to 8^{h} April 2012.

Questionnaire

The questionnaire used was developed by TREES (Tourism Research in Economic Environs and Society) at the North-West University and was previously used to determine the travel motives and profile of visitors to National Parks in South Africa (Kruger & Saayman, 2009; Van Vuuren & Slabbert, 2011), as well as marine destinations in South Africa (Tiedt, 2011; Van der Merwe *et al*., 2011). Section A captured geographic and socio-demographic details, such as gender, age, home language, country of origin and province, as well as marital status, level of education and income category. Closed-ended questions were used in this section. Section B determined the motivations or reasons for visiting Sodwana Bay. Examples of the statements included: „To get away from my routine"; „To explore new destinations"; „To acquire new skills"; and „So that I can learn more about marine life". Respondents were required to rate the reasons on a 6-point Likert scale where: 1= Not at all important; 5= Extremely important; and 6= Not applicable. Literature used for developing this section of the questionnaire included the works carried out by Ditton *et al*. (2002), Meyer *et al*. (2002), Saayman *et al*. (2009) and Van der Merwe *et al*. (2011).

Sampling method and procedure

Sodwana Bay received on average 1 635 divers per month in 2011, which translates to 20 000 divers per year. Krejce and Morgan (1970) state that for general research activities with a population (N) of 100 000, the recommended sample size (S) is 384 respondents. By using availability sampling, divers were asked to complete a self-administered questionnaire. On average, 40 questionnaires (10 days) were distributed each day by the 5 trained field workers who surveyed the divers after they completed their dive. This method of distribution resulted in 402 completed questionnaires.

Statistical analysis

The data of this research were captured using Microsoft© Excel© and was analysed using Statistical Package for Social Sciences (SPSS) version 2 (SPSS, 2013). In order to determine

the travel motives of the scuba divers at Sodwana Bay, a factor analysis was performed. The factor analysis was conducted by means of Principal Axis Factoring extraction with the Oblimin rotation method with Kaiser Normalisation. The Cronbach"s Alpha, as well as the mean value for each factor was determined. The pattern matrix of the principal axis factor analysis revealed 4 travel motives for diving at Sodwana Bay. These factors were labelled according to similar characteristics found within the specific category. The most important factor was determined by the higher mean value.

RESULTS

The results obtained from this study are twofold, namely the profile of the scuba divers and the travel motives for visiting Sodwana Bay.

Scuba divers to Sodwana Bay were mostly male (64%), with an average age of 34 years, thus indicating that scuba diving at Sodwana Bay is mainly preferred by males. The largest percentage of divers were English-speaking (50%) followed by Afrikaans-speaking (45%) divers who originated from Gauteng Province (56%) and KwaZulu-Natal (17%). The highest percentage of scuba divers were unmarried (46%) and held a diploma or degree (32%) and a matric certificate (31%), whilst 37% earned more than R500 000 annually. These scuba divers to Sodwana Bay were mostly South Africans (96%) followed by divers from Germany (1%). Respondents also enjoyed snorkelling (60%) and walking on the beach (51%). They

travelled in groups of 3 (56%) and spent an average of 4 nights in Sodwana Bay (54%). The majority (80%) of scuba divers indicated that they visited shops in the vicinity and 72% said they had visited Sodwana Bay previously (this is an indication of loyalty towards Sodwana Bay), between 1 and 10 times. These divers had already completed on average 298 dives, therefore, one can assume that they are experienced divers.

***TABLE 2*: PROFILE OF SCUBA DIVERS AT SODWANA BAY**

Variable	Scuba divers
Gender	Male= 62%; Female= 38%
Age	Mean age= 34 years
Home language	English followed by Afrikaans
Province of residence	Gauteng followed by KwaZulu-Natal & North-West Prov.
Marital status	Unmarried= 46%; Married= 39%
Level of education	Diploma/degree= 32%; Matric= 31%
Income	R500 000= 37%; R50 000 or less= 17%
Other activities	Snorkelling followed by beach walks
Group payment	Groups of 1 to 3 people
Times visited Sodwana Bay	Between 1-3 times at an average of 3.9 nights
Country of origin	South Africa= 94%; Germany= 1%
Nights spent	Average of 5 nights
Number of dives completed	Average of 298 dives

Travel motives of scuba divers

In order to measure the consistency and validity of the constructs with the underlying factor, Cronbach‟s Alpha was used to measure the performance of each construct. Cronbach‟s Alpha is given as a single number between 1 and 0.00. Variables derived from the factor analysis are declared as reliable when they provide stable and reliable responses during the administration of the test (Santos, 1999). A Cronbach‟s Alpha of between 0.6 and 0.8 is regarded as satisfactory with higher values being regarded as excellent (Santos, 1999).

The mean value, on the other hand, is the sum of the set of scores of all the constructs making up a single factor divided by the number of constructs. It constitutes the average score for each of the factors (Salkind, 2009) and gives an indication of the importance of each factor in relation to the others. The total variance explained for the 4 factors was 57%, which is acceptable. Four factors were identified by means of the factor analysis that summarised the main reasons for participating in scuba diving at Sodwana Bay.

Factor 1: Personal challenge

This factor consists of the following constructs, namely to overcome a fear, to be part of an expedition, it is an annual activity, for the feeling of success, to gain new experiences, and to photograph marine life. This factor has a Cronbach‟s Alpha of 0.809, which is highly acceptable, with a mean value of 3.67, which ranks it as the least important of the 4 factors.

Meyer *et al*. (2002) confirm this as a travel motive for scuba divers in north central Florida, but not as their most important travel motive. Tschapka and Kern (2012), however, found personal challenge to be the most important motive to participate in scuba diving in Australia.

***TABLE 3*: TRAVEL MOTIVES OF SCUBA DIVERS**

Travel motives	**Factor 1** Personal challenge	**Factor 2** Devotion	**Factor 3** Relaxation & escape	**Factor 4** Exploration & discovery
Overcome fear	0.839			
Be part of expedition	0.770			
Scuba diving Sodwana Bay annual activity	0.612			
Feeling of success after activity	0.458			
Gain new experiences	0.429			
Photograph marine life	0.405			
Fun to scuba dive		0.609		
Crazy about scuba diving		0.570		
Sodwana Bay world class diving spot		0.522		
Always come to dive here		0.391		
Relax			0.719	
Get away from my routine			0.650	
Spend time with friends			0.321	

Learn about marine life				-0.753
Acquire new skills				-0.566
Search for specific species				-0.481
Other members of party share challenge & adventure				-0.480
Explore new destinations				-0.381
Cronbach"s Alpha	0.809	0.673	0.679	0.751
Mean value	3.67	4.29	4.19	3.72

Factor 2: Devotion

Devotion was identified as the most important factor, obtaining the highest mean value of 4.29 and a Cronbach"s Alpha of 0.673. This factor includes aspects such as diving being fun, divers being crazy about scuba diving, Sodwana Bay being a world-class diving spot, and the continuous support of divers to this diving site. According to a study conducted by Meisel and Cotrell (2003), one of the most important factors found for diving in the Florida Keys was „for fun", which correlates with the findings of this study.

Factor 3: Relaxation and escape

This factor relates to the constructs of relaxation, getting away from a routine lifestyle and spending time with friends. Factor 3 had a Cronbach"s Alpha of 0.679 and a mean value of 4.19, ranking it as the second most important travel motive. According to Beh and Bruyerre (2007), „escape and relaxation" is a travel motive that is generally found in adventure tourism. In previous literature, researchers also reported that relaxation and escape is an important factor for scuba divers (Ditton *et al*., 2002; Meyer *et al*., 2002; Todd *et al*., 2002; Tschapka & Kern, 2012).

Factor 4: Exploration and discovery

The last factor relates to constructs, such as learning about marine life, acquiring new skills, for the variety of species found at Sodwana Bay, so that others can share in the challenge and explore new destinations. This factor obtained a Cronbach"s Alpha of 0.751 and a mean value of 3.72, thus ranking it as the third most important factor. Meyer *et al*. (2002) also reported „to explore new things" to be one of the most important factors for divers visiting north central Florida. Although familiar with the diving site, divers still seek opportunities to explore and discover this destination. The respondents in this study were highly familiar with the diving site, which might explain the lower (but still high) mean value of this factor.

From the above-mentioned it can be concluded that the travel motives of scuba divers to Sodwana Bay relate well to research regarding the travel motives of scuba divers to other diving destinations in the world and that devotion played a very important role in the travel motives of the respondents in this study. This finding holds significant and specific development, planning and management implications.

DISCUSSION AND IMPLICATIONS

The aim of this study was to determine who the scuba diver to Sodwana Bay is and why they travel. This could assist in improving dive operations at Sodwana Bay and in developing better products, giving operators a competitive advantage by understanding their diving client

better. The following findings can be drawn from this research.

Firstly, and significant to this research, *devotion* was revealed as being the most important reason for scuba divers to travel to Sodwana Bay for diving purposes. Therefore, there is a strong commitment among scuba divers to dive at Sodwana Bay. This holds positive implications for Sodwana Bay because this market will return again. Therefore, it would be useful to create a loyalty programme for scuba divers who visit Sodwana Bay on a regular basis. This programme could implement loyalty points and provide incentives, such as discounts on dives according to the number of points earned. Dive operators at Sodwana Bay could also consider hosting a dive festival, which could attract divers not just from Gauteng and KwaZulu-Natal but the rest of South Africa, as well as from aboard. This type of event can have an enormous positive impact (socially, as well as economically) on this area and community, which is dependent on divers and visitors. It is also recommended that the event should be hosted in the off-season (February to March), as it will extend the tourist season.

Secondly, as in other studies, this study also found that *relaxation and escape* is of great importance. Again, confirming the importance of tourism activities (diving) as vehicle for people that can be used to break away from their normal routines and everyday life. Dive operators should thus focus on creating an atmosphere for divers where they can relax, where the equipment is in order, the dives are well organised and the divers have sufficient time to enjoy each dive. Dive operators could provide snacks and drinks while divers are on the beach waiting to dive, clean their diving equipment after completion of dives and provide leisure activities, such as quad biking, horseback riding and some evening entertainment. Dive operators could further establish a marketing campaign based on the idea of „Escape to your second home away from home", so that Sodwana Bay could attract both loyal and new visitors, especially through social media sites.

Thirdly, it is important to include *exploration* opportunities in dives, since each dive is different and new things can constantly be discovered on a familiar reef. Diving instructors need to focus on special sightings during dives and also the small interesting sea life that is not seen every day. If special marine life is spotted, such as dolphins, sea turtles and whales, divers must have the opportunity to explore these sightings, but without harming or disturbing nature.

Fourthly, *personal challenge* also emerged as an important motive for scuba divers, even though it was the least important factor. The market consists of beginners and advanced divers for which both should be catered. Where beginner divers might consider aspects such as depth and rare sightings to be of importance, advanced divers feel differently. This market is an experienced market with an average of 298 completed dives; therefore, dive operators must find products with new challenges that will attract such divers. Reefs such as the Five Mile and the Nine Mile (which are the deepest and furthest reefs in Sodwana Bay), can provide advanced divers with experiences that are more challenging than the others. Different divers should, therefore, be challenged in different ways by developing challenges linked with rare sightings, new skills and first time experiences.

While studies have been conducted on the travel motives of scuba divers at destinations across the world, the research carried out for this study is the first of its kind to be conducted in a South African context. It will thus assist the dive industry of South Africa to promote and

market the activity in a more effective way. Targeting the correct market will have a positive impact on product development. This might also attract the attention of more international divers.

CONCLUSION

The aim of this study was to determine who the scuba diver to Sodwana Bay is and why they dive. In the process of doing so, new knowledge was developed and current literature supported.

Scuba diving is an important activity in the marine environment across the world. It is important for dive destinations to stay competitive in this ever expanding market. More and more dive operators are being established which offers the diver a greater choice. Thus, to be the first choice as a destination or dive operator, the establishment in question needs to place itself above the rest through constant and intensive marketing. Active promotion of scuba diving in South Africa will lead to more people becoming interested in taking up scuba diving

as recreation or a hobby, which will justify the number of dive operators in South Africa. Furthermore, marketing efforts should be focused on social networks which would involve young people. This study indicated that young people represent the greatest market for scuba diving in South Africa. This knowledge leads to various development opportunities.

The information obtained from this study is useful in many ways. The scuba diving industry can use this information to improve its services and products in relation to that which the market wants and that which it expects. The research findings are informative because previously the profile and travel motives of scuba divers in South Africa were not known. Marketers can attract divers by focusing on devotion, relaxation, exploration and personal challenge in marketing campaigns. Dive operators should pay attention to the loyal visitors and how to retain their patronage, as well as how to attract their friends and families.

Given the limited number of studies available on scuba divers in South Africa, various research questions, such as whether there are differences in the travel motives of less experienced divers, still need to be answered. Conducting further research on scuba diving in South Africa will not only improve knowledge on the subject, but will also aid in developing the product and establishing a strong niche market in the tourism industry. It would be useful to determine the international profile of scuba divers to Sodwana Bay, as well as the latest trends in this industry. This will aid in keeping the service offered fresh and linked to the desires and needs of the market. Furthermore, similar research to this study can be conducted at other scuba diving destinations in South Africa in order to allow for comparative studies.

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SUDDEN CARDIAC ARREST RISK PROFILE IN A GROUP OF AMATEUR LEVEL BASKETBALL PLAYERS FROM THE UNIVERSITY OF THE WITWATERSRAND

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ABSTRACT

The purpose of this study was to screen a sample (N=31) of urban university amateur level basketball players for the risk of sudden cardiac arrest (SCA). A questionnaire (self-reported) and physical assessment was used to elicit SCA risk factors for the participants. The physical part of the questionnaire comprised measuring blood pressure, body mass index (BMI), glucose and cholesterol measurement, and performing electrocardiograms (ECG) on those with positive signs of SCA risk, such as angina, syncope and family history of SCA. Resting blood pressures (BPs) were significantly different between the genders; males (n=17) 120mmHg (IR: 25) vs. females (n=14) 103mmHg (IR: 10)), p<0.0001, whereas total cholesterol (4.2 vs. 4.5mmol.L-1, p=0.07) and blood glucose (5 vs. 4.4mmol.L-1, p=0.13) were similar. ECGs were performed on those that displayed Marfanoid characteristics, such as pectus carinatum deformity, scoliosis, skin striae, and symptoms of dural ectasia; however, there was no evidence of underlying abnormalities. Basketball players may theoretically appear to be in the phenotype of high risk individuals for SCA, however, males and females in this group of university basketball players showed varying signs of SCA risk, with the overall risk being reasonably low, albeit abnormalities were highlighted in some and Marfanoid characteristics were clearly evident in others.

Key words: Sudden cardiac arrest; Basketball players, Marfan syndrome; Urban; South Africa.

INTRODUCTION

Sudden cardiac arrest (SCA) and the possibility of sudden cardiac death (SCD) during sport is a devastating event, representing 75% of all fatalities in young sportspersons (Harmon *et al*., 2011). Despite its rarity, SCA always receives a great amount of media attention. There are varying reports on the incidence of SCD, and the exact magnitude of the problem remains elusive. For example, the annual incidence of SCD is reported to be between 0.5 and three per 100 000 sportspersons (Ferreira *et al*., 2010; Pelliccia *et al*., 2011; Pugh *et al*., 2012), however, this may be underestimated due to the varying definitions of SCD (Borjesson & Pelliccia, 2009; Pelliccia *et al*., 2011). Although the rate of SCD varies between studies, there appear to be some steadfast trends. These include that males are at a greater risk than females, and university sportspersons had twice the death rate when compared to their school counterparts (Borjesson & Pelliccia, 2009). The incidence is estimated at being two to four times higher in sportspersons than non-sportspersons (Ferreira *et al*., 2010), due to the excessive demands placed on the heart during vigorous exercise (Corrado *et al*., 2003).

Most SCD cases in sportspersons have been attributed to silent disorders of the cardiovascular system (Montagnana *et al*., 2008). A wide range of underlying congenital cardiac conditions appear to be the cause of SCD in sportspersons. The most common cause is hypertrophic cardiomyopathy (Maron, 2003), and to a lesser extent, an aortic rupture or mitral valve prolapse, due to Marfan syndrome (McClain, 1989; Ferreira *et al*., 2010; Pelliccia *et al*., 2011). Although genetic cardiovascular diseases, such as Marfan syndrome are rare, they are frequently associated with increased risk of sudden death during exercise (Maron, 2010). Therefore, strategies to identify at-risk sportspersons, particularly tall sportspersons such as basketball players, are essential (Mendelson, 2011).

Pre-participation screening of student sportspersons is important to detect 'silent' cardiovascular abnormalities, or identify asymptomatic sportspersons with underlying genetic diseases (Maron, 2003). Screening is supported by the American Heart Association (AHA) and should include history taking and physical examination (Maron *et al*., 2007), although both these have limited sensitivity to detect asymptomatic conditions (Asif *et al*., 2013). A positive response in the history taking is an indication for further cardiovascular examination and electrocardiogram (ECG) (Maron *et al*., 2007). International debate surrounds the routine use of the 12-lead ECG test in sport pre-screening. For example, it is routinely used in Europe (Corrado *et al*., 1998), as it is deemed sensitive enough to detect or raise suspicion of the cardiovascular condition underlying SCD. Furthermore, approximately 75 to 95% of hypertrophic cardiomyopathy (HCM) patients will present with abnormal ECG findings (Maron, 2002). On the other hand, the AHA does not recommend the use of ECG as a feasible test in large scale screening (Maron *et al*., 2007). Although current evidence for the use of ECG in screening is contrasting (Pugh *et al*., 2012), it has been promoted as a practical and cost effective test (Maron *et al*., 2007; Wheeler *et al*., 2010; Asif *et al*., 2013) that is an important way to reduce the risk of SCD (Corrado *et al*., 2006; Ferreira *et al*., 2010).

PURPOSE OF STUDY

The aim of this study was to assess the risk of sudden cardiac arrest and sudden cardiac death of university basketball players. It is recommended that sportspersons at risk of SCD should

be screened, and basketball has one of the highest incidences of SCD when compared to other sport (Subasic, 2010; Harmon *et al.*, 2011). Likewise, the prevalence of Marfanoid characteristics may be relatively high in basketball players, as the attraction for tall stature and long extremities may provide an advantage in the game, and draw from a population at risk of Marfan's syndrome. Therefore, cardiac screening may be particularly pertinent in this population.

METHODOLOGY

Study design

This study used a descriptive, cross sectional study design using risk profiling to assess basketball players for sudden cardiac arrest risk and screen for Marfanoid characteristics.

Sample

A sample of university enrolled basketball players (N=31) were asked to volunteer to participate in the study, aged between 19 and 25 years (mean age 22±4.24) from the University of the Witwatersrand. These amateur level sportspersons trained regularly and competed against other South African universities. They were informed of the study objectives and what was expected of them in the data collection process.

Ethical clearance

The data was treated with strict confidentiality and ethical clearance was granted by the Human Research Ethics Committee of the University of the Witwatersrand (M110441).

Measures

Anthropometric and blood pressure measures

Standard methods for anthropometry (stature [using a Seca stadiometer] and body mass [using a Seca digital weighing scale]) and blood pressure (BP) measurements were followed (Armstrong, 2006). For the latter, participants were seated and rested for 5 minutes prior to brachial BP measurement. Waist and hip circumferences were measured using an inelastic, but flexible tape to the nearest centimetre and resting heart rate was obtained using the carotid artery pulse (Armstrong, 2006). Body mass index (BMI) and waist-to-hip ratios (WHR) were calculated (Armstrong, 2006).

Blood analyses

The Accu-Chek Instant Plus (Roche Diagnostics GmbH, Mannheim, Germany) system was used to measure serum total cholesterol and blood glucose levels. All standard product procedures were followed (Roche Diagnostics, 2012).

Questionnaire

The questionnaire was formulated predominantly from the pre-participation examination model developed by Fédération Internationale de Football Association (FIFA, 2012). It comprises self-reported and measured sections on personal and family history of cardiac risk in order to determine sportspersons risk profile for SCA and SCD, whereby having at least 3 risk factors indicated risk of SCA and increased probability of SCD on-field (FIFA, 2012; Gradidge, 2012). Specific items extrapolated risk factor information on the incidence of exertional chest pain or discomfort, syncope or near syncope, excessive, unexpected or unexplained shortness of breath or fatigue related to exercise, previous finding of a heart murmur or increased systemic blood flow, and further family history of specific occurrence of certain conditions (Marfan syndrome, HCM, and long QT syndrome), a history of premature

death, a disability resulting from a cardiovascular disease in close relatives who are younger than 50 years of age (Ferreira *et al*., 2010).

Electrocardiogram

Resting 12-lead ECG was performed (Schiller AT 6 ECG machine [Schiller AG], Switzerland) on the 10 participants that had 3 or more identified risk factors based on responses in the questionnaire. The ECG recorder was calibrated before testing, and this was done by recording the standard 1-mV deflection per centimetre. The time base was also standardised and the paper speed set at 25mm/sec. Electrodes were placed and connected in the customary fashion (Armstrong, 2006). The participants were requested to lie quietly in the supine position while the resting ECG was recorded. If any abnormalities were observed, the researchers were obliged to refer to a specialist cardiologist for further evaluation.

Marfanoid characteristics

Participants were assessed for Marfanoid characteristics by a medical practitioner according to the Ghent criteria, including skeletal, visual and cardiovascular investigations (De Paepe *et al*., 1996).

Analysis of data

The analyses were done using Statistica version 10 (Tulsa, USA). Descriptive statistics were used to describe the sample, cardiac risk profile and the incidence of Marfanoid characteristics. Participants were divided into gender groups for comparison and differences were determined using Student t-tests for normative data, otherwise Mann-Whitney U tests were performed. Data were reported as mean±SD or median (inter-quartile range), and where appropriate normalised by logged for analyses. A multiple linear regression model determined whether independent variables were associated with total risk of sudden cardiac arrest. The independent variables were systolic blood pressure, diastolic blood pressure, fasting glucose, total cholesterol, Marfanoid characteristics, flu-like symptoms, and dyspnoea. The level of significance was set at 5%.

RESULTS

University enrolled basketball players (N=31), 17 males and 14 females aged between 19 and 25 years (mean age 22±4.24), from the University of the Witwatersrand amateur level basketball team volunteered for this study.

***TABLE 1*: CHARACTERISTICS: MALE AND FEMALE BASKETBALL PLAYERS**

Parameters	Male (n=17)	Female (n=14)	p-value
Resting heart rate (bpm)	69.2±12.6	80.3±15.7	0.050*
Systolic blood pressure (mm Hg)	120 (25)	103 (10)	0.001**
Diastolic blood pressure (mm Hg)	78.2±9.8	71.7±7.3	NS
Total cholesterol (mmol.L-1)	4.2 (1.3)	4.5 (0.6)	NS
Fasting glucose (mmol.L-1)	5.0 (1.0)	4.4 (1.0)	NS
BMI (kg.m-2)	23.7 (3.5)	21.7 (3.8)	NS
WHR	0.77±0.04	0.68±0.03	0.001**

Data expressed as Mean±SD or Median (interquartile range) Mean age= 22±4.24 N= 31
BMI= Body Mass Index WHR= Waist-to-Hip-Ratio NS= No significant difference

Resting heart rates were significantly different, 69.2±12.6 vs. 80.3±15.7 bpm (p=0.04) respectively, which may reflect usual gender differences in these competitive basketball players (Table 1). Average stature was 1.84m±0.1 for males vs. 1.68m±0.1 for females. Total cholesterol, fasting glucose and BMI were similar between the genders, however, WHR was significantly different (p<0.0001), a difference which is indicative of normal growth development variation between the genders, as well as their natural adiposity depot sites.

***TABLE 2*: GENDER: PREVALENCE OF CARDIOVASCULAR DISEASE OR RISK FACTORS IN MALE AND FEMALE BASKETBALL PLAYERS**

Disease or physiological condition	Male (n=17)	Female (n=14)
Hypertension (SBP>=140mm Hg; DBP>90mm Hg)	29%	14%
Overweight (BMI>=25kg.m^{-2})	24%	7%
Obesity (BMI>=30kg.m^{-2})	12%	7%
Hypercholesterolaemia (>=5mmol.L^{-1})	24%	28%
Hyperglycaemia (>=5.6mmol.L^{-1})	17%	7%

Note: Differences were not significant between the male and female participants.

***TABLE 3*: GENDER: PERSONAL AND FAMILY HISTORY OF KNOWN RISK OF SUDDEN CARDIAC ARREST OR SUDDEN CARDIAC DEATH**

Cardiac conditions	Males (n=17)	Females (n=14)	p-Value
Marfanoid characteristics	35%	0	**
Flu-like symptoms	53%	64%	NS
Dyspnoea	94%	43%	**
Dizziness	0	36%	*
Syncope	0	14%	NS
Hypertension	0	7%	NS
Heart murmur	0	7%	NS
Angina	6%	21%	NS
Palpitations	0	7%	NS
Medication managed cardiac conditions	0	0	NS
Hypertension – FH	6%	29%	NS
Stroke – FH	0	14%	NS
Arrhythmia – FH	0	14%	NS
Diabetes mellitus – FH	12%	14%	NS
SCD – FH	0	7%	NS

*p<0.01 **p<0.001 NS= Not significant FH= Family history

A number of the male group (35%) had positive signs for Marfanoid characteristics; however, when investigated further on ECG, none showed underlying signs of abnormalities. The prevalence of cardiovascular disease risk was determined. Only a small number had existent cardiovascular risk or conditions (Table 2). Based on whether participants had 3 or more positive SCA risk factors (data not shown), a total of 10 participants consented to having ECGs done. All were negative for HCM or other ECG abnormalities.

Family histories of SCA risk factors were evident in a few participants, but only 1 female had a family history of SCD. A small number (n=5) had a history of hypertension in their family, however, this is in contrast to the relatively low resting blood pressures seen in this population (Table 1). Females clearly had more risk factors than male basketball players. This was shown by cumulative calculation, but is noticeable in Table 3, which shows that the maximum number of risks in the male group was 5 versus 9 in the female group. All the SCA risk factors were placed into a multiple regression model. Hypertension (adjusted beta value [b]= -2.7, p=0.045), BMI (b= 16, p=0.02) and hypercholesterolemia (b= -1.6, p=0.04) were found to be associated with total SCA risk in this sample. Furthermore, in this population Marfanoid characteristics were found to be a good determinant of SCA risk profile.

DISCUSSION

It is well known that regular aerobic exercise provides cardio protective benefits, it does not however, preclude the risk of SCA in those sportspersons with underlying abnormalities. Although exercise-related SCA is rare, the unexpected and potentially catastrophic event in an otherwise healthy sportsperson has driven much research in the area of pre-screening and prevention. Young seemingly healthy sportspersons in high school and university are not excluded from the risk of SCA. The most common competitive sport at risk for SCA is basketball followed by football (Maron *et al*., 1996; Milani *et al*., 1996), making the pre-participation physical examination (PPE) for these sports particularly important.

The findings of the present study showed that a small number of participants had underlying non-communicable diseases (NCD), but only one participant knew of possible existent hypertension, whereas 26% had the condition. This reinforces the need to include PPE for all sportspersons as some may have cardiovascular abnormalities which they may not be aware of (Montagnana *et al*., 2008). The prevalence of obesity (10% versus 13% in males and females respectively) and hypercholesterolemia (10%) was similar to that of university sportspersons, however, it was only BMI that was shown to be a positive risk of SCA risk in the present study (adjusted beta value [b]: 16, p=0.02) (Bakkum *et al*., 2011). The association of obesity and cardiovascular disease is known; hence this result is not surprising. However, in this instance, some of the basketball players' BMI may have been lower than expected due to their elevated stature in relation to their body mass (Armstrong, 2006). The findings also showed conflicting evidence for risk of SCA with hypertension (adjusted beta, b= -2.7, p=0.045) and hypercholesterolemia (adjusted beta, b= -1.6, p=0.04) showing a negative correlation, such that with increases in hypertension and hypercholesterolemia, the risk of SCA decreases. The data, however, should be interpreted with caution as the small sample size may have produced unstable results in the multiple regression analysis.

Findings from the current study demonstrate that 75% of these basketball players had three or more CV risk factors. This is similar to findings from a previous study done on university sportspersons in South Africa (Bakkum *et al*., 2011). Likewise, the present study found that

cardiac risk factors were more common in females than males (Bakkum *et al*., 2011). Common self-reported symptoms found in the females included flu-like symptoms, dyspnoea, dizziness, and to a lesser extent syncope, angina, heart murmur and palpitations. Familial hypertension, stroke, arrhythmia and diabetes were more prevalent in the females. A family history of SCD, which represents a red flag indicative of further investigation

(Subasic, 2010), was reported by one female basketball player. Reported prodromal symptoms, such as syncope, angina and palpitations, have been found in 36% of SCD cases (Subasic, 2010). The current study showed that these warning signs were present in 42% of the females in this group, and 5% of the males.

The role of routine ECG testing in PPE has stimulated much debate in the sporting environment. Many argue that this diagnostic test can greatly increase the detection of those at risk, and therefore, reduce the incidence of SCD, which is a major reason for PPE in the first instance (Harmon *et al*., 2011; Asif & Drezner, 2012). On the other hand, it is a costly exercise and, coupled with its potential false positive outcomes, has caused it to be branded as inefficient (Maron, 2005). Although ECG screening has been advocated as feasible in developed countries, its routine use in resource scarce countries, such as South Africa, may not be achievable. Therefore, in the current study, only participants that had three or more positive risk factors were screened for underlying signs of abnormalities. The most common underlying cause of SCD in sportspersons is hypertrophic cardiomyopathy (HCM) (Cross *et al*., 2011), however, in screening for HCM in this population all ECG readings were negative. In a much larger study of football players, Schmied *et al*. (2013) found structural abnormalities in 5% of players. In a previous study, 10% of football players in South Africa presented with abnormal ECG readings (Gradidge, 2012). In the current study none of the ECG tests presented with abnormal findings, however, only 10 tests were done and may not be reflective of this population.

Another causative factor for SCA is Marfan syndrome, the heritable disorder of connective tissue, which may lead to the weakening of the walls of the aorta and other anatomical structures (Judge & Dietz, 2005). The prevalence of Marfan syndrome is likely to be high in a sport such as basketball due to added performance advantage of being tall. Not surprisingly, there was a high (35%) prevalence of positive signs for Marfanoid characteristics in this group. Although the prevalence thereof is reported to affect both males and females equally (Stout, 2009), the current study found all those with positive signs for Marfanoid characteristics were male. In addition, mitral valve prolapse and early aortic root dilation are common complications presenting in cardiac assessment of those with Marfan syndrome (Stout, 2009). In the current study, none of the players displayed abnormal ECG findings. For example, Kinoshita *et al.* (2000) found a small prevalence of aortic dilation (0.96%) in basketball players, and this was associated with features of Marfan syndrome (Kinoshita *et al*., 2000). Furthermore, it is estimated that 70% of those with Marfan syndrome will die of acute cardiovascular complications (Stout, 2009). Despite the normal ECG findings in this study, late complications, such as aortic root dilation, may progress rapidly, and these patients are recommended to have serial ECG assessments (Stout, 2009). Therefore, it remains important to take particular care in evaluating sportspersons participating in certain sports, such as basketball and volleyball, for signs of Marfan syndrome or Marfanoid characteristics, and the diagnosis confirmed for appropriate recommendations to be made (Pelliccia *et al*., 2005).

CONCLUSIONS

The risk of SCA was relatively low in this group of young, adult competitive basketball players, however, there were a number that had positive signs of risk and it is these abnormalities that may place individual sportspersons at risk of SCD. Nevertheless, the sample was small and causality could not be determined in this cross sectional study of basketball players from the University of the Witwatersrand. The data validate the purpose and significance of the PPE screening and the use of ECG to exclude cardiomyopathy and other abnormalities aiding in reducing mortality. Furthermore, some of the basketball players had underlying cardiovascular and metabolic abnormalities, of which only one participant was aware, thus demonstrating the need for instigating PPE where it is not being done and continuing such a programme where one already exists. Future studies of SCA prevention in basketball players should explore PPE in order to justify its mandatory use in the sport.

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CHANGING RELATIONSHIPS WITH SIGNIFICANT OTHERS: REFLECTIONS OF NATIONAL AND INTERNATIONAL LEVEL STUDENT-ATHLETES

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ABSTRACT

The paper explores the nuanced articulation of social dynamics in relationships between elite athletes and their significant others. It captures that these relationships changes over time. A case study was undertaken at the University of Johannesburg to determine the roles of significant others at various phases of elite athletes' sporting careers. A retrospective research perspective was pursued, which yielded insightful data, reflecting on various socialisation phases. Symbolic interactionism provides the framework for analysing the building of relationships between elite athletes and their significant others. In-depth interviews were conducted with elite throwers and decathlon athletes. The sample included current (n=15) and retired (n=5) student-athletes, parents (n=5), coaches (n=2) and managers (n=10) from the University of Johannesburg (UJ Sport). A multi-method approach ensured triangulation and comprehensive data was obtained from case studies. The results reveal that a priority shift occurs in athletes' relationships over time. Support from parents demonstrates an engendered interaction and focus in addition to assisting in the provision of support and material resources. In one technical event, the athlete's father became the coach, and a similar transition from teacher-coach to professional-coach occurred during high school years revealing deepening commitment. The increased reliance on and solidarity with peer athletes increased after socialisation.

Key words: Socialisation; Significant others; Social agents; Elite athlete; Student-athlete.

INTRODUCTION

Socialisation is seen as a lifelong process, as people interact with others and their environment in a myriad of ways (Maguire *et al*., 2002). Coakley and Burnett (2014) describe socialisation as an active learning process, through real-life experiences, to which meaning is given within cultural settings as people discover and embrace values, beliefs and norms. Sport socialisation occurs through contact with multiple socialisation agents. Each agent plays a different role in the creation of overall socialisation pathways. During the initial years, parents are generally the most significant sport socialisation agents. Other important socialisation agents and influences include siblings, other family members, peers and role models. Various social institutions (schools) and environmental influences also expose one to

socialisation agents. Numerous researchers discuss the prominence and differential support relationships within the socialisation process, where the sportsperson filters and acts on influences according to his/her own circumstances and orientation (Hedstrom & Gould, 2004; Knight & Holt, 2013; Coakley & Burnett, 2014).

It is evident from the research that one‟s parents are central social agents in the life of the sportsperson (Brown *et al*., 1989; Domingues & Gonçalves, 2013). Generally, during the child‟s primary school phase, parents encourage him/her to participate in sport or facilitate an active lifestyle. Parents motivate their children to become physically active and to participate in sport for various reasons. It is also during primary school where teachers (teacher-coaches) take on the role as professionals with varied degrees of expertise. The teacher-coach has the responsibility of teaching and coaching in the school environment. The participation and commitment of the sportsperson is highly dependent on the environment facilitated by the teacher-coach. During the latter years of primary school, sportspersons become increasingly subjected to peer pressure. It is during this phase when the sportsperson‟s friends and peers become primary social agents and influence within a teenage culture of distinguishable norms and behaviours.

During the secondary school phase, parents still play a central role in socialisation. The father normally takes on the role as provider of material and technical matters, whereas the mother generally offers emotional and nurturing support (Domingues & Gonçalves, 2013). It is also during this phase that sportspersons decide to specialise in sport, and professional coaching is sourced. At the tertiary level, one‟s parents mainly offer (additional) financial support to the elite sportsperson, while the coach becomes the more prominent social agent and role model. During this phase, the elite sportsperson is challenged with balancing his/her sport and academic life (Watt & Moore, 2001). The sportsperson-coach relationship is very important during this heightened specialisation phase.

This article aims to document and reflect on relationship changes during the sporting life of elite sportspersons, with special focus on the student-sportsperson years.

LITERATURE REVIEW

Sport socialisation is viewed as “a process of learning and social development, which occurs as we interact with one another and become acquainted with the social world we live in” (Coakley & Burnett, 2014:76). The social learning theory of Bandura (1986) makes it evident that the influences of significant others (such as parents, peers, teachers and coaches) on the personal development and sport experiences of sportspersons provide directional growth and development pathways.

The first phase of socialisation is when the sportsperson is introduced to sport. The individual selectively experiences the influence of several key socialising agents, and the impact of these may vary from person to person over a period of time (Coakley, 2011). During the early formative years (primary school) of being socialised into sport participation, parents and caregivers are identified as the main social agents. The type of support (emotional, social, financial or physical) creates a culture of motivation and goal orientation, and this may have either a positive or negative impact on the sportsperson. If a caring climate is created, a

sportsperson is nurtured and may decide to pursue a sport career or pathway. However, if the sportsperson experiences failure and undue pressure, he/she may drop out or seek alternative sport or other activities in which to participate (Burnett, 2005; Knight & Holt, 2013).

Research conducted by Hedstrom and Gould (2004) and Knight and Holt (2013) indicate that sportspersons who acquire positive support from their parents are advantaged and able to cope more effectively with stressors during their sporting career. Research also reveals that such children experience a range of positive outcomes, such as enjoyment and are highly motivated and more committed to sport. Parents thus enable the youth to participate and progress in their participation in sport and can guide them towards socialisation (Nunomura & Oliveira, 2013). The family members, especially the father and same-sex siblings, play a significant role as facilitators of competitive sport participation. During adolescence (13 to 14 years), peers and coaches begin to assume a more dominant role, influencing the sportsperson‟s choice of and commitment to sport participation. This phase, which implies progression and intensification of role acquisition, thus forms the basis for consecutive phases (Domingues & Gonçalves, 2013).

Burnett‟s (2005) model indicates the changing nature of the influences of social agents on the experiences of the sportsperson during various socialisation phases, from the primary phase of being introduced to sport (play) to where sport becomes fun and then a more serious obligation.

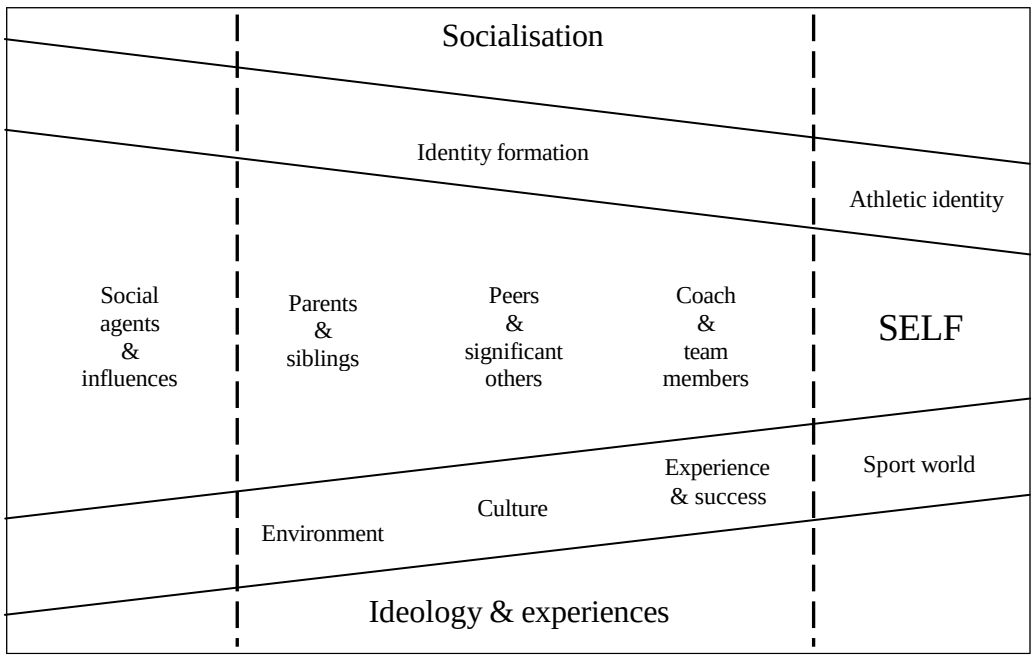

***FIGURE 1*: ATHLETIC IDENTITY SOCIALISATION MODEL** (Burnett, 2005:24)

Sport takes place within the context of the society‟s social spaces and influences. The roles of significant others are prioritised differently by sportspersons as they progress from being mere participants to acquiring a sporting identity. The sporting identity forms an integral part

of a sportsperson, and this „persona" is based on the sportsperson"s accomplishments and achievements (Burnett, 2005). It is during the deepening commitment phase that the sportsperson decides to take sport more seriously. This phase mainly takes place during the early years of secondary school. As the individual gets older, and he/she is successful in his/her sporting endeavours, the choice of specialisation in a specific sport might become a viable option. This process is also linked to the availability of resources and often contingent on the culture and ideology within the household. If parents are very supportive, or have also been sportspersons themselves, an enabling environment is created.

Over the years, the sportsperson"s attitude changes and he/she grows more professional and performance-orientated (Coakley & Donnelly, 1999; Coakley, 2011). During the initial years, the parents play a dominant role by introducing an active lifestyle and encouraging children to participate in sport. School-going children are mostly coached by their teachers who would take over the role as „mentor", with the exception where parents act as coaches. In the absence of expert coaches in individual sport, parents may take on this role as reported in various studies (Brown *et al*., 1989; Melnick & Wann, 2011). The social stimuli with the most impact are significant others, reference groups, and those individuals whose attitudes, values and behaviours contribute decisively to the formation of one"s own attitudes and values (Papaioannou *et al*., 2008).

For the sportsperson, playing with friends in the early years might be the determining factor for them entering into the world of sport. As the sportsperson commences his/her sporting career, the players generally become close friends. Especially around the age of 14 years, the peers become a prominent social influence and team mates often become friends as they share social space and similar experiences (Karweit, 1983). They might be accepted or rejected by others within the sporting culture and due to this, might decide to either proceed or quit.

The essence of this process is the increased level of commitment displayed by a sportsperson. He/she increasingly embraces the role of sportsperson and, as such, identifies with elite participants as a particular and identifiable sub-culture by „walking the walk and talking the talk" (Tinto, 2002). This decision mainly takes place during the latter years of the sportsperson"s secondary school career, coinciding with late adolescence and final school years (Norris, 2010; Canadian Sport for Life, 2011). As a result of the deepened commitment of the sportsperson, he/she starts to develop a sporting identity. Sportspersons consciously and subconsciously obtain a set of dispositions that orientate them towards a particular understanding and interpretation of the role they are fulfilling in their social world (Vaughrand, 2001). The most important influence on the identity formation of the sportsperson in the construction and understanding of his or her social world is the „self", as well as the interpretation of the sportsperson"s identity, success and goals. It is the sportsperson"s perception of goals and success that shapes the sporting identity and contributes towards the realisation of starting a sporting career (Stroot, 2002; Burnett, 2005). The sporting identity also comes with special social relationships where the coach is the main influence in taking responsibility for sport performance and often determines team selections.

Team mates are a key source of social support as sportspersons share a similar life style in training and competing.

The post-school years present another major transition in the structured environment of the sportsperson. For sportspersons who continue their studies at tertiary institutions, other

student-sportspersons provide unique socialisation components. During this transition phase when the student enters a tertiary institution, the individual takes on the identity of a student first and foremost, after which the student can begin participating in sport and become the student-sportsperson. Student-sportspersons are identified and recognised as a special grouping within the broader field of participation (Burnett, 2003). Social recognition co-constructs role acquisitions of student-sportspersons. They become outliers compared to their peers or fellow sportspersons. Success for individual sportspersons provides another shaping force for potential career fulfilment. They focus on sport-related achievements and might set specific goals, even putting their social lives on hold for a certain period of time to focus on reaching narrowly defined sport goals (Burnett, 2003). It is in this phase that the coach acts as the main social agent. The sportsperson might even have multiple coaches if he/she participates at a national or international level.

The role of the coach is complex and multidimensional. Multiple roles of coaches are particularly prevalent in contexts where the coach also has to act as manager and psychologist, compared to more professional set-ups where the coach is mainly responsible for coaching (Bloom *et al*., 2008). This relationship between the coach and sportsperson has been researched mainly from a leadership perspective, as the coach is considered a leader and mentor in the life of the sportsperson.

Jowett (2008) defines interpersonal relationships as the situation where coaches‟ and sportspersons‟ emotions, thoughts and behaviours are mutually and causally interconnected and inter-related. The interpersonal construction of closeness, co-orientation and complementarity were utilised to broadly define coaches‟ and sportspersons‟ emotions and thoughts respectively (Jowett & Ntoumanis, 2004). Student-sportspersons predominantly find a social home among co-sportspersons. Patrick *et al*. (1999) report on the social lives of male student-sportspersons who showed high levels of bonding and a sense of belonging to a special group.

This bond may become so strong that they often form sub-cultures which, in a sense, can be perceived as deviant due to over-compromising, as these students focus predominantly on pursuing a sporting career. It is for this reason that various universities in the United States acknowledge that students should be well-integrated into student life (Watt & Moore, 2001). It is also for this reason that sport residences, in which student-sportspersons reside, are not considered advantageous to these student-sportspersons‟ academic performance. In a study by Burnett (2010), it became clear that student sportspersons lead relatively segmented lives with the main thrust being that of sport, rather than academic- and social life. Student-sportspersons struggle to lead a balanced life and are mostly compelled to prioritise a sporting life, which is time-intensive and requires multiple sacrifices.

A sport career at this level might be relatively short. The life span of an elite sportsperson is often related to various influences and happenings, which could either extend or shorten it.

This, however, means that a pre-established pathway is not predictable as sportspersons might prematurely burnt out or may experience a career-ending injury (Wylleman *et al*., 2004). In some cases, the lack of access to essential resources might be a limiting factor, or the sportsperson might weigh the chances of a prolonged sports-related career against that of a more predictable profession within or outside the sport sector (Coakley, 2011). A highly competitive career of an elite sportsperson will inevitability end and the sportsperson may

then pursue different options beyond mere competitive participation.

RESEARCH PROBLEM

Discussing the changing roles of significant others in the study, and the sportspersons‟ priority shift, student-sportspersons at the University of Johannesburg were researched as case studies to investigate changes over time, within a particular institutional setting.

METHODOLOGY

This research utilised a mixed-method approach, as this has become increasingly employed by researchers to utilise more sources and thicker descriptions for complex realities (Bernard & Ryan, 2010). Data-set triangulation enriches the pool of information, validity and reliability of findings (Fielding, 2009). The research design of this in-depth descriptive study made use of both qualitative (interviews) and quantitative (questionnaires) data to explore and substantiate the case study as a type of research. For this article, only the qualitative data (interviews) will be used to discuss the influences of significant others in the various phases and settings of socialisation.

The purposive sample of the current student-sportspersons consisted of 15 individuals, of which 10 (67%) were male and 5 (23 %) female; while the retired student-sportspersons‟ sample included 5 individuals, of which 2 were male and 3 were female. The parent sample consisted of both mothers and fathers, and included a sample of 5 who were willing to take part in the research. Management and coaches totalled 12 individuals, with a gender representation of 6 (50%) males and 6 (50%) females. A total of 21 males and 16 females were included in the study.

The case study approach afforded the researcher the opportunity to interview various people in their different roles and to capture a variety of perspectives on the role of significant others during various socialisation phases. Against this outline of the socialisation process and the role of significant others, main result areas, which link to socialisation influences and practices, will be presented.

RESULTS AND DISCUSSION

The literature indicates that there are various social agents playing a role in the socialisation phase of the student-sportsperson. This is reflected in the narratives resulting from the study. The discussion will be against the backdrop of the various socialisation phases, incorporating the role that the social agent plays. The different sections are structured to follow a developmental pathway associated with the progression of socialisation in identifiable phases.

Introduction to sport (primary school level)

According to Hedstrom and Gould (2004), the parent‟s role is mainly to encourage and motivate their child to be successful in sport. The following narrative, captured during the interview, states the importance of parents during the primary phase of a sportsperson‟s participation:

> *The support from my parents was very important and the fact that they pushed me to do athletics was the ultimate motivation. They kept on pushing me to participate because I couldn't do it on my*

own. (22-year-old female, shot put athlete)

My mom and dad were my main support during my sporting years. They were always there for me, happy when I won, supported me when I did well. They provided me with the opportunities to participate in sport. They helped me to realise that sport is important, because you don't realise it when you are small. I wasn't born a great athlete – I had to work hard to become good and if it wasn't for the support of my parents, I would not be as successful as I am today. (25-year-old male decathlon athlete)

The narrative reflects the shared meaning of a family where the success of a son was partially contingent on parental support and parenting. It also speaks to the work ethic and understanding or demonstration (by or through parental guidance) that dedication and hard work are required for sporting success. These narratives demonstrate how parents are the initial motivators in their roles as primary educators to introduce their young children to an active life style. Taking part in physical activity forms an integrative part in the holistic development of children. It further demonstrates the personal involvement of parents in continuing to support children along a sporting pathway and having to provide the material means for specialisation.

In primary school, the teacher may recognise the sporting talent of a sportsperson. It is then when the teacher-coach dedicates more time and resources to the training of the talented sportsperson.

My teachers were amazing during my primary school years. One teacher told me that she thinks I will be a very good athlete, she believed in me. I didn't want to disappoint her, so I worked hard to become a good athlete.(26–year-old male shot put athlete)

I wanted to become the best but didn't always have the best opportunities or coaches. I made the best of the fact that my teacher was my coach and I respected her a lot. (24-year-old female, shot put athlete)

A teacher wrote me off in Grade 7, because I struggled to grow and it reflected in my distance. The teacher enjoyed the fact that somebody else would beat me. She would put more time and effort into the other athlete. (26-year-old male, shot put athlete)

Within a school setting, the status of the teacher-coach often rests in the success of his/her players or team. This contributes to a special bond of trust, empathy and reciprocity between the sportsperson and the teacher-coach. Teacher-coaches expect their sportspersons to succeed and the sportspersons internalise such expectations, potentially conferring on them a belief in their ability to succeed. From the sportsperson‟s perspective (as indicated in the narratives) teachers are not necessarily equipped to offer specialist technical coaching. The school is neither capacitated or has a high performance focus and as institution cannot facilitate that level of exposure to competitions. Not all teachers would prioritise the coaching

of a particular sportsperson, as personal factors and the judgement of „success‟ and potential of different sportspersons might play a determining role.

Siblings or family members may influence one another to participate in sport. They encourage each other to participate and compete and try to determine who is best.

My younger sister was my competition; we trained together and did everything together. Although she is not in the same age group as I am, she was my competition as she was also a strong competitor. I always wanted to be better than her. (24-year-old female shot put athlete)

My cousin was a South African high jumper. I used to go to him in December holidays from the age of 10. I wasn't the best in high jump but the fact that my cousin was so good, inspired me a lot. He

was my idol and I wanted to become like him. I even did an assignment on him in my primary school years, he inspired me a lot, his support was significant in my primary years. If I struggled with training he was always there to support. (25-year-old male, decathlon athlete)

In some cases, sibling rivalry creates additional motivation to succeed, as siblings compete for parental approval. Having a successful sportsperson as a family member is not only encouraging, but a sportsperson can get emotional and technical support, which is crucial during the primary years where the personal social relationships seem to be most influential.

Deepening commitment (high school level)

Research indicates that mother-daughter and father-son relationships represent differential influences. In most cases, the mother provides emotional support while the father augments the child‟s coaching and offers technical advice, as well as providing material support in a household where he is the main provider. In such households, fathers often influence the decision of allocating household funds and resources to the sporting career of a child. The stability of one‟s home environment plays a key role during socialisation stages, as children need emotional security and nurturing (Hedstrom & Gould, 2004).

One student-sportsperson explained the gender differentiation in this parental support structure. Shared experience and knowledge about competitive participation in sport disciplines influences parental guidance and goal setting. The following narrative captures this sentiment:

The stability of my parents' house was an incredible support aspect for me; it was a safe haven for me. I knew that I could share everything with my parents, especially my dad. My dad was very good in hammer throw and knew me personally and how I performed. He always showed me what to do; he had a lot of patience. He wanted me to become the best. (23-year-old male hammer throw athlete)

I have a very sporty family and my parents are very supportive. My mom did netball and hurdles and my dad played rugby. They lived their dream through me. They supported me a lot; they always came with me to competitions. I am doing exactly what they tell me to do because I know that they were successful. (22-year-old female, shot put athlete)

It is evident from this narrative that this student-athlete‟s father became the parent-coach. For this role, the parent-coach is based on a personal sporting career or, as mentioned in other cases, special learning by the parent. When a parent takes on the role as coach, the child may benefit from the intimate and trusting relationship, but it may also cause pressure to perform according to a parent‟s expectations. The longitudinal involvement of parents provided a

transition between introducing a child to sport and further „strategic‟ involvement. As parents become more knowledgeable about a sport, they increasingly act in an advisory capacity. A father acknowledged the differential support of individual parents:

We supported our son a lot as parents, we went to every single event that he participated in, we pushed him a lot. Mom didn't push him as hard as I did, but she also played a part. (Father of male decathlon athlete)

Inherent in this narrative, is the understanding that both parents had a role to play and that each in his/her own way contributed to a family environment that encouraged sport. There also seems to be support for the notion that fathers continue to play a more dominant role than mothers in shaping the perceptions of and effective outcomes experienced by their children in sports (Coakley, 2011). In the absence of qualified coaches in highly technical

sport disciplines, a father may extend his authority in his parental role and may act as a coach for this sportsperson. A father of a student-athlete explains:

> *As parent I have identified talent in my children and helped them to develop that talent in all possible ways. I also developed my own coaching skills to assist them with training due to a lack of coaching resources in the area. I've started getting involved in their sports, went on courses to help them develop their talent. There were not a lot of people with knowledge of the sport and the only way my children could develop is if I helped them. We have put a lot of resources into the development process, a lot of money. (Father of male hammer throw athlete)*

Parental role augmentation is taken up by the parent (in this case, the father) who feels responsible for facilitating his child‟s sporting career. The new role of a father-coach compromises the more traditional role of care-giver. In some cases, a dependency relationship may develop where the child‟s success confirms the quality of potential competencies. This constitutes a potential role conflict for both parties. This narrative is representative of several others obtained by the research where parents increased their involvement and obtain technical knowledge so as to advise and/or assist their children with their performances. Other parents also reflected on the material resources and financial sacrifices they had to make to facilitate their child‟s sporting career.

During the secondary school phase, the sportsperson may begin specialising in a sport or certain sports. The coach supports and encourages the sportsperson to participate and to train. He/she also sets boundaries for social and life experiences in association with demarcated expectations of what it means to be a successful sportsperson. The coach also acts as a mentor and sets priorities for the sportsperson. The coach helps the sportsperson set goals for advanced levels of competition where he/she judges the potential for competitive success and improvement (Mageau & Vallerand, 2003).

> *I had a very encouraging coach, which was also my teacher! She was the perfect coach; she never took the fun out of athletics. She never forced me to do anything. I think that played a very significant role in the fact that I still love athletics. I worked hard to become someone. (25-year-old male decathlon athlete)*

From a sportsperson‟s perspective, a successful coach (including his/her teacher-coach) is one who guarded against unrealistic goals or undue pressure to succeed. The level of success and specialisation of individual sportspersons are increasingly been recognised during the secondary school years and teachers seem to capitalise on the sportsperson‟s success for the honour of the school. During the secondary phase, the role of the teacher-coach becomes

more prominent. It is also evident from the following quote that the teacher of this student-athlete fulfilled multiple roles:

> *My teacher was the deputy head, nature science teacher and pole vault coach. He was such an incredible person and a big role model. He could do all the tasks and still made the best of everything. (25-year-old male decathlon athlete)*

Sportspersons recognise the strength and limitations of their coaches. Role modelling forms a meaningful part of setting normative behaviour patterns for sportspersons to follow. It can be a two-edged sword. On the one hand, it requires competencies and insight on the part of the educator and teacher while on the other hand it necessitates the role acquisition of being a coach. Balancing these roles effectively comes with unique challenges and opportunities of increased influences. The relationship change between the teacher-coach and the sportsperson, as there is a suggestion of transferred mentorship from the sports field to the

classroom.

Peer relationships and peer pressure start to become an issue and a dominant influence during the secondary school years (Patrick *et al*., 1999). It is clear that peer pressure can either be positive or negative. For instance, at secondary school level, peers can either help produce high levels of motivation or contribute to early drop out for their fellow sportspersons. If peers do not share the same experiences and goals, sportspersons are faced with challenges of associating with unsupportive peers. A student-athlete articulates such an experience:

> *My friends weren't very supportive in my athletics during school. They said I must go out with them and movie instead of training. (22-year-old female shot put athlete)*

Fellow sportspersons play a very supportive role in the secondary school phase. Athletics is an individual sport and friends taking part in the same sport motivate and support each other. Fellow sportspersons share experiences and challenges with each other, they train together and are interdependent on one another (Karweit, 1983; Brown *et al*., 1989). A student-athlete explains:

> *I had two athletes doing athletics with me, my fellow athletes (male decathlon athlete). My high school boyfriend was also an athlete and he knew what I was going through and supported me a lot. (22-year-old female, shot put athlete)*
>
> *I just kept on trying and working hard to beat my friends to become the best. Eventually I became the best by just keep on believing in myself, if it wasn't for the support and competition of my friends, there wasn't a reason why I had to become better. (25-year-old male, decathlon athlete)*

Successful sportspersons often socialise with other sportspersons and get support from members of the sporting fraternity. Sportspersons form a special cohort where shared experiences and identification underpin group formation and help establish meaningful and understanding relationships. Friendly rivalry becomes important as sportspersons may push one other to increased levels of performance. In this sense, they have to collaborate to compete, which adds a relatively complex dimension to friendship and social inter-dependency.

Post-school specialisation

In the student-sportsperson years, parents are essential agents in the support system of their children. In the post-school phase, parents may still be committed, but function as peripheral

providers of their children‟s competitive sporting life. The coach and peer relationships become more dominant during this phase. It is evident from previous research that when sportspersons moved into a university residence, they became separated from their family and slowly these ties lose their previous closeness and parental control diminishes. Sportspersons travel nationally and internationally for competitions, and it is not always possible for parents to accompany their children on these tours.

During this phase, the gradual shift of attention and embracing other recourses are obvious as expressed by this athlete:

> *My mom and dad are still very supportive during my university phase, although they are very far, they offer emotional support. They encourage me and keep me motivated. I still talk to them every day and share my experiences with them. My parents are really a great guide in life for me. (24-year-old female shot put athlete)*

Parents may still perform an emotionally anchoring role, which is important to the sportsperson as it constitutes a frame of reference. This narrative, as in others not presented here demonstrate the increased social distance and the change in parent-child relationship in continuing to motivate, encourage and also to provide sound personal advice on how to address various challenges in life of which sport is an important component.

Studies indicate that some parents have the ability to make substantial contributions, in terms of financial support, to their children's participation, but the capacity to do so is inevitably related to the socio-economic status of the family and household. A child‟s sporting career is often prioritised in the absence of access to their material or financial sources. In these cases, scholarships or sponsorships are made available. Financial factors may create barriers to children‟s participation in sport (Kirk *et al*., 1997). Such experiences are demonstrated in the following narrative:

> *My mom and dad still support me financially where I am today! I've been studying for over 6 years to compete in athletics. I've asked my dad to support my dreams and I will become a successful athlete. Not all parents can support their child financially till late 20's. But the fact that we don't get good money to participate in athletics in South Africa is a huge challenge. I am fortunate to have the financial support of my parents to pay for me. (25- year-old male decathlon athlete)*

This student-athlete confirms his continued dependency on parental (or external) financial means to support elite levels of competition. In some cases, additional funds are needed to finance tours, facilitate training, attend camps and/or pay for professional coaching.

Student-sportspersons rely on the competency of the coach and many believe that the coach is pivotal to their success in sport. A student-athlete explains this viewpoint as follows:

> *I have the best coach in the country – he helped me a lot through all the developmental phases to be the best athlete I could be. (23–year-old male decathlon athlete)*

The level of specialisation at this stage of a sportsperson‟s career necessitates expert knowledge and skills from highly qualified coaches. The sportsperson is increasingly forming a close relationship with the coach, who in some cases „replace‟ parental guidance and provide additional support.

Both cohesion and trust are unique to sport peer groups. Student-sportspersons, however, also find support from their friends (boyfriends or girlfriends) who are not sportspersons, which also helps to encourage them. Gender dynamics are different, though, with girlfriends being relatively more supportive of their boyfriends and they also associate themselves with their partners‟ sporting successes. Not all boyfriends are supportive of their girlfriends who are successful sportspersons as some perceive this as a traditional role reversal. This support is motivational, and others‟ understanding gives sportspersons the space to follow a sport career.

> *The support from my roommate in residence was phenomenal, she was not an athlete, but she inspired and motivated me so much. If I was tired or lazy to go and train she motivated me to go. (21-year-old female shot put athlete)*
>
> *My girlfriend gives me space, time, helps me to focus and respects the fact that I need to train. (25-year-old male, decathlon athlete)*

Some same-gender peers often provide a type of sisterhood or brotherhood with strong emotional ties. Inter-gender relationships is also built on a common understanding that the sportsperson needs time for training and would be away for competitions, in addition to

having to cope with competitive stress. From other narratives, it was evident that peer relationships that are not supportive are severed and athletes choose their friends to accommodate their competitive lifestyle. This represents a change from trying to fit in with friends and fellow competitors to finding friends and team mates that offer the capacity and safe space of support. It is evident from the narratives that student-athletes often form a cohesive insider group. Such bonding is motivational and uplifting. These relationships are based on fellowship, sharing and a special insider status.

> *My fellow thrower athletes support me a lot. That was a very good motivation when we all went together to the gym to train, or went to the field together, I felt guilty when I wanted to stay home and not train. The motivation at competitions was incredible. (24-year-old female shot put athlete)*

This bonding (and shared identity) generates norms and creates expectations of behaviour. At this level of strong emotional ties, trust and reciprocity are embedded values. To outsiders, this is recognisable as an athletic culture.

CONCLUSION

During the socialisation phases of the athlete‟s career, it is clear that the relationships with these social agents change over time, with recognisable manifestations. Relationships differ with role-crossing (father-coach and teacher-coach), constituting unique challenges and opportunities. On critical reflection, the narratives reflect that there is a clear priority shift in the roles of social agents as the needs of the athlete change and as a result, their reliance on certain relationships alters. It is apparent that there is a need to educate and equip athletes and their social agents with knowledge and skills. In this case, the sport-parent and team mates should know how best to play a supportive and motivational role.

The knowledge and skill set of coaches particularly relate to their roles as mentor, technical advisor and trainer, as well as being an expert within the particular discipline and address the holistic development of the athlete whilst ensuring an enabling environment. The very antecedents of parental support (financial, psycho-social and motivational) are core elements.

Gender-dynamics offer peer support structures among insiders (fellow athletes), and this affiliation serves as an identity reference. The coach increasingly becomes the role model (high school years) and this remains a significant influence in the construction of enabling relationships and helping form an athletic identity for competitive student-athletes. Understanding these role identification shifts has implications for coaching, teaching and parenting, which when well-articulated, can form a crucial enabling environment and supportive network.

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MEASURING STUDENT RESPONSIBILITY IN PHYSICAL EDUCATION: EXAMINATION OF CSR AND PSR MODELS

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ABSTRACT

The Contextual Self-Responsibility Questionnaire (CSRQ) and Personal and Social Responsibility Questionnaire (PSRQ) were developed to measure student responsibility within the field of physical education. In the present study, the factor structure of the CSRQ and PSRQ was examined. Unlike previous structure examination studies, it was hypothesised that two models would not fit the data due to the existing limitations of the CSRQ and PSRQ. The results of the confirmatory factor analysis (CFA) showed an extremely poor model fit to the data. In conclusion, supportive psychometric evidence of these two models could not be provided. It is, therefore, necessary to develop a new instrument for measuring student responsibility within the field of physical education.

Key words: Contextual Self-Responsibility Questionnaire (CSRQ); Personal and

Social Responsibility Questionnaire (PSRQ); Factor structure scale; Validity.

INTRODUCTION

Taking responsibility for students and others‟ well-being has been regarded as essential for physical education (Quay & Peters, 2008; Gordon, 2010; Walsh *et al*., 2010). Hellison‟s (2011) teaching personal and social responsibility model (TPSR) is grounded in the notion that teachers can use physical activity as a vehicle to promote responsibility among adolescents. There are five major levels of TPSR, namely respect for the rights and feelings of others, effort and cooperation, self-direction, helping others and leadership, and transfer outside the gym (Hellison, 2011). Teachers help students to learn all levels related to responsibility with the appropriate program design. Previous studies have supported that the TPSR is highly effective in promoting adolescents‟ responsibility (Hellison & Walsh, 2002; Hellison & Wright, 2003; Walsh, 2007; Walsh, 2008; Wright & Burton, 2008; Lee & Martinek, 2009).

However, previous studies have reported that there is insufficient quantitative evidence supporting TPSR outcomes (Schilling, 2001; Hellison & Walsh, 2002; Mrugala, 2002; Hellison & Martinek, 2006). Recently, there has been some quantitative research assessing the TPSR, such as a „coaching club‟ program implemented by Walsh *et al*. (2010) using attendance records of students as the indicator of responsibility development. Wright *et al*. (2010) used the students‟ absence and tardiness records and grades as indicators. Gordon (2010) implemented the TPSR in a physical education class for six months and used self-examination results as an indicator. This aforementioned research involved small-scale case studies. Although these studies contributed much to this line of research and practical applications of the TPSR, their inferential potential is limited.

To better assess adolescent responsibility through the TPSR, it is necessary to conduct large-scale research based on larger sample sizes. Therefore, the development of a reliable and valid instrument for assessing adolescent responsibility is warranted. There are two existing instruments measuring responsibility among studies related to the TPSR: the Contextual Self-Responsibility Questionnaire (CSRQ) developed by Watson *et al*. (2003); and the Personal and Social Responsibility Questionnaire (PSRQ) developed by Li *et al*. (2008).

The CSRQ is a self-report questionnaire with a total of 15 items. Watson *et al*. (2003) surveyed 130 adolescents participating in a TPSR program, and data were analysed with an exploratory factor analysis (EFA). Results showed that three factors were extracted, which were labelled „care for others/goal setting‟, „self-responsibility‟, and „self-control/respect‟. Results also showed that some items did not load onto the expected factors, and some items, such as “I tried hard” loaded onto multiple factors. In addition, the extracted factors included constructs with significantly different meanings. For instance, „care for others‟ and „goal setting‟ were two completely different concepts. As Li *et al*. (2008) commented on CSRQ, the concept of „self-responsibility‟ was vague and this concept may contain elements of other factors.

The PSRQ is also a self-report questionnaire with a total of 14 items. Li *et al*. (2008) assessed 253 high school students using this instrument, and preliminary CFA and internal-consistency results supported the validity and reliability of this measure. The PSRQ consisted of two

factors, referred to as „personal responsibility‟ and „social responsibility.‟ „Personal responsibility‟ contained two levels of TPSR: „effort‟ (“I try hard”) and „self-direction‟ (“I want to improve”). „Social responsibility‟ contained another two levels of TPSR: „respect‟ (“I respect others”) and „caring and helping‟ (“I encourage others”). Generally, the PSRQ constitutes a new development for the conceptualisation of personal and social responsibility.

Nevertheless, the PSRQ also has some defects, with the items “I set goals for myself” and “I do not make any goals” being too similar to each other. The item “I control my temper” loaded onto the social responsibility factor; however, temper control may sometimes be just a personal issue and not necessarily related to others (Hellison, 2011). Furthermore, “I respect others” and “I respect my teacher” overlapped due to the former item perhaps containing aspects related to respect for both classmates and teachers.

The CSRQ and PSRQ have been assessed in past studies (Newton *et al*., 2006; Lee *et al*., 2012). Newton *et al*. (2006) suggested that the generalizability of the CSRQ be examined since factors were extracted only via an EFA. Lee *et al*. (2012) also reported that the two-dimensional structure of the PSRQ was not convincing due to the absence of a theoretical rationale. Although research has already shown the limitations of these two measures, re-examination of the factorial structure through an empirical approach is still necessary. To date, no study has conceptually tested the CSRQ and PSRQ dimensions with an empirical approach, using confirmatory factor analysis (CFA). Therefore, two sub-studies were conducted to examine whether the three-dimensional structure of the CSRQ and the two-dimensional structure of the PSRQ could be confirmed.

PURPOSE OF THE STUDY

Specifically, the purpose of Sub-study 1 was to examine the factor structure of the CSRQ. The purpose of Sub-study 2 was to examine the factor structure of the PSRQ. As mentioned, there are some limitations in the concepts and application of the CSRQ and PSRQ. It was hypothesised that the models derived from previous studies would not provide adequate fit to the data.

METHODOLOGY

Participants

For Sub-study 1, the participants (n=280) consisted of 152 males and 128 females between the age of 14 and 16 years (M=15.2, SD=1.04), from 5 middle schools. For Sub-study 2, 305 students (170 males, 135 females), between the age of 14 and 16 years (M=15.4, SD=0.96), were also selected from 5 different middle schools. Prior to data collection, students were briefed on the purpose of the questionnaire. All participants were informed that their responses would be confidential and only used for research purposes. Students who decided not to respond after reading the consent form and questionnaire had the option to return the questionnaire form blank.

Measures

The Contextual Self-Responsibility Questionnaire (***CSRQ***) of Watson *et al*. (2003) was assessed in Sub-study 1. The students in this study responded to 15 items (*Care for Others/Goal Setting*, *Self-Responsibility*, and *Self-Control/Respect* with 5 items each),

measured on a scale ranging from 1 (strongly disagree) to 4 (strongly agree). Each item followed the stem "I take part in PE". Example items are "I supported the others in my group" (Care for Others/Goal Setting), "I participated even when I didn‟t want to" (Self-Responsibility), and "I was able to control what I did" (Self-Control/Respect). The Personal and Social Responsibility Questionnaire (***PSRQ***) of Li *et al*. (2008) was assessed in Study 2. The students in this study responded to 14 items (*Social responsibility*, and *Personal responsibility* with 7 items each) measured on a scale ranging from 1 (strongly disagree) to 6 (strongly agree). Each item also followed the stem "I take part in PE." Example items are: "I am kind to others" (Social responsibility) and "I set goals for myself" (Personal responsibility). Only 1 item "I do not make any goals" in the PSRQ was worded negatively.

Data analysis

Confirmatory Factor Analysis (CFA) was employed using AMOS in Sub-studies 1 and 2. To evaluate model fit, several model fit values have been assessed (Hu & Bentler, 1999; Jackson & Gillaspy, 2009), such as the comparative fit index (CFI), the root-mean-square error of approximation (RMSEA), and the Tucker-Lewis index (TLI). For the CFI and TLI indices, values greater than 0.90 are typically considered acceptable, and values greater than 0.95 indicate good fit to the data. For the RMSEA index, a value less than 0.08 is acceptable and less than 0.06 indicates good fit to the data (Browne & Cudeck, 1993; Byrne, 2001; Marsh *et al*., 2004). Descriptive statistics (M and SD), Cronbach‟s alpha coefficients, and Pearson‟s product moment correlations were computed.

RESULTS

Sub-study 1

Means of the 3 CSRQ factors ranged from 2.39 to 2.84. The standard deviations ranged from 0.40 to -0.49. Univariate skewness (ranged from -0.65 to -0.123) and kurtosis (ranged from 0.56 to 1.62) values indicate that the observed variables were approximately normal suggesting that the multivariate normality assumption for model testing was not violated (Marshall & Mardia, 1985). Values for means, standard deviations, Cronbach‟s alphas, and inter-correlations are shown in Table 1.

***TABLE 1*: DESCRIPTIVE STATISTICS, RELIABILITY COEFFICIENTS AND INTER-CORRELATIONS (Sub-study 1)**

CSRQ factors	1	2	3	M±SD	Skewness	Kurtosis	Cr. alpha
1. Care for others/ Goal setting	-	0.46	0.42	2.82±0.40	-1.23	1.62	0.75
2. Self-responsibility		-	0.39	2.84±0.41	-1.12	1.04	0.76
3. Self-control/Respect			-	2.39±0.49	-0.65	0.56	0.65

All correlations are significant at the 0.01 level. Cr. alpha= Cronbach‟s alpha M= Mean

***TABLE 2*: FACTOR LOADINGS FOR EACH VARIABLE (Sub-study 1)**

Statements	Factor 1	Factor 2	Factor 3
I was concerned for others	0.60		

I set goals	0.67		
I supported the others in my group	0.60		
I was able to set goals	0.56		
I listened to others in my group	0.63		
I participated even when I didn‟t want to		0.57	
I practiced on my own		0.64	
I took responsibility for what I did		0.63	
I tried to do what the teacher said		0.66	
I tried hard		0.67	
I was able to control what I did			0.44
I controlled my behaviour			0.61
I did not lose my temper; I kept my cool			0.49
I made fun of some of the others			0.50
I respected others			0.63

Factor 1= Care for others/Goal setting; Factor 2= Self-responsibility; Factor 3= Self-control/Respect

To test the CSRQ structure, a CFA with maximum-likelihood estimation was performed. The hypothesised model consisted of 3 latent variables: „Care for Others/Goal Setting‟, „Self-Responsibility‟ and „Self-Control/Respect‟. As seen in Table 2, the standardised loadings ranged from 0.44 to 0.67, which are marginally acceptable. However, the CFA results indicated that the hypothesised factor structure did not have an acceptable fit (χ^2=346.21, df=87, p<0.05; χ^2/df=3.98; TLI=0.77; CFI=0.81; RMSEA=0.10). The CSRQ structure could not be supported according to the criteria suggested by statistics scholars (Browne, & Cudeck, 1993; Byrne, 2001; Marsh *et al*., 2004).

Sub-study 2

Means of the 2 PSRQ factors were 4.01 and 3.76 respectively. The standard deviations were 1.04 and 0.96 respectively. Univariate skewness (-0.86 and -0.46) and kurtosis (0.20 and -0.52) values indicated that the observed variables were approximately normal suggesting that the multivariate normality assumption for model testing was not violated (Marshall & Mardia, 1985). Values for means, standard deviations, Cronbach‟s alphas and inter-correlations are presented in Table 3.

***TABLE 3*: DESCRIPTIVE STATISTICS, RELIABILITY COEFFICIENTS AND INTER-CORRELATIONS (Sub-study 2)**

CSRQ factors	1	2	M±SD	Skewness	Kurtosis	Cr. alpha
1. Social responsibility	-	0.55	4.01±1.04	-0.86	0.20	0.88
2. Personal responsibility		-	3.76±0.96	-0.46	-0.52	0.83

All correlations are significant at the 0.01 level. Cr. alpha= Cronbach‟s alpha M= Mean

***TABLE 4*: FACTOR LOADINGS FOR EACH VARIABLE (Sub-study 2)**

Statements	Factor 1	Factor 2
I respect others	0.77	

I respect my teacher(s)	0.73	
I help others	0.75	
I encourage others	0.78	
I am kind to others	0.80	
I control my temper	0.60	
I am helpful to others	0.69	
I participate in all of the activities		0.63
I try hard		0.81
I set goals for myself		0.72
I try hard even if I do not like the activity		0.67
I want to improve		0.64
I give a good effort		0.83
I do not make any goals		0.24
Factor 1= Social responsibility	Factor 2= Personal responsibility	

To test the PSRQ structure, a CFA with maximum-likelihood estimation was performed. The hypothesised model consisted of 2 latent variables: „Social Responsibility" and „Personal Responsibility". As seen in Table 4, the standardised loading of the item "I do not make any goals" is too low, whereas those of other items are marginally acceptable. CFA results indicated that the hypothesised factor structure did not have an acceptable fit (χ^2 =324.04, df=76, $p<0.05$; χ^2/df=4.26; TLI=0.86; CFI=0.88; RMSEA=0.10). The PSRQ structure could not be supported according to the criteria suggested by statistics scholars (Browne, & Cudeck, 1993; Byrne, 2001; Marsh *et al*., 2004).

DISCUSSION

Previous structure examination studies (Chen *et al*., 2009; Li *et al*., 2011; Bekiari, 2012; Scarpa *et al*., 2012) within physical education generally hypothesised that the factor structure of existent scales are well supportive. In contrast, the current study hypothesised that the structure of the CSRQ and PSRQ would not show adequate goodness of fit. Even though this approach seems bold, it is reasonable given the existent limitations in the concepts and application of the CSRQ and PSRQ. To make a worthy contribution to this structure-development research related to the TPSR, the generalizability of these two assessments should be examined. Results of current CFAs indicated that the three-dimensional model of the CSRQ and the two-dimensional model of the PSRQ were poor fitting.

The development of the CSRQ was based on the five responsibility levels of the TPSR model (Watson *et al*., 2003). However, the study sample of Watson *et al*. (merely 130 students who attended a TPSR summer camp), might not have been adequate to assess the validity of the CSRQ. Their validity results are insufficient given that they conducted only a cross-sectional exploratory factor analysis. From their EFA, „*care for others*" and „*goal setting*" were combined into a single factor, whereas „*care for others*" and „*goal setting*" were combined into another one. However, the combined concepts were completely different in nature (Li *et al*., 2008). Compared to Hellison"s TPSR model (Hellison, 2011), the eventual results of the CSRQ showed a significant drop in elevation.

The CSRQ was used in a follow-up study. Newton *et al*. (2006) tested the moderating role played by the three-dimensional structure of responsibility between goal constructs (task orientation, ego orientation, task climate and ego climate) and dependent variables (enjoyment, future expectation, sport interest, leader respect). With the overlapping factors of the concept of responsibility, it was difficult to further discuss the results, such as why „*care for others/goal setting*" and „*self-responsibility*" had moderating effects while „*self-control/respect*" did not.

As for the PSRQ, the concepts of „*respect*" and „*caring/helping*" are associated with others, whereas, the concepts of „*effort*" and „*self-direction*" are associated with the self. It seems more logical and consistent with the conceptual framework of the TPSR that personal responsibilities and social responsibilities would constitute distinct factors (Li *et al*., 2008). However, as mentioned in the introduction, the design of the PSRQ items has some deficiencies. Furthermore, according to the TPSR (Hellison, 2003; Li *et al*., 2008), „*respect*" and „*effort*" are grounded responsibility levels, which are easier for adolescents to achieve; „*caring/helping*" and „*self-direction*" are advanced responsibility levels, which are difficult to

achieve. Most adolescents may already possess the responsibility of respect and effort in terms of physical education, while the development of caring and self-direction are relatively immature (Li *et al*., 2008; Hellison, 2011). Therefore, respect and caring/helping cannot be considered as a single factor related to „*social responsibility.*" Similarly, effort and self-direction should not be viewed as a „*personal responsibility*" factor.

CONCLUSIONS

There are some limitations in the concepts and application of the CSRQ and PSRQ, making it necessary to revise the instruments or develop new ones. Therefore, it is suggested that future studies should focus on developing a new instrument measuring students" responsibility in physical education. Furthermore, in order to develop a conceptualisation of „responsibility in a physical education context", interviews should be conducted to develop initial items. To provide more psychometric evidence for these scales, additional factor analytical tests (EFA and CFA), and tests of criterion-related validity, are recommended.

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HOW DO MOUNTAIN BIKERS AND ROAD CYCLISTS DIFFER?

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ABSTRACT

Limited research has focused on different types of cycling events and how these participants differ in terms of their socio-economic and behavioural profiles. This research attempts to fill the gap in the literature regarding the travel motives of participants in cycling events. A sample from the participants at two different cycling events in South Africa was extracted in order to identify and compare different market segments at these events. The two events selected were an ultra-cycling event (Cape Argus Cycling Tour) and an endurance race (Cape Epic). Surveys were conducted during the registration period in March 2012 and a factor analysis was performed in order to identify the motives of the participants. The t-test was conducted to identify significant differences between road cycling and mountain bikers in terms of their profiles and their motives to compete. Results confirm that the profile and motives for participating differed according to the type of cycling event. Marketers and sports event organisers need to be aware that not all participants share the same profiles and reasons for competing. The findings of this study provide valuable and clear guidelines on how to expand exposure and grow the sport of cycling in the country.

Key words: Travel motivation; Sport tourism; Cycling tourism; Cycling participants; Mountain biking; Road cycling.

INTRODUCTION

Cycle tourism is a growing and important niche tourism market that has the potential to provide a range of economic and social and environmental benefits to regional areas and the wider community (Lumsdon, 1996, 2000; Ritchie, 1998). Cycling is a well-known physical activity/sport or form of exercise (Dixon, *et al*. 2003: Cavill *et al*., 2006). Road cycling and

mountain biking events can be classified as among the most intense endurance exercises which take place in changing conditions. Both road cycling and mountain biking demand extreme physical effort and devotion and involve a certain amount of risk (Helou *et al*., 2010), and it is these qualities that make the sport one of the most popular outdoor recreational activities in the world (Rauter & Topič, 2010). However, although road cycling and mountain biking both uses 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 terrain on which the bicycles are ridden (Duroy, 2000). Lee *et al*. (2002) explain that "in road cycling, races can vary in format from single day events (criteria, time-trials, point-to-point and multiple-lap circuit races) to three week stage races. The terrain can vary from predominantly flat to extremely mountainous. In contrast, cross-country mountain bike races are mostly held on a single day

and competitors complete several laps of a circuit course over diverse off-road terrain consisting of dirt and gravel roads, narrow wilderness trails and open fields. Mountain bike races also typically include technical descents and a significant proportion of hill climbing".

Due to the distinct differences between road cycling and mountain biking, it can be assumed that the profile of the participants in the two events will differ and that they be motivated by different reasons. According to Boo and Jones (2009), motivation should be seen as a prerequisite for any events marketing strategy and motives play a role in understanding what a person wants and how to satisfy these needs (Mill & Morrison, 1985). Rachael and Douglas (2001) add that travel motives differ from one event to the next, making it critical in giving behaviour purpose and direction to target a specific market (Kreitner, 1989). Understanding the various motives for participating in cycling events, as a form of cycling tourism, may therefore play an important role in developing and increasing adherence to training programs, promoting cycling-related events, and increasing physical activity among adults (LaChausse, 2006). Past research on the sport of cycling has nevertheless mostly been limited to physiological studies of elite cyclists, strength and power output measures, and the efficacy of various training regimes (Thomas & Dyall, 1999; LaChausse, 2006) and not on the psychological aspects of cycling and the differences between different cyclists.

LITERATURE REVIEW

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 and thus can lead to different market segments. This is also evident when analysing existing literature on cycling participants and there are distinct differences in the profiles of these two types of cyclists. In the study conducted by Streicher and Saayman (2010) on the profile of road cyclist, the results showed that participants are mainly in their mid-thirties, bilingual, highly educated, male cyclists from surrounding provinces. This profile corresponds with the profile of road cyclists identified by Brown *et al*. (2009). Cessford (1995), Morey *et al*. (2002) and Getz and McConnnell (2011) did research on mountain bikers and found that mountain bikers can be seen as younger male participants, although Morey *et al*. (2002) and Getz and McConnell (2011) also found mountain bikers to be in their late thirties with "active" type of interests and professional backgrounds. These cyclists also have a level of education, a high degree of club involvement and high level of experience in the sport. Most of the riders are also involved in other sport like running,

walking and tramping. The more experienced cyclist spends more money on their bikes and improvements on their bikes.

In view of the Self-determination Theory, motivation for sport is a complex phenomenon, with most athletes having multiple motives for engagement (Pellentier *et al*., 2013). Understanding the motives of different cyclists is therefore complex. LaChausse (2006) states that due to the increasing popularity of cycling and the amount of time and money devoted to the sport, it is both timely and important to understand the reasons or motives why individuals participate in the sport. Iso-Ahola (1982:230) defines a motive as "an internal factor that arouses, directs and integrates a person‟s behaviour". A distinction is commonly made in sport between intrinsic and extrinsic motivation, frequently using the Sports

Motivation Scale (Pellentier *et al*., 1995) based on the Self-determination Theory (Deci & Ryan, 1985). In general, intrinsic motivation refers to engaging in an activity purely for the 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 leads to more positive experiences (Vallerand & Losier, 1999). When intrinsically motivated, a person is moved to act for the fun, for experiencing feelings of competence, achievement and self-determination and for the challenge entailed, rather than because of external prods, pressures, or rewards (Pelletier *et al*., 1995; Ryan & Deci, 2000). Extrinsic motivation on the other hand, pertains to the participation in sport in order to derive tangible benefits such as material (for example, trophies) or social (for example, prestige) rewards (Deci, 1975; Vallerand & Losier, 1999; Ryan & Deci, 2000).

Various other participation motivation theories explain why participants choose to participate in a particular sport, namely Nicholls‟ (1989) *Achievement Goal Theory*, Pellentier‟s *et al*. (1995) *Sport Motivation Scale*, Vallerand‟s (1997) *Hierarchical Model of Intrinsic and Extrinsic motivation*, Mallett‟s *et al*. (2007) *Sports Motivation Scale 6* (a revision on the original model) and Lonsdale‟s *et al*. (2008) *Behavioural Regulation in Sport Questionnaire*. Although not specifically tested in this research, these models provide valuable insights on the reasons people participate in sport. It is important for every sport event and other tourism product to determine participants‟ motives (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 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 participants base their decisions on (Kruger *et al*., 2011; Kruger *et al*. 2012; Kruger & Saayman, 2013).

With regard to previous research on motives of cyclists, Brown *et al*. (2009) found five motives for competing: social; embodiment; self-presentation; exploring the environment; and physical health outcomes while six motives were identified by Streicher and Saayman (2010) for competing in the Cape Argus, namely socialisation, event attractiveness, personal motivation, escape and relaxation, event attributes and event attributes. Event attractiveness was found to be the main motive for these road cyclists. LaChausse (2006) identified nine motives of competitive and non-competitive cyclists, namely 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. 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 toward the sport itself (intrinsic motivation), while the road cyclists are driven by results, reputation (prestige) and money.

Road cyclists in comparison with mountain bikers place more emphasis on the motive achievement and competition and they like to compete more. Mountain bikers on the other hand appreciate risk, the search for new adventure and getting to know more people. Skar *et al*. (2008) identified seven motives for mountain bikers, namely speed and excitement, physical exercise, contemplation, managing challenges, social relations, equipment and

attention and lastly nature and place. Getz and McConnell (2011), on the other hand, identified four factors for mountain bikers, namely 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 seem to value winning compared to other active cycling tourists. Previous research also indicates that the reasons for participation may vary by gender (Masters *et al*., 1993; King & Burke, 2000; Kolt *et al*., 2004), level of participation (Ogles & Masters, 2003) and type of activity (Croft *et al*., 1999; Ogles & Masters, 2003).

From the above it seems that road and mountain biking cyclists are not homogeneous and are motivated by different reasons and aspects of an event. This result confirms that motives for participating differ from each sporting event and, therefore, marketers and event organisers must be aware that participants are different and not make the assumption that participants are the same; they may have different motives and hence should be lured by different marketing strategies (Kruger *et al*. 2011). While previous studies focused on road cycling events in South Africa like the Cape Argus (see Streicher & Saayman, 2010), and other endurance athletes, such as marathon runners (Kruger *et al*., 2011; Kruger & Saayman, 2012) and swimmers (Kruger *et al*., 2011), limited research has focused on mountain bikers or compared the characteristics of these two types of cyclists. This research thus contributes to a greater understanding of different cyclists. Knowing the differences in characteristics of sport event participants could help identify additional factors that can encourage and motivate further participation in sporting events or attract newcomers (Šetina & Pišot, 2009). The research done at these two events may furthermore play an important role in adapting training programs, promoting other cycling events and motivating physical activity (Ogles & Masters, 2003; Filo *et al*., 2009).

PURPOSE OF THE RESEARCH

The purpose of this research is to narrow this gap by determining and comparing the profiles and motives of road and mountain biking cyclists participating in two cycling events in South Africa, respectively the Pick n Pay Cape Argus Cycle Tour (a road cycling event) and the ABSA Cape Epic (a mountain biking event). These two events are two of South Africa‟s most well-known ultra-endurance cycling events and although the Cape Argus and Cape Epic are both cycling events held in Cape Town (located in the Western Cape Province); they differ significantly from one another. The Cape Argus is South Africa‟s largest road cycling event as well as the largest individually timed cycle race in the world. The route is usually 109 kilometres and the race attracts approximately 32 000 cyclists from around the world

(Streicher & Saayman, 2010). The race gives both professionals and novices the opportunity to participate and cyclists can enter in various categories including professional, charity, corporate teams as well as tandems. The ABSA Cape Epic on the other hand is one of South Africa‟s biggest endurance mountain bike events attracting over 1 200 participants who have to participate in teams. This event attracts a large percentage of international participants and mostly attracts professional or experienced mountain bikers. The race is held over an 8-day period and includes a trail prologue. The route is approximately 800km and consists of gravel paths, rocky uphills, river crossings, technical downhills and routes in the forest (Cape Epic, 2012).

METHODOLOGY

Research design

The data were collected using the same structured self-completion questionnaire at both events. This questionnaire consisted of three sections: Sections A and B captured demographic details (gender, home language, age, occupation, home province, marital status and preferred accommodation), as well as spending behaviour (number of persons paid for, length of stay and expenditure), while Section C measured the motivational factors for competing in the respective races. In Section C, 21 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 demographic questions were based on the works of Ogles and Masters (2003) and Kotze (2006) and the items included in the motivation section were based on the research done by LaChause (2006), Brown *et al*. (2009), Rauter and Topič (2010), Streicher and Saayman (2010) and Kruger *et al*. (2011). The items included in the motivation section ranged from self-actualisation, prestige and competitive related motives.

Survey implementation

A total of 365 (Cape Argus) and 205 (Cape Epic) completed cyclist questionnaires were analysed. According to Israel (2009:6), from a population of 30 000 (N), 204 respondents (n) are considered to be representative and result in a 95% level of confidence with a ±7% sampling error. Since approximately 35 000 cyclists participated in the Cape Argus and 1200 mountain bikers participated in the Cape Epic, the number of completed questionnaires is greater than the number required. An onsite intercept survey was conducted, with field workers handing out questionnaires during registration at the Good Hope Centre in Cape Town (Cape Argus) from 8 to 10 March 2012 and at the Forum, V&A Waterfront (Cape Epic) on 24 March. The field workers were trained to ensure that they understood the aim of the study as well as the questionnaire. Cyclists were approached while they queuing for registration. Respondents were briefed about the purpose of the research beforehand to ensure that they participated willingly and responded openly and honestly.

Research limitations

One potential limitation of this research included the language barrier of participants competing in the Cape Epic. Numerous international teams participate in the race and for many English is not their first language making it difficult for them to understand and complete a questionnaire. This made it difficult to approach, and target, a percentage of

foreign participants. Future research should try making use of interpreters to aid with the research and data collation; however, this will have serious budget implications.

Data analysis

The data were captured using Microsoft© Excel© and analysed using SPSS (SPSS Inc, 2012). Firstly, the data from the Cape Argus and the Cape Epic were pooled where after, The Kaiser-Meyer-Olkin measure of sampling adequacy was used to determine whether the covariance

matrix was suitable for factor analysis. Using an Oblimin rotation with Kaiser normalisation, a principal component factor analysis was performed on the 21 motives to explain the variance-covariance structure of the set of variables through a few linear combinations of these variables. Kaiser‟s criteria for the extraction of all factors with eigenvalues larger than 1 were used. All items with a factor loading above 0.3 were considered as contributing to a factor, whereas those with loadings lower than 0.3 were considered as not correlating significantly with a factor (Steyn, 2000; Pallant, 2007).

In addition, any item that cross-loaded on 2 factors, with factor loadings greater than 0.4, was categorised in the factor where interpretability was best. A reliability coefficient (Cronbach‟s alpha) was computed to estimate the internal consistency of each factor. All factors with a reliability coefficient above 0.6 were considered as acceptable in this study (Pallant, 2007). The average inter-item correlations were also computed as another measure of reliability, which should lie between 0.15 and 0.55 (Clark & Watson, 1995).

Secondly, independent t-tests, 2-way frequency tables, and chi-square tests were used to investigate any significant differences between the participants at the Cape Argus and Cape Epic. The study used demographic variables (gender, home language, age, occupation, level of education, marital status and province of origin) and behavioural variables (length of stay, type of accommodation, expenditure, initiator of participation, and when the decision to participate was made), to examine whether there were statistically significant differences between the different type of cyclists. The results of the statistical analyses are discussed in the next section.

RESULTS

This section discusses the results of the factor analysis (travel motives) and presents the results of the *t*-tests and cross-tabulations with chi-square tests to investigate significant differences.

Factor analysis: Motives to compete

The Kaiser-Meyer-Olkin measure of sampling adequacy of 0.86 also indicated that patterns of correlation are relatively compact and yield distinct and reliable factors (Field, 2005). Barlett‟s test of sphericity also reached statistical significance ($p<0.001$), supporting the factorability of the correlation matrix (Pallant, 2007). The pattern matrix identified 5 motivation factors to compete in the Cape Argus and Cape Epic. These factors were labelled according to similar characteristics (Table 1) and accounted for 61% of the total variance. All had relatively high reliability coefficients, ranging from 0.66 (the lowest) to 0.81 (the highest). The average inter-item correlation coefficients (with values of between 0.36 and 0.50) implied internal consistency for all factors. Moreover, all items loaded on a factor with

a loading greater than 0.3, and the relatively high factor loadings indicated a reasonably high correlation between the factors and their component items. Factor scores were calculated as the average of all items contributing to a specific factor in order to interpret them on the original 5-point Likert scale of measurement.

***TABLE 1*: FACTOR ANALYSIS OF MOTIVES TO PARTICIPATE IN THE CAPE ARGUS AND CAPE EPIC EVENTS**

Motivational factors and items	**Fac. 1**	**Fac. 2**	**Fac. 3**	**Fac. 4**	**Fac. 5**
Factor 1: Event attractiveness					
Because I am a professional cyclist	0.86				
Because I am participating as part of a club	0.75				
Because this race allows me to train, qualify or prepare for other events, such as the Ironman etc.	0.63				
I am addicted to training and this event sets training targets for me	0.58				
I am pursuing a personal goal of participating in a predetermined number of cycling events	0.51				
To share group identity with other cyclists	0.34				
It is an international event	0.32				
I do it annually	0.31				
Factor 2: Achievement and challenge					
To feel proud of myself and to feel a sense of achievement		0.83			
This event is a huge challenge		0.73			
It is a must-do event		0.42			
This event tests my level of fitness and endurance		0.40			
Factor 3: Escape and socialisation					
To relax			0.79		
To get away from my routine			0.66		
To spend time with family and friends			0.65		
To meet new people			0.42		
It is a sociable event			0.40		
To improve my health			0.23		
Factor 4: Team work					
I am participating as part of a team				0.59	
Factor 5: Event novelty					
Because I enjoy cycling					0.68
Because the event is well organised					0.68
Total variance explained	61%				
Reliability coefficient	0.81	0.73	0.76	-	0.66
Average inter-item correlation	0.36	0.36	0.39	-	0.50
Mean value	2.67	3.84	3.11	2.99	4.07

As Table 1 shows, the following 5 motives were identified: *Event attractiveness* (Factor 1); *Achievement and challenge* (Factor 2); *Escape and socialisation* (Factor 3); *Team work*

(Factor 4); and *Event novelty* (Factor 5). With the highest mean value (4.07), a reliability coefficient of 0.66 and an inter-item correlation of 0.50, *Event novelty* was the most important

motive to compete. This was followed by *Achievement and challenge,* with a mean value of 3.84, a reliability coefficient of 0.73 and an inter-item correlation of 0.36. Cyclists participating in both events regarded *Escape and socialisation* as the third most important motive (3.11), with a reliability coefficient of 0.76 and an inter-item correlation of 0.39 and *Team work* (2.99) as the fourth most important motive. *Event attractiveness* obtained the lowest mean value (2.67).

Results from the independent t-tests and Tukey's post hoc multiple comparisons

Independent t-tests were used to determine whether significant differences existed between the 2 types of cycling participants in terms of their socio-demographic and behavioural variables, as well as travel motives. As Table 2 shows, there were statistical significant differences between the road cyclists (Cape Argus) and the mountain bikers (Cape Epic), based on 4 of the 5 motives, namely *Intrinsic achievement and challenge* (p=0.001), *Escape and socialisation* (p=0.001), *Team work* (p=0.001) and *Event novelty* (p=0.001). Mountain bikers were motivated more by *Event novelty* (4.20), *Achievement and challenge* (4.01), and unsurprisingly more by *Team work* (3.72). Road cyclists, on the other hand, were motivated more by *Escape and socialisation* (3.19). It is clear from these results that the type of and nature of the event substantially influenced participants‟ motives.

***TABLE 2*: DIFFERENCES IN TRAVEL MOTIVES OF CYCLISTS AND BIKERS**

Motives	Cape Argus Road cyclists N	M±SD	Cape Epic Mountain bikers N	M±SD	t-Value	p-value
Event attractiveness	304	2.89±1.048	177	2.64±0.97	0.491	0.624
Achievement and challenge	312	3.74±0.882	183	4.01±0.71	3.607	0.001*
Escape and socialisation	312	3.19±0.924	182	2.99±0.99	2.256	0.025*
Team work	265	2.53±1.414	168	3.72±1.15	9.204	0.001*
Event novelty	311	4.00±0.911	181	4.20±0.79	2.399	0.017*

*Significance at the 5% level

With regard to socio-demographic and behavioural aspects, Table 3 indicates that the Cape Argus and Cape Epic cyclists differed significantly based on age (p=0.017), nights spent in the area (p=0.001), spending per person (p=0.001), all the various spending categories (p=0.001), number of times participated (p=0.001), and the number of times participants had previously completed the respective events (p=0.001). Road cycling participants in the Cape Argus were older (mean 41.64 years), had participated in the event more times (mean 4.25 times) and had finished the race more times (mean 4 times) compared to the mountain bike cyclists in Cape Epic who were younger (mean 39 years) and had participated and finished the event fewer times (mean 1.52 and 1.61 times respectively). The mountain bike cyclists had a significant higher average spending (R20 181.32) compared to the road cyclists (R2 866.95). This is also evident when looking at the different spending categories, with the Cape Epic cyclists having significantly higher average spending across all the different categories. It is clear from these results, that the type of activity, the event in this case, and the duration

thereof greatly influenced the money required to participate in the respective events.

***TABLE 3*: COMPARISONS (t-test) OF SOCIO-DEMOGRAPHIC AND BEHAVIOURAL PROFILE OF CYCLISTS**

Variables	Cape Argus Road cyclists M±SD	N	Cape Epic Mountain bikers M±SD	N	t-value	p-value
Age	41.64±11.94	333	39.22±8.55	179	2.400	0.017*
Group size	3.49±3.54	328	3.34±2.22	203	0.051	0.614
No. of people paid for	1.57±1.32	328	1.49±1.42	187	0.602	0.547
Nights in area	4.29±3.67	207	8.26±5.18	163	8.112	0.001*
Spending per person (R)	2866.95±3960.05	287	20 181.32±27752.99	168	10.397	0.001*
Registration fee	286.51±368.22	365	7678.71±10585.30	205	13.337	0.001*
Accommodation	861.48±1801.70	365	2788.63±7411.25	205	4.728	0.001*
Transport (return)	1021.92±1673.89	365	2263.17±4493.99	205	4.728	0.001*
Sport equipment	849.73±2616.10	365	9456.39±20236.30	205	8.012	0.001*
Food and restaurants	587.43±951.90	365	1195.88±2285.11	205	4.448	0.001*
Beverages	167.67±318.74	365	654.76±3592.31	205	2.574	0.010*
Medicine	24.66±93.15	365	368.05±1088.92	205	5.989	0.001*
Souvenirs/gifts	105.89±324.57	365	493.74±2309.05	205	3.156	0.001*
Entertainment	126.85±362.52	365	364.05±1619.53	205	2.682	0.001*
No. of times participated in event	4.25±5.286	340	1.52±1.62	186	6.899	0.001*
No. of times previously completed event	4.02±5.420	309	0.91±1.61	158	7.069	0.001*

Cross-tabulations and chi-square test results

Based on the information depicted in Table 4, road cyclists and mountain bikers were statistically significantly different in terms of gender (p=0.001), home language (p=0.001), province of origin (p=0.001), marital status (p=0.001), level of education (p=0.001), when the decision was made to participate (p=0.001) and self (p=0.001), friends (p=0.001) and family (p=0.001) as initiators of participation. Although both events attracted more male cyclists, more Cape Epic cyclists were male (89% compared to 74%). Significantly more cyclists in the Cape Epic were foreign language participants (31%), while more cyclists in the Cape Argus were English-speaking. Corresponding with cyclists‟ home language, more mountain bike cyclists were foreign participants while the Cape Argus attracted more local cyclists as well as cyclists from Gauteng Province. Both events attracted cyclists from across South Africa. With regard to marital status, the majority of cyclists in both events were single (respectively 64% and 58%), while more Cape Argus cyclists were married (21%) and more Cape Epic cyclists lived together (16%). Cyclists in both events were furthermore well-educated with a diploma or degree, a post-graduate or professional qualification with more Cape Argus cyclists indicating that matric was their highest level of education. More mountain bikers initiated their participation in the Cape Epic themselves (45%), while friends (30%) also influenced their decision compared to the road cyclists who‟s participation was influenced more by their family (10%). Due to the nature of the event and the training

required, significantly more Cape Epic cyclists made the decision to participate a year ago while participation is an annual commitment (33%) for the majority of Cape Argus cyclists or they made the decision to participate more than a month ago (20%).

***TABLE 4*: PARTICIPANT CHARACTERISTICS AND CHI-SQUARE RESULTS**

Characteristics	CYCLISTS Cape Argus Road cycl.	CYCLISTS Cape Epic Mnt. bikers	CHI-Square value	df	Sign. level	PHI-value
Gender			16.722	1	0.001*	0.175
Male	74%	89%				
Female	26%	11%				
Home language			90.433	2	0.001*	0.400
Afrikaans	39%	25%				
English	59%	44%				
Other	2%	31%				
Province			514.810	22	0.001*	0.930
Western Cape	48%	20%				
Gauteng	25%	25%				
Eastern Cape	4%	2%				
North West	2%	2%				
Mpumalanga	5%	4%				
Northern Cape	2%	1%				
KwaZulu-Natal	1%	1%				
Limpopo	1%	1%				
Free State	1%	1%				
Outside RSA borders	11%	43%				
Marital status			20.277	5	0.001*	0.189
Single	64%	58%				
Married	21%	17%				
Living together	6%	16%				
Divorced	7%	5%				
Widow/er	1%	0%				
Level of education			20.583	5	0.001*	0.191
No school	1%	2%				
Matric	18%	9%				
Diploma, degree	37%	28%				
Postgraduate	23%	32%				
Professional	20%	29%				
Other	1%	1%				

cont.

***TABLE 4*: PARTICIPANT CHARACTERISTICS (cont.)**

Characteristics	CYCLISTS Cape Argus Road cycl.	CYCLISTS Cape Epic Mnt. bikers	CHI-Square value	df	Sign. level	PHI-value
Initiator of participation						

Self	No=58%	No=55%	18.785	2	0.001*	0.178
Spouse	No=93%	No=95%	2.686	2	0.261	0.067
Media	No=100%	No=99%	3.818	2	0.148	0.080
Friends	No=76%	No=70%	11.256	2	0.004*	0.138
Children	No=99%	No=99%	0.486	2	0.784	0.029
Family	No=90%	No=96%	8.779	2	0.012*	0.121
Club	No=98%	No=99%	0.798	2	0.671	0.037
Company	No=96%	No=97%	1.494	2	0.474	0.050
Decision to attend			43.575	4	0.001*	0.315
Spontaneous decision	18%	17%				
More than a month ago	20%	19%				
A year ago	26%	53%				
Annual commitment	33%	9%				

*Significance at the 5% level

DISCUSSION

The first finding from this research is that motives for participation indeed differed from one type of cycling event to the next. Five travel motives for cycling and mountain bike participants were identified namely *event attractiveness, achievement and challenge*, *escape and socialisation*, *team work* and *event novelty*; with *event novelty* regarded as the most important motive to compete in both the road and mountain biking cycling events. Corresponding with the self-determination theory, cyclists have multiple motives for participating in the events. Cyclists were furthermore motivated more by intrinsic motives than extrinsic reasons which are also consistent with self-determination theory which states that participants are pushed to achieve goals through intrinsic pressures.

When comparing the motives between the different cycling participants, road cyclists were motivated more by *escape and socialisation*. This result corresponds with the findings by Streicher and Saayman (2010) and Brown *et al*. (2009), who also found that road cyclists were motivated by socialisation and to escape. It, however, contradicts the findings by LaChausse (2006) and Rauter and Topič (2010), who did not identify it as a motive for road cyclists. Similar to the results obtained by Rauter and Topič (2010) and Getz and McConnell (2011), mountain bikers, on the other hand, were motivated significantly more by *event novelty*, *achievement and challenge* and *team work*. This finding, however, contradicts LaChausse (2006) who found that mountain bikers were motivated more by life meaning and Skar *et al*. (2008) who found that these cyclists were motivated by an array of other motives such as speed and excitement and physical exercise. An explanation for these variances could be the difference in the route distances and timing of the two events and the fact that only teams of two can participate in the Cape Epic and no individual cyclists. Cape Epic is furthermore an eight day race compared to the Cape Argus which is only a one-day event. In support of Kruger and Saayman (2012), this finding emphasises that the type of event greatly influences participants‟ motives to compete.

Therefore, the marketing campaigns of the two events should focus on these motives in order to attract more cyclists as well as to position the respective events. Since *event novelty*, *achievement and challenge* as well as *escape and socialisation* were important motives for road cyclists, it would make sense to combine *event novelty* and the fun and sociable nature

of the event with achievement of personal (intrinsic) goals in the Cape Argus marketing campaign. Mountain bikers participating in the Cape Epic also regarded event novelty and achievement and challenge along with team work as important motives. The marketing campaign for this event should, therefore, also combine the characteristics of the event (time, duration, terrain and skill required), as well as emphasise team work which is key to the event.

The second finding was that mountain bikers and road cyclists differed significantly in terms of their socio-demographic and behavioural characteristics, thereby confirming the notion by Faulks *et al*. (2006) and Kruger *et al*. (2011), that cycling participants cannot be regarded as homogeneous in terms of their profiles and reasons (motives) for competing. The profile of the road cyclist furthermore corresponded with the profile identified by Streicher and Saayman (2010) and Brown *et al*. (2009), while the profile of the mountain bikers also corresponded with the profile compiled by Cessford (1995), Getz and McConnell (2001) and Morey *et al*. (2002). Therefore, if one wants to attract these cycling markets for which ever reason, their profile seems to be similar in all studies conducted internationally. This has the advantage that the marketing campaign used nationally will most probably be successful for the international market. Marketers and organisers of cycling events should furthermore take the results of this research into consideration; to not only sustain the respective events, but also to grow the sport of cycling.

The advantage that cycling events have, which was also a key finding from this research, is that the sport of cycling can appeal to various participants, since their profiles and motives for participating in the respective events differ. Cycling can thus appeal to a variety of participants in terms of fitness level, endurance and challenge. There are various cycling events held in the country and these events should work together to not only promote their events, but also to create greater awareness of the sport. This in return can also increase tourism to the areas where these events are held thereby contributing towards sport tourism in South Africa. The main goal of sport organisers should be to make cycling events accessible to all people of South Africa irrespective of ability, gender, race or geographic location.

In terms of specific variables some interesting results were found, for example, mountain bikers spent significantly more compared to road cyclists. The nature of the two events needs to be taken into consideration (a one-day event versus an eight-day event; the type of bike required as well as additional equipment). However, these results can be seen as a useful tool for event managers who plan to host similar events. If the focus of their planned cycling event is to have a significant economic impact then multiple day events are the preferred option. From an environmental point of view road cycling can have a lesser impact since it takes place on existing infrastructure. Mountain biking events generally take place in natural

settings that if it is not well planned could have a far greater negative environmental impact. It is, therefore, recommended that the route for mountain biking events change periodically in order to manage the impact as well as give cyclists an added challenge of an unfamiliar route.

Another interesting result is that, taking the number of previous races into consideration, road cyclists were more loyal to this specific event compared to mountain bikers. From a marketing perspective, it is therefore easier to attract and retain road cyclists. A possible reason for mountain bikers being less loyal could be their drive for adventure and that the same route might not be that challenging the second time round. Hence, event managers

should be aware of this and, as mentioned, change routes regularly.

CONCLUSION

Internationally cycling tourism is a growing phenomenon which leads to an increase in the number of events and participants. This also leads to an increased need in a greater understanding of participants of such events. This research compared the participants at two different cycling events and found that they differed significantly. These differences are especially evident when one compares the socio-demographic and behavioural characteristics. In addition the events also differ significantly. These results and subsequent findings fill a gap in the literature concerning cycling events and their participants. From this research various lessons are learned that can assist event managers in their decision taking as indicated in the section above. It is recommended that future research focus on possible reasons for the differences between these two types of cyclists in more depth over and above their socio-demographic and behavioural aspects and motivational factors. These include the event and its associated characteristics, namely the type of cycle, the distance, the level of fitness required, duration of the activity, the terrain. In addition, loyalty to the event and a sense of adventure versus tradition should also be analysed as this could provide valuable information on the nature of mountain bikers and road cyclists.

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CORRELATION BETWEEN ANTHROPOMETRICAL AND HEALTH-RELATED PHYSICAL FITNESS COMPONENTS FOR 7- TO 10-YEAR-OLD RURAL AND URBAN BOYS IN THE EASTERN CAPE PROVINCE

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ABSTRACT

Overweight and obesity that is increasing among South African pre-adolescent boys can be attributed to lack of physical fitness, thus suggesting that correlation exists between anthropometrical and health-related physical fitness components. This

correlation is still under researched in the Eastern Cape Province. The aim of this study was to determine the correlation between anthropometrical and health-related physical fitness components among 7- to 10-year-old rural and urban boys (N=325). Descriptive statistics and the Spearman correlation ($p<0.05$) were used to analyse the data. Anthropometrical and health-related physical fitness components showed no strong correlation among all 7- to 9-year-old rural and urban boys. Stature correlated positively with right and left handgrip muscle strength among 10-year-old rural ($r=0.71$ and $r=0.61$; $p<0.001$) and urban boys ($r=0.67$ and $r=0.60$; $p<0.001$). BMI correlated positively with 10m- and 35m-dash among 10-year-old rural ($r=0.84$ and $r=0.77$; $p<0.001$) and urban boys ($r=0.81$ and $r=0.78$; $p<0.001$). The correlations were similar for 10-year-old rural and urban boys, suggesting that the environment may have a minimal effect on correlations between certain anthropometrical and health-related physical fitness components as boys grow older.

Key words: Anthropometrical components; Health-related physical fitness; Correlation; Rural and urban boys.

INTRODUCTION

The increasing prevalence of overweight and obesity, especially among children, has reached epidemic proportions globally (Mirmohammadi *et al*., 2011). The prevalence of overweight and obesity has also increased rapidly among South African children and adolescents (Toriola *et al*., 2012). Overweight and obesity exacerbate the development of chronic diseases, including diabetes mellitus (Wellen & Hotamisligil, 2005), cardiovascular disease, hypertension (Sorof & Daniels, 2002; Daniels, 2006), stroke and certain forms of cancer (Daniels, 2006) during adulthood.

The prevalence of overweight and/or obesity among South African men was 29.2% in 1998 (Puoane *et al*., 2002). This epidemic is also being observed among children. The prevalence of overweight and obesity among 6- to 13-year-old South African boys was 10.9% and 2.4%, respectively in 2004 (Armstrong *et al*., 2006). Pestana *et al*. (1996) reported that South

Africa's direct and indirect costs of cardiovascular diseases were between R4 and R5 billion in 1991. The overweight and obesity related diseases, which is currently overburdening South African's economy/healthcare systems, is most likely to escalate due to this increasing prevalence of overweight and obesity among South African children and adolescents (Goedeckee *et al*., 2006). Since it is well documented that overweight and obesity tracks from childhood into adulthood (Venn *et al*., 2007; Rossouw *et al*., 2012), it is, therefore, essential that possible interventions focus on children.

The epidemiologists suggest that the lack of physical activity and/or low physical fitness levels are some of the reasons that contribute to the increased prevalence of overweight and obesity in the last 20 years among boys (Lobstein *et al*., 2004; Brunet & Tremblay, 2007; Mak *et al*., 2010). Physical fitness can be thought of as an integrated measure of most, if not all, of the body functions involved in the performance of daily physical activity and/or physical exercise (Martinez-Vizcaino & Sanchez-Lopez, 2008; Ortega *et al*., 2008).

There are some physical fitness components that were found to be directly related to health,

which resulted in the words being coined into 'health-related' physical fitness components (Powell *et al*., 2009). Some of these health-related physical fitness components are: flexibility; muscular strength; muscular endurance; agility; speed; cardiovascular endurance; and body composition (Moliner-Urdiales *et al*., 2011). For the purpose of this article, the term health-related physical fitness components will be used to describe the mentioned components.

Certain anthropometrical components, such as weight, body mass index (BMI) and body fat percentage (%BF) have a negative correlation with certain physical fitness tests in which the body is projected through space (Malina *et al*., 2004; Wilmore *et al*.,2008), or moving forward (Monyeki *et al*., 2005), such as long jump and sprinting. Brunet and Tremblay (2007) reported a negative correlation between BMI and standing long jump among 7- to 10-year-old Canadian boys. A negative correlation was reported between BMI and PACER (Progressive Aerobic Cardiovascular Endurance test), and between body fat percentage and PACER among 9- to 12-year-old South African children (Truter *et al*., 2010). In contrast, Monyeki *et al*. (2005) observed a positive correlation between high BMI and standing long jump among 7- to 14-year-old rural boys in Ellisras, South Africa. BMI correlated positively with 35m-dash among 8.5- to 14.5-year-old rural Senegalese boys (Benefice, 1998). A negative correlation was observed between body fat percentage and 20m shuttle run test among 5- to 13-year-old urban American boys (Kim *et al*., 2005).

On the other hand, Malina (1994) and Benefice and Malina (1996) reported that weight had a positive correlation with performance where no body movement was required, such as handgrip muscle strength tests. This was supported by Gandhi *et al*. (2010) who reported a positive correlation between weight and handgrip muscle strength among 6- to 16-year-old Indian boys, and Dana *et al*. (2011) reported similar results for 7- to 11-year-old rural and urban Iranian boys. Stature correlated positively with right and left handgrip muscle strength among 7- to 11-year-old rural and urban Iranian boys (Dana *et al*., 2011). No correlation was observed between weight and the sit-up test among 7- to 11-year-old rural and urban Iranian boys (Dana *et al*., 2011).

PURPOSE OF THE RESEARCH

The various studies mentioned with sometimes conflicting findings, would suggest that not only is there a correlation between certain anthropometrical and health-related physical fitness components, but that correlations are different in different populations. This suggests that more investigation is needed especially among Eastern Cape boys, as no similar studies could be found for this specific region in South Africa. Therefore, the purpose of this study was to determine the correlation between anthropometrical and health-related physical fitness components among 7- to 10-year-old rural and urban boys in the Eastern Cape Province.

METHODOLOGY

Ethical clearance

Informed consent letters were given to all parents/legal guardians for the boys to participate in this study. The Eastern Cape Education Department also provided permission to conduct this study. The University of Fort Hare ethical committee further granted approval (03-REC-270710–028) to conduct this study.

Participants

The research design is a one-way cross sectional design based on baseline data. A total of 4 schools were selected by using a stratified random sampling method. Stratified random sampling is a probability sampling technique of dividing 2 or more homogeneous subgroups based on categories of interest (Cesar & Carvalho, 2011). Two schools were selected in a rural area (Nkonkobe municipality) and 2 schools in 2 urban areas (King William's Town, Buffalo City Municipality and East London, Amathole Municipality). A rural area is classified as a place where people are living on farms or in traditional villages, which is characterised by low population densities, low levels of economic activity alongside a low level of infrastructure (Milne & Taylor, 2006). An urban area is classified as a city or town with higher population densities, high levels of economic activities and high levels of infrastructure (Milne & Taylor, 2006). The total sample size consisted of 325 (139 rural and 186 urban), 7- to 10-year-old boys from the Eastern Cape Province.

Measurements

Four anthropometrical components were measured, namely weight, stature, and 2 skinfolds (triceps and calf). All skinfolds measurements were done with the Level 1 International Society for the Advancement of Kinanthropometry (ISAK) technicians who performed tests (3 times) on each subject according to the International Standards for the Anthropometric Assessment (Stewart *et al*., 2011). BMI was calculated from weight (kg) and height (m) using the equation (kg/m^2). The sum of 2 skinfolds (triceps and calf) was used to calculate body fat percentage (Slaughter *et al*., 1988). The reliability and validity of all health-related physical fitness tests have been verified by some physical field test batteries and researchers as follows: vertical jump; sit-and-reach (Meredith & Welk, 2004); agility test (r=0.90) (Johnson & Nelson, 1986); 10m- and 35m-dash (r=0.67) (Mackenzie, 2005); right handgrip (r=0.70) and left (r=0.67) handgrip tests (EUROFIT, 1993); 1-minute press-up (Meredith & Welk, 2004); 2-minute sit-up (Johnson & Nelson, 1986); and 1-mile walk/run (Meredith & Welk, 2004).

Statistical analyses

Descriptive statistics and Spearman correlation were used to determine mean and standard deviations of all anthropometrical and health-related physical fitness components. Spearman's correlation method is a statistical measure of the strength or weakness of 2 variables when paired together, that is, either the variables increase in value together, or 1 decreases when the other increases (Spearman, 1905). The Spearman correlation method ($p<0.05$) was used to evaluate the correlation between anthropometrical and health-related physical fitness components among 7- to 10-year-old rural and urban boys. Strong correlations range between r=0.70 to 0.90 /or -0.70 to -0.90 and moderate correlations range between r=0.45 to 0.70 /or -0.45 to -0.70 were considered, while weak correlations, less than r<0.45/-0.45, were not reported.

RESULTS

The means and the standard deviations of the anthropometrical and health-related physical fitness components for 7- to 10-year-old rural and urban boys are summarised in Table 1 and

2. According to the results, the urban boys presented higher mean values in most of the anthropometrical (weight, stature, BMI and body fat percentage) and health-related physical fitness (flexibility, muscular strength, muscular endurance, agility, speed and cardiovascular endurance) components in all age groups.

***TABLE 1*: RURAL BOYS AGE GROUPS: DESCRIPTIVE STATISTICS OF ANTHROPOMETRICAL AND HEALTH-RELATED PHYSICAL FITNESS MEASURES**

Measures	**7 years** (n=41) M±SD	**8 years** (n=47) M±SD	**9 years** (n=30) M±SD	**10 years** (n=21) M±SD
Weight (kg)	26.4±7.2	29.7±5.8	32.1±7.2	34.4±10.5
Stature (cm)	122.4±6.3	129.3±6.4	133.3±6.3	140.0±0.1
Body mass index (kg/m²)	17.5±7.2	17.6±2.7	17.9±2.8	18.1±4.5
Body fat percentage (%)	18.9±9.8	20.5±8.0	19.0±8.2	18.1±8.6
Sit-and-reach (cm)	40.3±5.1	40.9±5.7	44.6±7.8	39.5±7.3
Vertical jump (cm)	14.0±5.1	15.2±4.6	15.5±4.7	21.3±6.4
Agility (sec)	18.5±2.5	16.6±2.1	15.1±1.9	15.2±2.6
10m-dash (sec)	2.5±0.2	2.4±0.2	2.3±0.2	2.2±0.3
35m-dash (sec)	7.8±1.2	7.4±0.7	6.8±0.6	6.7±0.9
Right handgrip (kg)	13.6±3.0	15.3±3.8	15.5±3.2	17.8±3.3
Left handgrip (kg)	13.0±3.0	14.6±3.3	16.2±4.1	17.9±4.3
1-min press-ups (n)	9.1±4.7	11.1±7.5	10 ± 7.2	12.0±6.3
2-min sit-ups (n)	21.3±12.3	21.8±13.4	25.5±14.7	31.1±19.6
1-mile walk/run (min)	12.6±3.1	12.1±2.5	12.5±2.6	12.4±2.6

***TABLE 2*: URBAN BOYS AGE GROUPS: DESCRIPTIVE STATISTICS OF ANTHROPOMETRICAL AND HEALTH-RELATED PHYSICAL FITNESS MEASURES**

Measures	**7 years** (n=41) M±SD	**8 years** (n=47) M±SD	**9 years** (n=30) M±SD	**10 years** (n=21) M±SD
Weight (kg)	26.8±5.3	31.2±6.4	35.9±8.9	39.5±13.6
Stature (cm)	124.8±5.4	131.3±6.5	136.1±6.8	143.9±7.7
Body mass index (kg/m²)	17.2±2.8	18.1±3.0	19.2±3.8	20.4±7.2
Body fat percentage (%)	16.4±6.5	17.6±5.9	19.7±7.2	25.4±13.6
Sit-and-reach (cm)	41.1±6.9	40.8±5.8	38.9±6.7	39.2±5.7
Vertical jump (cm)	17.3±5.2	17.9±3.9	17.6±6.1	18.3±3.7
Agility (sec)	16.9±2.5	15.0±1.8	14.0±2.0	13.9±3.2
10m-dash (sec)	2.4±0.2	2.3±0.2	2.2±0.17	2.1±7.48
35m-dash (sec)	7.6±0.6	8.6±10.2	7.0±0.6	6.5±0.7
Right handgrip (kg)	14.3±2.9	15.6±6.0	17.6±2.9	19.2±4.2
Left handgrip (kg)	13.9±2.3	14.7±3.6	16.8±4.1	19.2±3.3
1-min press-ups (n)	9.1±5.7	8.2±6.3	10.1±5.8	10.4±6.8
2-min sit-ups (n)	25.1±12.3	23.7±12.4	30.8±19.5	32.1±19.6
1-mile walk/run (min)	11.0±3.2	9.9±1.8	10. 2±2.5	10.3±2.5

Most of the anthropometrical components increased consistently with age among 7- to 10-

year-old rural and urban boys. In Table 1, the 8-year-old boys had the highest body fat percentage value (20.5±8.0) compared to the other age groups. The 9-year-old boys had the best mean for the sit-and-reach test value (44.6±7.8) among all rural boys and the 1-minute press-up value (10±7.2) was lower than the 8-year-old 1-minute press-up test (11.1±7.5). Table 2 indicates that the 7-year-old boys had the best value in the sit-and-reach test (41.1±6.9). The 8-year-old urban boys had the fastest 1-mile walk/run value (9.9±1.8), while the 9-year-old rural boys had the best sit-and-reach value of (44.6±7.8) (Table 1). The 8-year-old boys had the poorest mean values on the 35m-dash test (8.6±10.2 sec), 1-minute press-up (23±12.4) and 2-minute sit-up test (23±12.4) among other urban boys (Table 2).

No strong correlations were found between anthropometrical and health-related physical fitness components among **7-year-old** rural and urban boys, thus only moderate correlations were reported in Table 3. A correlation was found between weight and right and left handgrip muscle strength (r=0.57 and r=0.47; p<0.001), and between stature and right and left handgrip muscle strength (r=0.50; p<0.003 and r=0.55; p<0.004), among the *rural* boys. There was a positive correlation between weight and left handgrip muscle strength (r=0.48; p<0.001) and between stature and the left handgrip (r=0.56; p<0.001) among the *urban* boys. A correlation between BMI and right handgrip (r=0.47; p<0.001) exists for *rural* boys. There was a negative correlation between BMI and 1-mile walk/run for *rural boys* (r=-0.46; p<0.001) and a positive relationship for *urban* boys (r=0.48; p<0.007). Between weight and 1-mile walk/run for *urban* boys the relationship (r=-0.45; 0.001) was also negative.

***TABLE 3*: CORRELATION (r) BETWEEN ANTHROPOMETRICAL AND HEALTH-RELATED PHYSICAL FITNESS TESTS FOR 7-YEAR-OLD RURAL AND URBAN BOYS**

Measures	Area	Weight	Stature	BMI	% Body fat
Vertical jump (cm)	Rural	r=0.12; p<0.060	r=0.32; p<0.04	r=0.31; p<0.009	r=0.24; p<0.003
	Urban	r=0.14; p<0.503	r=0.06; p<0.72	r=0.11; p<0.061	r=0.02; p<0.130
Sit-and-reach (cm)	Rural	r=0.28; p<0.100	r=0.06; p<0.691	r=0.07; p<0.671	r=0.20; p<0.240
	Urban	r=0.29; p<0.052	r=0.45; p<0.001	r=0.10; p<0.002	r=0.07; p<0.630
Agility (sec)	Rural	r=0.03; p<0.610	r=0.26; p<0.372	r=0.08; p<0.813	r=0.32; p<0.180
	Urban	r=0.14; p<0.350	r=0.01; p<0.501	r=0.17; p<0.220	r=0.23; p<0.033
10m-dash (sec)	Rural	r=0.27; p<0.011	r=0.16; p<0.196	r=0.41; p<0.001	r=0.38; p<0.001
	Urban	r=0.11; p<0.006	r=0.19; p<0.843	r=-0.03; p<0.273	r=0.05; p<0.392
35m-dash (sec)	Rural	r=0.08; p<0.210	r=0.31; p<0.071	r=0.26; p<0.006	r=0.29; p<0.001
	Urban	r=-0.03; p<0.470	r=0.17; p<0.501	r=0.04; p<0.551	r=0.24; p<0.001
Right handgrip (kg)	Rural	r=0.57; p<0.001^	r=0.50; p<0.003^	r=0.47; p<0.001^	r=0.35; p<0.001
	Urban	r=0.40; p<0.001	r=0.30; p<0.006	r=0.40; p<0.023	r=0.20; p<0.005
Left handgrip (kg)	Rural	r=0.47; p<0.001^	r=0.55; p<0.004^	r=0.32; p<0.001	r=0.32; p<0.001
	Urban	r=0.48; p<0.001^	r=0.56; p<0.001^	r=0.35; p<0.001	r=0.39; p<0.003
1-min Press-up (n)	Rural	r=0.34; p<0.23	r=0.11; p<0.776	r=0.30; p<0.001	r=0.39; p<0.061
	Urban	r=0.19; p<0.20	r=0.11; p<0.230	r=0.17; p<0.242	r=0.13; p<0.889
2-min Sit-up	Rural	r=0.22; p<0.02	r=0.07; p<0.473	r=0.26; p<0.524	r=0.32; p<0.212

(n)	Urban	r=0.03; p<0.64	r=0.19; p<0.140	r=0.13; p<0.093	r=0.19; p<0.090
1-mile walk/run	Rural	r=0.37; p<0.001	r=0.02; p<0.031	r=-0.46; p<0.001^	r=0.22; p<0.001
(min)	Urban	r=-0.45; p<0.001^	r=0.14; p<0.891	r=0.48; p<0.007^	r=0.43; p<0.001

*p<0.05 **Strong correlations: 0.70 to 0.90 or -0.70 to -0.90 ^ Moderate correlation: 0.45 to 0.69 or -0.45 to -0.69

No strong correlations were found between anthropometrical and health-related physical fitness components among **8-year-old** rural and urban boys, thus only moderate correlation are reported in Table 4. There was a correlation between weight and the 1-minute press-up test (r=0.48; p<0.001) and the left handgrip muscle strength test (r=0.53; p<0.001), among the *urban* boys. A correlation was found between stature and right handgrip (r=0.52; p<0.001) and left handgrip (r=0.46; p<0.001**),** muscle strength among the *rural* boys. BMI and the 10m-dash test correlate among the *rural* (r=0.53; p<0.001) and *urban* (r=0.54; p<0.005) boys, while BMI and left handgrip muscle strength correlate (r=0.46; p<0.003) among the *urban* boys. There was a negative correlation between BMI and the 1-mile walk/run test (r= -0.47; p<0.001) among the *urban* boys. The percentage body fat and agility correlate negatively (r=-0.48; p<0.001) for the *rural* boys.

***TABLE 4*: CORRELATION (r) BETWEEN ANTHROPOMETRICAL AND HEALTH-RELATED PHYSICAL FITNESS TESTS AMONG 8-YEAR-OLD RURAL AND URBAN BOYS**

Measures	Area	Weight	Stature	BMI	% Body fat
Vertical jump	Rural	r=0.08; p<0.601	r=0.33; p<0.001	r=0.06; p<0.110	r=0.33; p<0.001
(cm)	Urban	r=0.24; p<0.002	r=0.05; p<0.260	r=0.30; p<0.061	r=0.05; p<0.261
Sit-and-reach	Rural	r=0.10; p<0.050	r=0.04; p<0.091	r=0.08; p<0.210	r=0.31; p<0.800
(cm)	Urban	r=0.05; p<0.711	r=0.07; p<0.900	r=0.04; p<0491	r=0.33; p<0.008
Agility	Rural	r=0.40; p<0.110	r=0.13; p<0.401	r=0.44; p<0.001	r=-0.48; p<0.001^
(sec)	Urban	r=0.11; p<0.0816	r=0.01; p<0.001	r=0.21; p<0.001	r=0.17; p<0.071
10m-dash	Rural	r=0.36; p<0.001	r=0.05; p<0.995	r=0.53; p<0.001^	r=0.23; p<0.022
(sec)	Urban	r=0.44; p<0.001	r=-0.19; p<0.133	r=0.54; p<0.005^	r=0.21; p<0.155
35m-dash	Rural	r=0.09; p<0.266	r=0.28; p<0.001	r=0.29; p<0.007	r=0.24; p<0.019
(sec)	Urban	r=0.21; p<0.211	r=0.17; p<0.176	r=0.16; p<0.118	r=0.39; p<0.009
Right handgrip	Rural	r=0.34; p<0.002	r=0.52; p<0.001^	r=0.12; p<0.641	r=0.01; p<0.188
(kg)	Urban	r=0.27; p<0.001	r=0.31; p<0.007	r=0.16; p<0.001	r=0.13; p<0.030
Left handgrip	Rural	r=0.33; p<0.011	r=0.46; p<0.001^	r=0.15; p<0.041	r=0.14; p<0.611
(kg)	Urban	r=0.53; p<0.001^	r=0.36; p<0.008	r=0.46; p<0.003^	r=0.17; p<0.261
1-min Press-up	Rural	r=0.15; p<0.600	r=0.04; p<0.281	r=0.17; p<0.110	r=0.34; p<0.059
(n)	Urban	r=0.48; p<0.001^	r=0.13; p<0.131	r=0.43; p<0.251	r=0.40; p<0.001
2-min Sit-up	Rural	r=0.03; p<0.961	r=0.05; p<0.144	r=0.01; p<0.711	r=-0.09; p<0.903
(n)	Urban	r=0.17; p<0.056	r=0.18; p<0.061	r=0.12; p<0.339	r=0.09; p<0.711
1-mile walk/run	Rural	r=0.23; p<0.055	r=0.03; p<0.819	r=0.28; p<0.056	r=0.30; p<0.006
(min)	Urban	r=0.42; p<0.001	r=0.14; p<0.018	r=-0.47; p<0.001^	r=0.42; p<0.001

*p<0.05 **Strong correlations: 0.70 to 0.90 or -0.70 to -0.90 ^ Moderate correlation: 0.45 to 0.69 or -0.45 to -0.69

Table 5 presents no strong correlation between anthropometrical and health-related physical fitness components among **9-year-old** rural and urban boys, thus only moderate correlation were reported. Weight correlated with right (r=0.50; p<0.001) and left (r=0.48; p<0.001) handgrip muscle strength among the *rural* boys. However, weight correlated negatively with agility (r= -0.47; p<0.001), the 10m-dash (r= -0.48; p<0.001) and the 35m-dash (r= -0.48, p<0.001), among *urban* boys. For the *urban* boys, stature and the 1-minute press-up test correlated positively (r=0.49; p<0.001). In the case of the *rural* boys, BMI correlated positively with the 10m-dash test (r=0.53; p<0.001) and the right handgrip test (r=0.45; p<0.001). The BMI of the *urban* boys also correlated positively with the right handgrip test (r=0.62; p<0.001) and the 1-mile walk/run test (r=0.57; p<0.004). Lastly, body fat percentage correlated negatively with the 10m-dash test (r= -0.47; p<0.001) and the 1-mile walk/run (r=-0.57; p<0.001), among the 9-year-old *urban* boys.

***TABLE 5*: CORRELATION (r) BETWEEN ANTHROPOMETRICAL AND HEALTH-RELATED PHYSICAL FITNESS TESTS AMONG 9-YEAR-OLD RURAL AND URBAN BOYS**

Measures	Area	Weight	Stature	BMI	% Body fat
Vertical jump (cm)	Rural	r=0.03; p<0.700	r=0.14; p<0.168	r=-0.09; p<0.619	r=-0.03; p<0.161
	Urban	r=-0.09; p<0.911	r=0.23; p<0.009	r=-0.25; p<0.001	r=-0.08; p<0.064
Sit-and-reach (cm)	Rural	r=0.07; p<0.633	r=0.25; p<0.003	r=-0.00; p<0.035	r=-0.05; p<0.151
	Urban	r=-0.06; p<0.122	r=-0.09; p<0.789	r=0.03; p<0.121	r=0.28; p<0.009
Agility (sec)	Rural	r=-0.20; p<0.110	r=0.05; p<0.110	r=0.27; p<0.001	r=-006; p<0.220
	Urban	r=-0.47; p<0.001^	r=0.24; p<0.001	r=0.46; p<0.005^	r=0.39; p<0.002
10m-dash (sec)	Rural	r=0.37; p<0.003	r=0.11; p<0.111	r=0.53; p<0.001^	r=0.25; p<0.001
	Urban	r=-0.48;p<0.001^	r=0.06; p<0.791	r=0.62; p<0.001^	r=-0.47;p<0.001^
35m-dash (sec)	Rural	r=0.26; p<0.003	r=0.05; p<0.801	r=0.27; p<0.001	r=0.36; p<0.001
	Urban	r=-0.48;p<0.001^	r=0.11; p<0.001	r=0.59; p<0.001^	r=0.36; p<0.001
Right handgrip (kg)	Rural	r=0.50; p<0.001^	r=0.41; p<0.001	r=0.45; p<0.001^	r=0.29; p<0.001
	Urban	r=0.25; p<0.052	r=-0.25; p<0.916	r=0.10; p<0.010	r=0.14; p<0.841
Left handgrip (kg)	Rural	r=0.48; p<0.001^	r=0.33; p<0.001	r=0.41; p<0.004	r=0.21; p<0.002
	Urban	r=0.01; p<0.090	r=0.07; p<0.910	r=-0.01; p<0.100	r=0.06; p<0.091
1-min Press-up (n)	Rural	r=0.40; p<0.001	r=0.44; p<0.001	r=0.28; p<0.006	r=0.30; p<0.001
	Urban	r=0.49; p<0.060	r=0.49; p<0.001^	r=0.46; p<0.061	r=0.40; p<0.001
2-min Sit-up (n)	Rural	r=-0.28; p<0.582	r=-0.08; p<0.067	r=-0.32; p<0.111	r=0.33; p<0.001
	Urban	r=0.42; p<0.001	r=-0.20; p<0.856	r=0.42; p<0.001	r=0.43; p<0.003
1-mile walk/run (min)	Rural	r=0.44; p<0.001	r=0.29; p<0.004	r=0.40; p<0.001	r=0.39; p<0.001
	Urban	r=0.42; p<0.055	r=0.21; p<0.050	r=0.57; p<0.004^	r=-0.57;p<0.001^

*p<0.05 **Strong correlations: 0.70 to 0.90 or -0.70 to -0.90 ^ Moderate correlation: 0.45 to 0.69 or -0.45 to -0.69

Several moderate correlations were found between weight and certain health-related physical fitness components among **10-year-old** rural and urban boys (Table 6). Weight correlated

with right and left handgrip muscle strength (r=0.66 and r=0.61; p<0.001) and (r=0.62 and r=0.60; p<0.001) among the *rural and urban* boys respectively. However, weight correlated negatively with the 1-minute press-up test (r=-0.56 and r=-0.52; p<0.001) and 2-minute sit-up test (r=-0.64 and r= -0.62; p<0.001), among *rural and urban* boys respectively. In the case of the *urban* boys, weight also correlated negatively with the 35m-dash (r=-0.48; p<0.001). Stature correlated with right handgrip muscle strength (r=0.71 and r=0.61; p<0.001) and left handgrip muscle strength (r=0.67 and r=0.60; p<0.001), for the *rural and urban* boys respectively.

***TABLE 6*: CORRELATION (r) BETWEEN ANTHROPOMETRICAL AND HEALTH-RELATED PHYSICAL FITNESS TESTS AMONG 10-YEAR-OLD RURAL AND URBAN BOYS**

Measures	Area	Weight	Stature	BMI	% Body fat
Vertical jump (cm)	Rural	r=0.32; p<0.001	r=0.20; p<0.571	r=0.39; p<0.001	r=0.35; p<0.001
	Urban	r=0.31; p<0.001	r=0.02; p<0.920	r=0.32; p<0.001	r=0.43; p<0.007
Sit-and-reach (cm)	Rural	r=0.23; p<0.119	r=0.24; p<0.672	r=0.35; p<0.001	r=0.20; p<0.120
	Urban	r=0.07; p<0.688	r=0.12; p<0.550	r=0.35; p<0.029	r=0.01; p<0.330
Agility (sec)	Rural	r=0.32; p<0.122	r=0.01; p<0.911	r=0.39; p<0.008	r=0.31; p<0.071
	Urban	r=0.09; p<0.766	r=0.02; p<0.140	r=0.08; p<0.678	r=0.11; p<0.009
10m-dash (sec)	Rural	r=0.42; p<0.001	r=0.14; p<0.201	r=0.84; p<0.001*	r=0.45; p<0.001^
	Urban	r=0.06; p<0.877	r=-0.00; p<0.991	r=0.81; p<0.001*	r=0.15; p<0.851
35m-dash (sec)	Rural	r=0.35; p<0.002	r=0.09; p<0.481	r=0.77; p<0.001*	r=0.35 p<0.001
	Urban	r=-0.49; p<0.001^	r=0.31; p<0.122	r=0.78; p<0.001*	r=0.38; p<0.001
Right handgrip (kg)	Rural	r=0.66; p<0.001^	r=0.71; p<0.001^	r=0.20; p<0.030	r=0.29; p<0.001
	Urban	r=0.62; p<0.001^	r=0.67; p<0.001^	r=0.60; p<0.001^	r=0.45; p<0.001^
Left handgrip (kg)	Rural	r=0.61; p<0.001^	r=0.61; p<0.001^	r=0.19; p<0.327	r= 0.22; p<0.004
	Urban	r=0.60; p<0.001^	r=0.60; p<0.001^	r=0.55; p<0.001^	r=0.49; p<0.001^
1-min Press-up (n)	Rural	r=-0.56; p<0.001^	r=0.29; p<0.189	r=0.41; p<.001	r=-0.54; p<0.001^
	Urban	r=-0.52; p<0.001^	r=-0.17; p<0.221	r=0.41; p<0.007	r=-0.53; p<0.001^
2-min Sit-up (n)	Rural	r=-0.64; p<0.001^	r=0.42; p<0.011	r=0.40; p<0.001	r=0.41; p<0.001
	Urban	r=-0.62; p<0.001^	r=0.05; p<0.911	r=0.38; p<0.083	r=0.43; p<0.002
1-mile walk/run (min)	Rural	r=0.40; p<0.003	r=0.10; p<0.010	r=0.40; p<0.007	r=-0.52; p<0.001^
	Urban	r=0.42; p<0.001	r=0.22; p<0.111	r=-0.53; p<0.001^	r=-0.55; p<0.001^

*p<0.05 **Strong correlations: 0.70 to 0.90 or -0.70 to -0.90 ^ Moderate correlation: 0.45 to 0.69 or -0.45 to -0.69

BMI correlated with the 10m-dash test (r=0.84 and r=0.81; p<0.001) and the 35m-dash test (r=0.77 and r=0.78; p<0.001), for the *rural and urban* 10-year-old boys. Furthermore, BMI correlated positively with right and left handgrip muscle strength (r=0.60 and r=0.55; p<0.001), among *urban* boys respectively, while BMI correlated negatively with the 1-mile walk/run (r= -0.53; p<0.001) of the *urban* boys.

Body fat percentage correlated positively with the left (r=0.49; p<0.001) and right (r=0.45;

p<0.001) handgrip test of the *urban* boys, however, body fat percentage correlated negatively with the 1-minute press-up test (r= -0.54 and r= -0.53; p<0.001) and the 1-mile walk/run (r=-0.52 and r=-0.55; p<0.001), among *rural and urban* boys respectively. Finally, body fat percentage correlated positively with the 10m-dash (r=0.45; p<0.001) in the case of the *rural* boys.

DISCUSSION

The aim of this study was to determine the correlation between anthropometrical and health-related physical fitness components among 7- to 10-year-old rural and urban boys. The study indicated that **weight** correlated negatively with the sit-up test among 10-year-old rural boys. This contradicts the findings of Dana *et al*. (2011) who found no correlation between weight and the sit-up test among 7- to 11-year-old rural and urban boys. With regard to the previous studies, Malina *et al*. (2004), Gandhi *et al*. (2010) and Dana *et al*. (2011) all reported that weight positively correlates with performance, especially ones that are associated with static strength such as handgrip muscle strength tests.

The results further indicated that **stature** correlated from moderately to strongly, and positively, with the right- and left handgrip tests among 7-, 8- and 10-year-old rural and urban boys (Gandhi *et al*., 2010; Dana *et al*., 2011).

In the present study the **BMI** correlated positively with the 10m- and 35m-dash tests among 8- to 10-year-old rural and urban boys. Therefore, these results are similar to the findings of Benefice (1998), who found that the BMI and the 35m-dash test showed positive correlations among 8.5- to 14.5-year-old rural Senegalese boys, whilst it also contradicts the findings of Kim *et al*. (2005) who reported that BMI and the 20m shuttle run test showed negative correlations among 5- to 13-year-old urban American boys. In the present study no correlations were observed between anthropometrical components and vertical jump and sit-and-reach test among any of the 7- to 10-year-old rural and urban boys. The latter contradicts the findings of Monyeki *et al*. (2005) who reported a positive correlation between BMI and the sit-and-reach test among 7- to 14-year-old rural South African boys.

In the present study there was a positive correlation between **body fat percentage** and the 35m-dash test among 10-year-old urban boys, the 1-mile walk/run tests among 9-year-old urban boys, 10-year-old rural and urban boys, which is in agreement with the results of Wilmore *et al*. (2008) and Dana *et al*. (2011) who reported that excessive body fat percentage is an extra burden when the body has to be propelled forward.

CONCLUSION

It is interesting to note that most of the correlations between the anthropometrical and strength-related physical fitness components observed in this study were moderate between 7- to 9-year-old boys and strong among the 10-year-old boys in both rural and urban populations. Therefore, the correlations observed between anthropometrical and health-related physical fitness components were the same for rural and urban boys, thus possibly indicating that the environment plays less of a role among all boys. Maturation might have attributed in some correlations between anthropometrical and health-related physical fitness components among rural and urban 10-year-old boys.

Limitations

Maturation was not measured in this study, therefore, the effects of maturation on the correlation between anthropometrical and health-related physical components could not be clearly detected.

Recommendations

For the future, similar research should be done as a longitudinal study in order to identify to what extent maturation influence the correlation between anthropometrical and health-related physical fitness components among the 7- to 10-year-old rural and urban boys. Further investigation is also needed to determine the levels of physical activity differences among rural and urban boys, as this will provide a better understanding of the possible causes of inactivity among these age groups. Also, similar research should be done to investigate the differences between the anthropometrical and health-related physical fitness among 7- to 10-year-old rural and urban boys in the Eastern Cape Province.

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TIME-MOTION ANALYSIS: DISCRIMINATING BETWEEN WINNING AND LOSING TEAMS IN PROFESSIONAL RUGBY

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ABSTRACT

The current trend in video analysis is the development of performance profiles to describe individual or team patterns created from combinations of key performance indicators. The aim of this study was to quantify distance covered, high-intensity distance covered and percentage work rate at high intensity of various playing positions, as well as to provide a meaningful body of data to determine winning and losing components that jeopardise rugby matches at professional level. The ProZone version 3 time-motion analysis program was used to gather data from 18 matches (Test and Super 14 Rugby). Average distances covered by positional groups ranged from 5816m for front rows to 7166m for inside backs. No significant differences ($p<0.05$) were found between the winning and losing teams. However, positional group comparisons indicated that the distance covered by the locks showed a significant difference ($p=0.03$) between the winning and losing teams. Backs performed more high-intensity distance than forwards (backs 1549 to 1715m versus forwards 789 to 1333m). There were no significant differences ($p<0.05$) between playing positions and winning and losing teams regarding the percentage work rate at high intensity. Time-motion analysis is an effective method of quantifying the demands of rugby and provides a conceptual framework for the specific physical preparation of players.

Key words: Rugby; Time-motion analysis; Distance covered; High-intensity distance covered; Percentage work rate at high intensity.

INTRODUCTION

Now more than ever, rugby players need coaching in weaknesses and strengths to create an even more conditioned individual to perform in the professional arena. The continuing development of professionalism in rugby has included the comprehensive analysis of behavioural aspects of rugby performance known as match or notational analysis. Research of this nature in rugby is often undertaken within the confines of the environment of the team and the organisation or governing body (Vaz *et al*., 2010).

In rugby, research about the game has traditionally been focused on describing the patterns of the game (Williams *et al*., 2005; Deutsch *et al*., 2007), performance indicators (James *et al*., 2005; Ortega *et al*., 2009; Vaz *et al*., 2010) and work ratios (Docherty *et al*., 1988; Deutsch *et al*., 2002; Duthie *et al*., 2005; Deutsch, *et al*., 2007). The current trend in video analysis is the development of performance profiles to describe individual or team patterns created from

combinations of key performance indicators. This area is of great interest for research and

training purposes (Hughes & Bartlett, 2002).

Another measure of interest is the distance covered during a game (McLean, 1992). Time-motion analysis provides an objective and non-invasive method for quantifying the demands of rugby and provides a conceptual framework for the specific physical preparation of players (Deutsch *et al*., 2002; Duthie *et al*., 2005; Deutsch *et al*., 2007; Cahill *et al*., 2013). Detailed information on the movements in a game provides comprehensive assessment of the demands of competition and assists in developing specific training regimes. However, according to Vaz *et al*. (2010), despite the range of detailed analyses there is no obvious structure or progressive evolution to the development of analysis methods and there are still large gaps in the literature, especially in the area of rugby. Vaz *et al*. (2010) also stated that it must be borne in mind that the game of rugby is complex, with many key performance indicators. Circumstances also change from game to game due to many varying conditions, including the weather, strategies, tactics and players available. Rugby players have a diverse range of physical attributes. The game is intermittent in nature, requiring players to compete in a challenging contest comprising intense bouts of sprinting and tackling separated by short bouts of lower-intensity activity (recovery) (Gabbett, 2005). Sirotic *et al*. (2009) showed that two standards of competition have similar game-specific skills and physical demands during a match; however, there is variation within a match according to standard. Specifically, the higher physical demands placed on elite players could lead to earlier onset of fatigue.

Detailed descriptive analyses of the occurrence of these activities during competition will assist coaches and conditioning staff in the prescription of training for forwards and backs. According to Cahill *et al*. (2013), such knowledge is deemed valuable to coaches and scientific support staff in a training environment, facilitating optimal player conditioning and match preparation. It was for this purpose that Docherty *et al*. (1988) classified movements during amateur club and international fixtures (regional vs. international touring teams). Modifying the movement classification system of Reilly and Thomas (1976), the relative times (expressed as percentages) spent standing still, walking and jogging, running, sprinting, shuffling, and engaged in intense static activity were analysed for props and centres. The activities of scrimmaging, rucking and mauling, line-out‟s and tackles are critical components in the game of rugby. McLean (1992) quantified times spent in both work and rest during first division and international match-play.

Deutsch *et al*. (1998) also used time-motion analysis to quantify the physiological demands of Under 19 match-play. However, their analysis combined absolute measurements (frequency, time [s] and relative [%] time spent in various activities) with individual work-rest ratio data. Deutsch *et al*. (2007) combined these previous time-motion analysis methods to estimate the physical demands on professional rugby union players in various playing positions and to provide specific information for the preparation of elite rugby players. However, Deutsch *et al*. (2007) also stated that there was a lack of empirical research investigating the physiological demands of professional rugby, and advised that this lack of data on elite players and rule modifications, since the publication of most previous studies, made a comprehensive time-motion analysis of elite rugby timely. Therefore, Vaz *et al*. (2010) aimed to analyse a large sample of rugby matches from northern and southern hemisphere competitions, apply a measure to control for the differences in match scores and

to determine if there are any game related statistics that can discriminate between winning and losing teams. Cahill *et al*. (2013) also quantify the movement characteristics of elite

rugby union players during competitive play and identify whether position-related differences exist. Ninety-eight elite players from eight English Premiership Clubs were tracked using global positioning systems (GPS) during 44 competitive matches throughout the 2010/2011 season. Jones *et al*. (2004) highlighted a number of team factors which contribute to winning matches. Subsequent combination of these variables (line-out‟s won, tries scored, turnovers won, etc.) may be used to develop a model to predict future performance within rugby union.

Probably the most important component for rugby players, conditioning coaches and coaches to consider when structuring an exercise programme, is the high-intensity distance covered. This component is represented by the distance covered during running, high-speed running and sprints. Dwyer & Gabbett (2012) suggest that a sprint can be defined as any movement that reaches or exceeds the sprint threshold velocity for at least one second and any movement with an acceleration that occurs within the highest 5% of accelerations found in the corresponding velocity range. The high-intensity distance covered can be regarded as the actual playing intensity, because most activities are performed during this stage. McLean (1992) observed that when the ball was in open play, the average running pace of players central to the action ranged from five to eight metres per second. This together with scrum, line-out, ruck and maul was classified as high-intensity exercise. According to Austin *et al*. (2011), the durations of the most intense repeated high-intensity exercise bouts for each position ranged from 53 sec to 165 sec and the minimum recovery periods between repeated high-intensity exercise bouts ranged from 25 sec for the back row forwards to 64 sec for the front row forwards. The most intense periods of activity are likely to last as long as 120 sec and as little as 25 sec recovery may separate consecutive repeated high-intensity exercise bouts.

During a game, outside backs are engaged in more sprints than front row forwards. As a result, outside backs spend significantly more total time sprinting than front row forwards. An overall difference between forwards and backs is also observed. Mean sprint duration is longer for outside backs than for any other positional group, contributing to significantly longer mean sprint duration for backs than for forwards (Deutsch *et al*., 1998). Deutsch *et al*. (2007) reported an overall difference between forwards and backs (10.2 sec vs. 29.4 sec). In contrast to this believe, Cahill *et al*. (2013) provided new insight into the position-related sprinting demands of the game, for instance, that the forwards sprinted greater total distances than the backs. It will, therefore, be meaningful for conditioning coaches and coaches to be aware of differences and to adapt their programmes to the demands revealed by time-motion analysis.

According to Deutsch *et al*. (2002) and Cahill *et al*. (2013), the distance covered during a game of rugby commonly includes distances covered by walking, jogging, running, high-speed running and sprints. Walking in rugby can be considered as the rest phase and the time passing between set phases, walking back to position after a high-intensity bout or walking to a scrum or line-out. Jogging can also be found between set phases or when moving back to position either after the ball has gone dead or whilst the game is still underway. Running, high-speed running and sprints take place while the game is underway to get to rucks and mauls or when defending, and also include running with the ball and chasing a ball. The sum of all these activities is considered the distance covered (Deutsch *et al*., 2002).

Early estimations of the distance covered during a rugby match indicated that a centre

covered 5 800m, of which 2 200m was walking, 1 600m jogging and 2 000m sprinting (Morton, 1978). Deutsch et *al*. (1998) monitored six players during four Under-19 matches between different levels of play. Although backs had a lower overall exertion based on heart rate, they covered the greatest distance, with props and locks covering 4 400±398m, back row 4 080±363m, inside backs 5 530±337m and outside backs 5 750±405m. Within elite Under-19 colts‟ rugby, forwards spent a larger percentage of time standing still (46%) compared with the backs (39%), and covered a shorter distance in all gait movements except jogging. Data from Cunniffe *et al*. (2009) revealed that players covered on average 6 953m during play. Of this distance, 2 800m was spent standing and walking, 1 900m jogging, 700m cruising, 990m striding, 320m high-intensity running, and 420m sprinting. The distance covered during a game of rugby has been influenced by rule changes over the last few years, but can also be influenced by weather, playing conditions, competition structure, team structure or the magnitude of the game (Vaz *et al*., 2010).

The physiological ability of the player to cope with high-intensity exercise with very little rest in between bouts are expressed as a percentage of the work rate at high intensity and can be related to the overall performance of the team or an individual. McLean (1992) found that the mean duration of work in a rugby union game was 19s; he further indicated that 60% of the duration of work periods were between 11 sec and 25 sec and 5% were between 50 sec and 60 sec. Work-rest ratios were on average 80:106 per game; 20% were 2:1, 18% were 1:4 and higher and 5% was higher than 3:1 (McLean, 1992). In a study done by Sykes *et al*. (2009) on rugby league, outside backs had a higher work to rest ratio for ball in play and defending than all other positional groups ($p<0.05$).

Deutsch *et al*. (2007) reported mean work-rest ratios of 7.3 for front rows, 7.5 for back rows, 20.9 for inside backs and 22.8 for outside backs. In his study on Super 12 players, front row and back row forwards performed significantly more high-intensity work than inside and outside backs ($p<0.01$) as a result of performing work more frequently. The mean rest period was significantly longer for inside and outside backs than for front row and back row forwards ($p<0.01$). As a result of a shorter mean rest period, the inside and outside backs had significantly lower mean work-rest ratios than front and back row forwards ($p<0.01$). Heart rate data collected by Deutsch *et al*. (1998) indicated that props and locks (58.4%) and back row forwards (56.2%) spent significantly more time in high exertion (85-95% HRmax) than inside backs (40.5%) and outside backs (33.9%). Inside backs (36.5%) and outside backs (38.5%) spent significantly more time in moderate exertion (75-84% HRmax) than props and locks (22.6%) and back row forwards (19.8%). These results add to our understanding of the variety in the positional demands of rugby union and can be utilised in our methods for the preparation of elite rugby players.

PURPOSE OF THE STUDY

This research attempted to identify time-motion statistics in the game of rugby that discriminate between winning and losing teams, and to provide, by means of time-motion

analysis, a meaningful body of data to determine winning and losing components that jeopardise matches at senior international level through specific movements. The question must therefore be asked if there is a significant difference ($p<0.05$) between the total distances covered, high-intensity distances covered and percentage work rate at high intensity of various playing positions in the winning and losing teams during professional rugby union match-play. The question also arises if total distance covered, high-intensity distances

covered and percentage work ratio (%) significantly discriminate between winning and losing in international rugby games.

METHODOLOGY

Subjects

A total of 270 rugby players that participated in 18 games played during the 2005-2007 Super 14 competitions (n=12), Tri-nations (n=2) and International tours (n=4) were included in the study. The participants varied from Super 14 level to international test playing nations, including South Africa, New Zealand and Australia. Super 14 teams are all regarded as international teams due the international players from all 3 participating nations that compete for these teams. Team positions were classified according to subgroups reflecting positional commonality (front row, locks, loose forwards, inside backs and outside backs) (Meir *et al*., 2001). Players from each of the positional groups were studied: front rows (players 1 & 3); locks (players 4 & 5); loose forwards (players 2, 6, 7, 8); inside backs (players 9, 10, 12, 13); and outside backs (players 11, 14, 15). A total of 36 front rows, 36 locks, 72 loose forwards, 72 inside backs and 54 outside backs were evaluated.

Research method and techniques

Time-motion analysis was conducted on all 18 games played. Data was supplied by the ProZone Company to the South African Rugby Union and Springbok management team. The study did not involve any verbal or physical contact with the players, as data were collected with informed consent via the Springbok teams‟ video analyst and the ProZone analysis system. The Research Ethics Committee of the Faculty of Humanities, University of the Free State approved the study.

To obtain data about the game, ProZone uses 8 cameras placed around the stadium in combination with manual operators. Computer vision technology is used to capture the movements of the players and the ball, but a lot of manual work is required, not only to register all the events that happen during the game, such as free kicks, penalties and passes, but also to aid the automatic tracking (Mylvaganam *et al*., 2002). The validity of ProZone has been established by Di Salvo *et al*. (2006).

Statistical analysis and interpretation of data

All data were captured in Microsoft Excel 2007. The SAS Version 9.1.3 statistical software was used for the further analysis. Means and standard deviations were used for numerical data. Mean values between winning and losing sides were compared using the t-test procedure. A significance level of $p<0.05$ was used throughout. To determine if the distance covered, high-intensity distance covered and percentage work rate at high-intensity could discriminate between winning and losing teams in international games, a discriminant

analysis (SPSS, 2013, version 21) was done. The measure of agreement with help from the *Kappa (k)*-coefficient were used to explore the aim. The practical significance of the results was also investigated in order to provide findings on the practical importance of the statistical significant results which were found with the research. As standard of practical significance, the effect size was also be calculated (Hopkins, 2002). A total of 270 rugby players that participated in 18 games played during the 2005 to 2007 Super 14 competitions were included in the analysis. Data collected were statistically analysed to show the differences

between winning and losing sides.

RESULTS AND DISCUSSION

The influence of each component (total distance covered, high-intensity distance covered, and the percentage work rate at high intensity) was compared between the winning and losing teams. All 3 variables were added simultaneously to the comparison and a Wilk"s Lambda value of 0.996 was recorded. The corresponding χ^2-value was 2.185 for the 3 degrees of freedom. This value does not show a statistically significant result (p=0.535), and therefore, it was concluded that total distance covered, high-intensity distance covered, and the percentage work rate at high intensity was not able to discriminate significantly between winning and losing teams. The statistical analysis indicates that:

- 51.3% of the winning results were again classified as winning, whilst 48.7% of the winning results have been wrongly classified as a loss.
- 52.5% of the losing results were correctly classified, while 47.5% of the losing results have been wrongly classified as a win.

It is, therefore, clear that all 3 variables (distance covered, high-intensity distance covered and percentage work rate at high-intensity) could not successfully discriminate between winning and losing in a rugby game.

***TABLE 1*: DESCRIPTIVE STATISTICS AND EFFECT SIZE FOR ALL VARIABLES FOR WINNING AND LOSING TEAMS**

Position	Vari-able	Winning team M±SD	Losing team M±SD	Mean Diff.	Ave-rage	Effect size	Size effect	p-value
Front rows	Dist (m)	5829±547	5802±698	27	622.5	0.04		0.85
	HI dist (m)	789±318	812±287	-23	302.5	-0.08		0.75
	% WR HI	11±4	12±4	-1	4	**-0.25**	**Small**	0.33
Inside backs	Dist (m)	7260±586	7072±677	188	631.5	**0.30**	**Small**	0.07
	HI dist (m)	1690±325	1715±396	-25	360.5	-0.07		0.67
	% WR HI	22±3	23±4	-1	3.5	**-0.29**	**Small**	0.20

TABLE 1*. DESCRIPTIVE STATISTICS AND EFFECT SIZE FOR ALL VARIABLES FOR WINNING AND LOSING TEAMS (*cont.)

Position	Vari-able	Winning team M±SD	Losing team M±SD	Mean Diff.	Ave-rage	Effect size	Size effect	p-value
	Dist (m)	5958±679	6263±498	-305	588.5	**-0.52**	**Small**	0.03*

Locks	HI dist (m)	1016±242	1109±305	-93	273.5	**-0.34**	**Small**	0.15
	% WR HI	16±3	16±4	0	3.5	0.00		0.93
Loose forwards	Dist (m)	6404±421	6329±485	75	453	0.17		0.32
	HI dist (m)	1331±276	1333±317	-2	296.5	-0.01		0.96
	% WR HI	19±3	20±4	-1	3.5	**-0.29**	**Small**	0.25
Outside backs	Dist (m)	7194±523	6976±715	218	619	**0.35**	**Small**	0.07
	HI dist (m)	1549±254	1562±347	-13	300.5	-0.04		0.82
	% WR HI	21±2	22±3	-1	2.5	**-0.40**	**Small**	0.11
Team Average	Dist (m)	6529±700	6489±700	40	700	0.06		-
	HI dist (m)	1275±500	1307±500	-32	500	-0.06		*
	% WR HI	18±5	19±5	-1	5	-0.20		-

The actual p-values of all variables were only provided for positional groups of winning and losing teams and not with team averages. *p<0.05 M= Mean SD= Standard deviation Dist= Distance HI= High Intensity WR= Work Rate

High-intensity distance covered

Table 1 presents the distance covered, high-intensity distance covered and percentage work rate at high intensity of various playing positions during professional rugby union in winning and losing teams, as well as the significance of these differences and the effect size. It is interesting to note that the losing teams covered a greater distance in high intensity in all positions and in team averages (1 307m vs. 1 275m). However, there was no significant difference in the high-intensity distance covered and it provides a small effect size between winning and losing teams. It must be noted that the difference is only 32m in an 80 minute game of rugby. This can be due to the pressure of losing and having to play harder to be successful. When the winning and losing teams are compared, there are some differences between playing positions. The results of this study also supports the findings of Deutsch *et*

al. (1998), showing that the backs were engaged in more sprints than front row forwards (outside backs 1 549m; inside backs 1 690m vs. front rows 789m). Front row forwards were more engaged in set pieces like rucking and mauling and did not often have the freedom or space to sprint. As expected the loose forwards were also engaged in more sprints (1 331m) than the other forwards. Sirotic *et al*. (2011) showed that positional roles play an important part in determining the amount of physical and game-specific skill involvement during match play. The hooker spent more time jogging than the backs and forwards and touched the ball on more occasions than any other positional group.

Distances covered

The distances that were covered by the winning and losing teams are compared in Table 1. Interestingly, of the 18 games that were played, 12 were won by the home team, which confirms the belief that it is more difficult to win matches away from home. Only 7 of the 12 winning teams were able to cover greater distances than the losing teams. This study showed average distances ranging from 5 816m (front rows) to 7 166m (inside backs). The distances covered by positional groups showed only one significant difference ($p<0.05$) between the winning and losing teams. The total distance covered by the locks showed a significant difference ($p=0.03$) but the value provides a small effect size of 0.52 between the winning and losing teams (see Table 1). Locks had an increase in distance from winning a game to losing (winning= 5 958m; losing= 6 263m). It can then be stated that the role of locks might change as the possibility of winning or losing becomes more apparent. Locks are also frequently used as primary defenders in close quarters or around the fringes of the rucks because of their weight, but mobile locks also play a significant role in defence and attack. Reasons for the only 1 significant difference and small effect sizes would be that positional groups, whether in losing or winning teams, have the same work or game description no matter the team.

Early estimations on the distance covered during a rugby match indicate that a centre covered 5 800m, of which 2 200m was walking, 1 600m jogging and 2 000m sprinting (Morton, 1978). Data from Cunniffe *et al*. (2009) revealed that players covered on average 6 953m during play. Of this distance, 2 800m was spent standing and walking, 1 900m jogging, 700m cruising, 990m striding, 320m high-intensity running, and 420m sprinting. In the study of Cahill *et al*. (2013) the backs covered greater absolute distances (6 545m) than the forwards (5 850m) during competitive matches. However, these distances were substantially lower than for the backs (7 002m) and forwards (6 427m) reported by Coughlan *et al*. (2011) and the backs (7 227m) and forwards (6 680m) in the article by Cunniffe *et al*. (2009). The average distance covered during this study was 6 509m, which is greater than what Morton (1978) and Cahill *et al*. (2013) estimated, but less than reported by Cunniffe *et al*. (2009) and Coughlan *et al*. (2011). This increase in distances covered by players could explain the change in opinion over the last 20 years regarding the game being quicker, more demanding and a lot more entertaining (Deutsch *et al*., 2002). The team averages in the current study indicated that the winning team covered a slightly greater distance (40m) than losing team averages (6 529±700m vs. 6 489±700m).

Deutsch *et al*. (1998) monitored 6 players during 4 Under-19 matches between different teams. Although backs had a lower overall exertion based on heart rate, they covered the greatest distance, with props and locks covering 4 400±398m, back row 4 080±363m, inside backs 5 530±337m and outside backs 5 750±405m. It is important to note that distances covered at senior level rugby is much higher (Table 1). In comparing the distance covered by inside backs, it was found that the winning team had covered more distance than their losing opponents (7 260 vs. 7 072m) in this positional group because of possible sustained pressure on the attack and having more ball possession, but no significant difference was found ($p=0.07$). The same can be said about the distance covered by front rows, which varied from 5 802m when the game was lost to 5 829m when the game was won; still no significant difference was found ($p=0.85$). Another possible reason could be due to the fact that forwards spent a larger percentage of time standing still (46%) compared with the backs (39%), and covered a shorter distance in all gait movements except jogging (Deutsch *et al*., 1998).

Percentage work rate at high intensity

The percentage work rate at high intensity also showed no significant differences ($p<0.05$) and only small effect sizes between playing positions in winning and losing teams (Table 1). Team averages showed that the losing teams had a higher percentage work rate at high intensity than the winning teams (19%±5% vs. 18%±5%), which could be attributed to either having to defend more or to playing harder to achieve success. Van Rooyen *et al*. (2008) concluded that 80% of the impact contacts were recorded at a higher frequency when the team lost as opposed to when they won. Within the winning and losing teams, the forwards had a lower work rate than the backs, which could be due to higher distances performed in high intensity by the backs as opposed to the forwards‟ predominant involvement in high-activity actions like scrumming or rucking (front row 11.8%, locks 16.7%, loose forwards 19.7%, inside backs 22.8%, outside backs 21.1%).

In contrast to this finding, Holmyard *et al*. (1988) found that front row and back row forwards performed more high-intensity work than inside and outside backs, as the result of performing work more frequently. Possible reasons for this contrast in results are the different actions taken into consideration when performing time-motion analysis. Some authors may regard high-intensity actions as only the contact phases on the field and not necessarily high-speed running or sprinting. Docherty *et al*. (1988) declared in this regard that centres spent more time in intense running and that the time spent in static exertion by the forwards contributed to a greater time spent in high-intensity activity (forwards, 11 minutes) compared with the backs (4 minutes) (Docherty *et al*., 1988). The mean duration of recovery periods was reported to be 33 seconds during international matches, with the majority of rest periods less than 40 seconds (Menchinelli *et al*., 1992).

Rugby players have a diverse range of physical attributes, and it must be borne in mind that the game of rugby is complex, with many key performance indicators. Circumstances also change from game to game due to many varying conditions, including the weather, strategies, tactics, and players available and so forth (Vaz *et al*., 2010).

CONCLUSIONS AND RECOMMENDATIONS

The questions subsequently answered were firstly, if time-motion analysis could be implemented as a variable in identifying rugby success. Rugby consists of many different components, like skills (passing, kicking and catching), fitness (aerobic, anaerobic, endurance, speed, agility, strength and power) and game phases (scrums, line-out‟s, rucks and mauls). It is impossible to recognise one or two specific components that influence the result, especially in professional rugby where coaches spend equal amounts of time to improve each component. Coaches have to provide players with enough assistance to improve on these components and realise that all components need attention. Time-motion analysis is, therefore, an effective method of quantifying the demands of rugby and provides a conceptual framework for the specific physical preparation of players.

Secondly, it was attempted to determine which variable (total distance covered, high-intensity distance covered and percentage work rate at high intensity), in time-motion analysis differed significantly ($p<0.05$) between winning and losing teams. It was clear that all three variables

(distance covered, high-intensity distance covered and percentage work rate at high-intensity), could not successfully discriminate between winning and losing in a rugby game. The game plan, weather conditions and competition structure (as teams will continue play even if the time have been exceeded in order to secure the bonus point), may be some reasons for different high-intensity distances covered, distances covered and percentage work rate at high intensity. The level of experience of players improve their ability to „read" the game better, and therefore, can reduce the distance covered by choosing shorter routes to rucks, mauls and tackle ball situations.

Thirdly, the current study attempted to determine if there were significant differences ($p<0.05$) between positions in the different components in time-motion analysis. Some positions (locks and inside centres) showed differences, but game situations and conditions change too often to confirm the significance of these differences. Positional activities will also be influenced by the game plan incorporated by the team. Certain teams will play an expansive game, and therefore, distances will increase in all positions, whereas other teams will play more physical by keeping the ball between the forwards and as a result the percentage work rate at high intensity will increase, but not the distance. Even these game plans are prone to change on account of weather conditions, home ground advantage, player experience and team experience, and the magnitude of the game. This means that no assumption could be made that one specific positional group or variable would influence success.

In summary, this study showed that international competitions including teams from different nations were unlikely to show statistically significant differences in time-motion analyses between winning and losing teams and a comprehensive profile that include patterns of the game, performance indicators and work ratios would be needed. Quarrie and Hopkins (2007) believe that law changes and developments in match analysis, equipment technology, and player training have contributed to the changes associated with the introduction of professionalism.

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COMPARISON OF TYRE ROLLING RESISTANCE FOR DIFFERENT MOUNTAIN BIKE TYRE DIAMETERS AND SURFACE CONDITIONS

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ABSTRACT

Tyre-road rolling resistance is a major factor in the performance of a vehicle. By investigating the rolling resistance, a better understanding of the efficiency of different wheel diameters will develop. A major issue in the mountain biking world is the relative merits of using 26in. versus 29in. wheels and the resultant effect on cyclist performance. As rolling resistance is indicative of the behaviour of a vehicle over specific terrain, it can be viewed as an objective parameter to compare the relative performance of these two wheel sizes. The aim of this study was to evaluate the rolling resistance of four mountain bikes as affected by wheel diameter and

terrain type, cyclist mass, tyre inflation pressure and suspension type using coast-down tests. The following major conclusions were drawn: average rolling resistance of the 26in. diameter wheel was higher than that of the 29in. diameter wheel; a sand surfacing had the highest rolling resistance coefficient; terrain surface showed the largest effect on rolling resistance coefficients measured, followed by the cyclist mass, wheel diameter and tyre inflation pressure; and the best combination for maintaining momentum after traversing over an obstacle was high tyre inflation pressure, low cyclist mass and full suspension 29in. wheel diameter option.

Key words: Rolling resistance; Mountain bike; Tyres; Road surface.

INTRODUCTION

The invention of the wheel is one of the most significant advances in history. As the need for more efficient transportation increased through history, the wheel evolved to allow faster transport between origin and destination. Cycling has been a mode of transportation since the first bicycle was invented in 1790. In 1868, cycling became an organised sport. There are four important components of a bicycle that affect a bicycle's performance when racing: frame mass; brakes; suspension; and wheels. As the bicycle evolved, the wheel evolved with it to the modern 26in. diameter wheels. A larger diameter wheel was developed in the mid-1990s for mountain bikes, having a diameter of 29in. This wheel diameter was professed to be unbeneficial until it was reintroduced in 2001, raising debate about the difference in speed and performance between the 26in. and 29in. wheels (Herlihy, 2004). It is customary to express the wheel diameter of mountain bikes in inches, and a specific mountain bike is often referred to in terms of its wheel diameter (26er or 29er). In this article, the same custom is adopted.

Rolling resistance between the wheel and road surface is a major factor in the performance of any vehicle. By investigating the physics between the wheel-terrain surface interactions, a better understanding of the performance efficiency of different wheel diameters will develop.

The terrain surface has a major impact on the rolling speed of a wheel and the overall performance of the vehicle (Jackson *et al*., 2011). Grappe *et al*. (1999) found increased rolling resistance for bikes with added mass and decreased rolling resistance for conditions of increased tyre inflation pressures.

PURPOSE OF RESEARCH

The debate around the relative effects of using a 26in. compared to a 29in. wheel diameter in mountain biking contains many personal and subjective arguments. One potential objective parameter that should differentiate between the relative performances of the two options is the rolling resistance of mountain bikes with the two wheel diameters. The aim of this article is to evaluate the rolling resistance of four mountain bikes as affected by:

- 26in. and 29in. wheel diameters for each terrain surface;
- Four different terrain surfaces;
- Three different tyre inflation pressures;
- Three different cyclists with different masses; and
- Two different suspensions for each wheel diameter.

The conservation of momentum for two wheel diameters was investigated to determine the diameter which provides the best all-round performance. Coast-down tests were conducted to determine the rolling resistance, while the investigation of momentum preservation was conducted by introducing an obstacle on the bituminous surface and repeating the coast-down test.

BACKGROUND

Since the first bicycle was invented in 1790, the bicycle's evolution progressed in terms of comfort, speed and safety. The cycling world advanced into eight different types of races namely road races, track cycling, cyclo-cross, mountain bike racing, BMX, bike trials, cycle speedway and motor-paced racing (Herlihy, 2004). One of the main focus areas of the advancements of the bicycle, aside from safety against component failure, is performance. The structural components of a bicycle have been the foundation of experimentation since the 1890s when the first metallurgical innovation was used to improve the safety against component failure and, in so doing, the overall performance of the bicycle. The invention of pneumatic tyres increased the rider safety and comfort of the bicycle even more in 1890 (Herlihy, 2004). The geometry of a bicycle is generally the same although the different uses of the bicycle affects the quality, mass, size and shape of the different components. The general components of a mountain bike are shown in Figure 1. The following subsections discuss the four major components and related mechanisms of the bicycle, and their relative importance and potential influence in rolling resistance.

Frame

Minimising the mass of a bicycle is essential to reduce the energy required to propel the bicycle. The bicycle frame and geometry determines how the bicycle handles due to the position that the cyclist assumes on the specific frame. Mountain bikes are designed for manoeuvrability and stability (Ballantine & Grant, 1998).

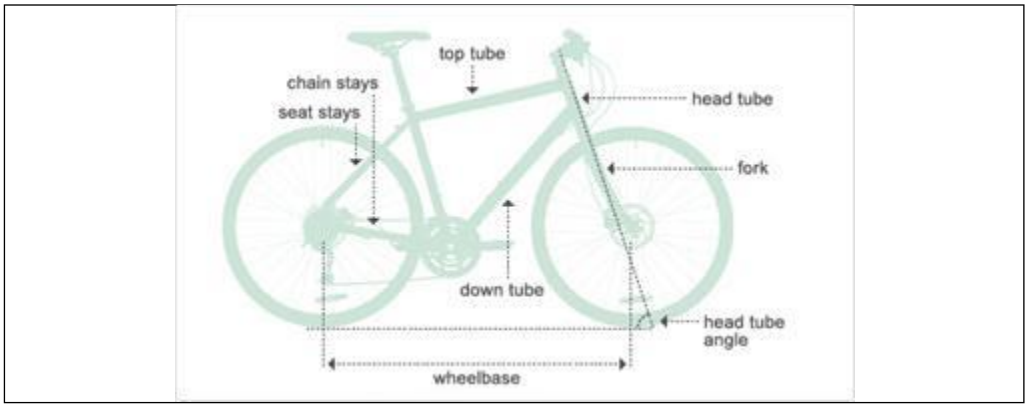

***FIGURE 1*: COMPONENTS FOUND ON A TYPICAL MOUNTAIN BIKE**
(Brown, 2012)

Wheel

As the bicycle evolved, the wheel evolved with it to allow for comfort, speed and safety (Herlihy, 2004). The basic components of a bicycle's wheel are the hub, spokes and rim. The

hub forms the rotational axle in the centre of the wheel. It comprises of an axle, hub shell and bearings. The axle of the hub allows for the wheel to be easily removed or attached to the frame. The bearings allow for the wheel to easily and smoothly rotate around the axle. The rim forms the outermost hoop of the wheel where the tyre connects to the wheel. The spokes are the connectors between the hub and the rim (Downs, 2005; Grant, 2010).

The tyre consists of four major components that influence the performance of the entire bicycle, namely the tyre width, tread pattern, tread count and tyre inflation pressure. The quality of any of the components of the wheel affects the performance and durability of the wheel.

For many years, 26in. wheels were the most general size of wheels that mountain bikes were sold in (Herlihy, 2004). Cyclists have been arguing for years that the smaller diameter wheels are more efficient and provide a faster performance on any terrain surface. The key to reducing rolling resistance is to minimise the tyre casing deformation and, in so doing, minimising the loss of energy. Comparing the difference between deformation of the 26in. and 29in. wheels with the same tyre inflation pressure, it is evident that the larger wheel diameter suffers less deformation. This means that the 29in. wheel should provide a better performance than the 26in. wheel. The conservation of rotational momentum by the longer effective leverage provided by the 29in. wheel, results in less energy required to overcome any tyre bulge that exists at the contact patch between the tyre and the road surface. The effective contact patch area of a 29in. wheel is longer and narrower than that of a 26in. wheel under optimal conditions, leading to similar total contact patch areas (Huang, 2011).

Tyre inflation pressure affects the contact surface between the tyre and the ground. When the tyre is under inflated, the rolling resistance increases (Grappe *et al*., 1999). When the tyre is over inflated, there is poor grip due to the minimal contact surface, which will result in slippage. The slippage will render the brakes ineffective, especially during wet conditions. Optimal tyre inflation pressures are shown in Table 1 (Khan, 2003).

***TABLE 1*: OPTIMUM MOUNTAIN BIKE TYRE INFLATION PRESSURE**

Cyclist mass (kg)	Mountain bike tyre inflation pressure [kPa]
50	241 to 262
60	248 to 269
70	262 to 283
80	276 to 296
90	290 to 310
100	303 to 324

Suspension

The rolling resistance of a bicycle is affected by the vertical load compliance of the bicycle frame and components. The purpose of the suspension is to dampen the impact (caused by moving over rough terrain) that is transmitted to the rest of the frame and the cyclist. The suspension effectively reduces the amount of fluctuations on the tyres, which reduces the rolling resistance. Mountain bike suspensions can be divided into three types - Rigid, Hardtail

and Full suspension. Rigid bikes have no suspension and are not very common in mountain biking. A *Hardtail* only has suspension at the front fork that absorbs shock from impact through coil or air compressed shocks. A Full suspension bike has suspension on the front fork and at the rear stays. The implementation of the rear shock improves comfort and riding quality when going downhill or passing over rocky sections due to the rear shock absorbing most of the impact. Front suspension is implemented through the use of shock absorbers in the front fork. The suspension fork design has become more sophisticated allowing for more travel, adjustable travel and a lockout mechanism. The addition of the shock absorber may add mass but greatly increases comfort, performance and control. The suspension also increases traction, resulting in much quicker cornering, as well as better climbing (Sutherland, 1995; Ballantine & Grant, 1998).

Cyclist

The mass of the cyclist affects the rolling resistance of the bicycle tyre. The technique of the cyclist also contributes to the rolling resistance of the tyres by the way that he/she distributes his/her mass whilst riding. The two tyres may not support the same mass and hence offer the same contact surface which will affect the rolling resistance of each. The bicycle suspension will determine whether the vertical load on the tyre will fluctuate or not. The combined rolling resistance of both tyres will, in effect, change depending on the technique of the cyclist (Ballantine & Grant, 1998).

Rolling resistance

Rolling resistance is the reaction force acting on the bicycle due to the interaction between the mountain bike tyre and the terrain surface it is travelling on. The interaction between the

tyre and the terrain surface causes a loss of energy. The main cause of this loss of energy is the deformation of the tyre (depending on tyre properties), the deformation of the terrain surface (depending on terrain material properties) and the movement below the surface. A distinction is made between basic rolling resistance, which occurs on a frictionless horizontal surface, and additional resistances which arise due to uneven and macro textured surfaces (Karlsson *et al*., 2011). The following components directly affect the rolling resistance of a mountain bike (SCHWALBE, 2011):

- Combined mass of the cyclist and bicycle components - causes deformation of tyres, increasing contact surface area between tyre and terrain surface;
- Wheel components:
  Tyre width - wider tyre increases contact surface area between tyre and terrain surface;
  Tyre inflation pressure - lower tyre inflation pressure create larger contact surface area between tyre and terrain surface;
  Tread type - larger tread type creates larger contact surface area between tyre and terrain surface; and
  Wheel diameter - Smaller diameter at the same tyre inflation pressure and mass cause greater tyre deformation;
- Suspension causes less vertical mass fluctuation transferred to tyres, decreasing tyre deformation.

The terrain surface has a major contribution to the rolling resistance of the bicycle:

- Terrain texture - rolling resistance of soft terrain is larger than firmer terrain due to

decrease of terrain surface deformation and increase in roughness increases tyre / terrain friction;

- Terrain compaction - combination of rocks and compacted sand cause smaller rolling resistance than rocks and soft sand; and
- Presence of obstacle on terrain surface.

The resistant forces on the bicycle include rolling, gradient and air resistance. The speed of the bicycle has a great effect on the total resistance on the bicycle with speeds above 10km/h causing air resistance to become a resistance factor. The effect of gradient resistance can be minimised by using a test section of horizontal terrain and performing the test in both directions. Air resistance can be minimised by performing rolling resistance tests on a wind-still day (Rutman, 2007).

Various studies have been conducted measuring and evaluating the effect of rolling resistance on cyclists and their performance (Grappe *et al*., 1999; Titlestad *et al*., 2006; Takken *et al*., 2009; Bertucci & Rogier, 2012). These studies confirmed the relative importance of terrain conditions and cyclist properties on the rolling resistance and related performance properties, however, none of these studies compared the relative effect of the use of 26in. versus 29in. wheel diameters on the cyclist performance.

The rolling resistance force experienced by a wheel subjected to a wheel load W, is defined by Equation 1 (Rutman, 2007):

$$F_r = C_r W \qquad (1)$$

Where: F_r- rolling resistance (N); W-load on wheel (N)

(load is assumed to be constant for the experiment as the cyclist does not change position during the experiment)

$$C_r = {}^{c_l}/_{r}$$

rolling resistance coefficient (dimensionless)

c_l- rolling resistance coefficient or coefficient of rolling friction with dimension length (m)
r - wheel radius (m)

The air resistance force is defined by Equation 2 (Rutman, 2007):

$$F_d = \frac{1}{2}\rho C_d A V^2 \qquad (2)$$

Where:
F_d - air resistance (N)
ρ - air density at location of tests=1.07 kg/m^3
(assumed to remain constant for the experiment as it is conducted at the same altitude and location)
C_d - coefficient of drag= 0.76 (dimensionless)
(calculated using Bertucci *et al*. (2013), assumed constant for specific bicycle / cyclist combination used in experiments)
A - frontal projected area of bicycle and cyclist= 0.509 m^2
(measured and assumed constant for specific bicycle / cyclist combination used in experiments)
V - velocity relative to air (m/s)

The gradient resistance force is defined by Equation 3 (Swain, 1998):

$$F_g = WG \qquad (3)$$

Where:
F_g - gradient resistance force (N)
W - load on wheel (N)
$G = \frac{h}{l}$ grade inclination (m/m)

The total resistance experienced by the bicycle is, therefore, defined by Equation 4 (Rutman, 2007):

$$F_T = F_r + F_d + F_g \qquad (4)$$

The power required to overcome the moving force at a certain speed can be calculated using Equation 5:

Where:
P - power (Watt)
F_T - total resistance force (N)

$$P = F_T V \quad (5)$$

Coast-down test

The coast-down test is a standard way of determining the rolling resistance of a vehicle. The following steps are followed when conducting a coast-down test:

- Accelerate to a predetermined velocity (V) (based on calibrated speedometer);
- Free-ride the vehicle in a straight line until it comes to a stop;
- Measure the distance (s) and time (t) taken for the vehicle to come to a stop; and
- Determine the rolling resistance coefficient using Equation 6 (Delanne, 1994; Rutman, 2007):

Where:

$$Cr.g = \frac{\Delta v}{\Delta t}$$

(6)

Δv - difference between initial (v_0) and final (0) velocity (m/s)

Δt - time taken to stop (s)

Note: $F_g = 0$ for a gradient of 0, while $F_g \approx 0$ for relatively slow initial speed

The coast-down test has to be performed in both directions of a specified section of terrain. The average of the results is taken. This removes the effect of any small gradient differences.

METHODOLOGY

Data analysis

The experimental work and results consist of 5 parts:

1. The difference in the effect on rolling resistance of 2 wheel diameters was tested. The test was conducted on 4 different terrain surfaces namely a single bituminous sealed road, sand with gravel, grass and soft sand. Gravel, for this study's purposes, refers to an unconsolidated variety of small rocks and pebbles (less than 25mm diameter);
2. The difference in the effect on rolling resistance of 3 different cyclists' masses was tested. The test was conducted on the same 4 terrain surfaces and the same 2 wheel diameters;
3. The difference in the effect on rolling resistance of different tyre inflation pressures was tested. The test was conducted on the same 4 terrain surfaces, the same 2 wheel diameters and the different cyclists' masses;
4. The difference in the effect on rolling resistance of 2 different suspensions was tested. The test was conducted on the same 4 terrain surfaces, the same 2 wheel diameters, the different tyre inflation pressures and the same 3 different cyclists' masses; and
5. The difference in the effect on rolling resistance of the 2 wheel diameters with an obstruction on the terrain surface was tested. The test was conducted on the gravel surface with the same 2 wheel diameters at 2 different tyre inflation pressures and the same 3 different cyclists' masses. The difference between the rolling resistances measured when rolling over an obstruction and the rolling resistances of the corresponding terrain surfaces and wheel diameters previously measured were calculated. These differences are the preservation of momentum of each wheel diameter in terms of rolling resistance force.

Procedures

The test was conducted at the Rhino Park Airfield in Pretoria. Four horizontal sections with different terrain surfaces were selected where the coast-down test was conducted. The 4 surfaces were selected to realistically represent the surfaces encountered on mountain bike trail routes (Figure 2). The obstacle used was a rock with a height of 100 mm selected to provide adequate obstruction while not harming the tyres. The method to determine the loss of momentum due to an obstacle has been devised to enable the effect of a relatively large anomaly (much larger than normal unevenness or obstacles such as smaller rocks), within the riding path to be quantified (to enable comparison between situations), in a manner that has practical relevance to the cyclist.

Two calibrated Global Positioning System (GPS) devices (velocity accuracy of ± 0.5km/h) were used to measure and collect the speed and location of the mountain bikes during the

coast-down tests. Typical speed / time data are shown in Figure 3. Data analysis excluded the last number of points (less than 2km/h speed) as the cyclist was losing balance at this low speed and came to a virtual standstill. Exclusion of this data did not affect the outcome of the analysis significantly.

***FIGURE 2*: FOUR SURFACE TYPES USED IN EXPERIMENT**

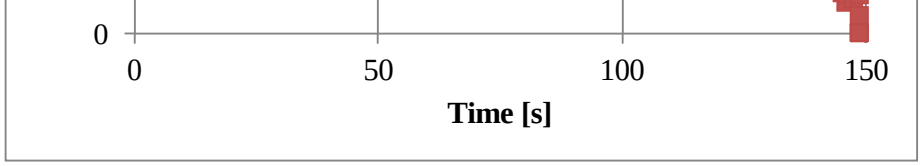

FIGURE 3: **EXAMPLE OF SPEED/TIME DATA OBTAINED FROM GPS ON BIKE**

FIGURE 4: **EXAMPLES OF FOUR MOUNTAIN BIKES USED IN EXPERIMENT**

Cyclists and bikes

Three cyclists were used in the experiment. Their masses were adjusted using weights to represent masses of 70, 80 and 90 kg respectively. The cyclists accelerated to 15km/h to incorporate some air resistance in the measurements and calculations. The 3 cyclists had similar frontal projected areas as required in Equation 2. Four mountain bikes were used in the experiment, consisting of a Hardtail 26in. (HT26), Full suspension 26in. (FS26), Hardtail 29in. (HT29) and Full suspension 29in. (FS29) (Figure 4). Data collected from the GPS devices for each of the tests were analysed using Equations 1 to 7 to generate the rolling resistance coefficients for each of the collected data sets. In this article the rolling resistance coefficients were used in the discussions and analyses.

FINDINGS

All Data

All the calculated rolling resistance coefficients are shown in Figure 5 to indicate the general trends observed for all conditions. The data were analysed for each of the different parameters separately, based on the average rolling resistance coefficients calculated for each of the various parameters. A summary of the mean, standard deviation (SD) and Coefficient of Variation (CoV) of the rolling resistance coefficients calculated for the 5 main parameters investigated in the paper are provided in Table 2. These values were used in the analysis, with

small SD and CoV values indicating relatively small differences between the parameters in the analysis. The horizontal axis legend (Figure 5) indicates the frame type (FS - or HT - Hardtail), wheel diameter (26 or 29in), cyclist mass (70, 80 or 90kg), tyre inflation pressure (180, 250 or 500kPa) and surface type (bituminous, grass, gravel or sand).

Wheel diameter

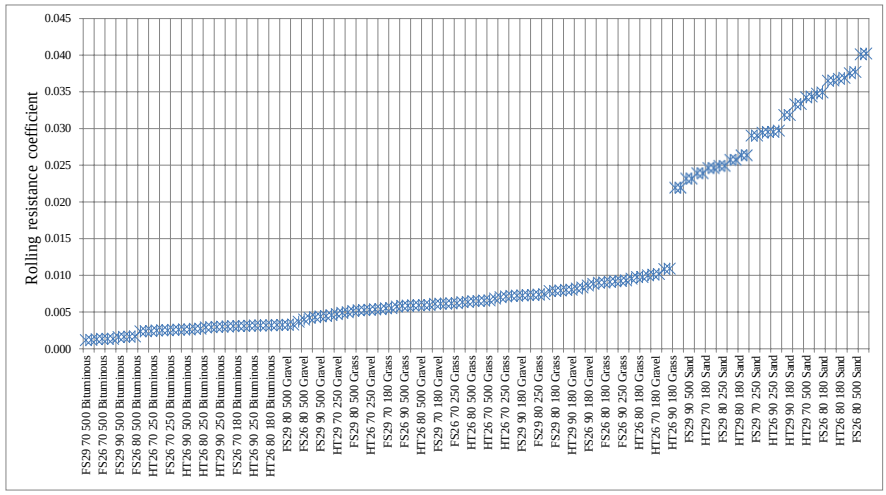

***FIGURE* 5: ROLLING RESISTANCE COEFFICIENTS (four types of cycles, cyclist's masses, wheel diameters analyses inflation pressures and surfaces analyses)**

The average rolling resistance of the 26in. diameter wheel was higher than that of the 29in. diameter wheel. As one of the main objectives of this article was to evaluate the effect of the wheel diameter on the rolling resistance, the rolling resistance coefficient data for the 2 wheel diameters and suspension types are shown in Figure 6 for the different surface types. The data indicated that the 26in. wheel diameter (both suspension types) had higher rolling resistance for the sand, grass and gravel surfaces. For the bituminous surface the differences were negligible. The data thus indicate that the 29in. wheel diameter should provide a benefit when riding off-road surfaces, but on paved surfaces the benefit will be negligible.

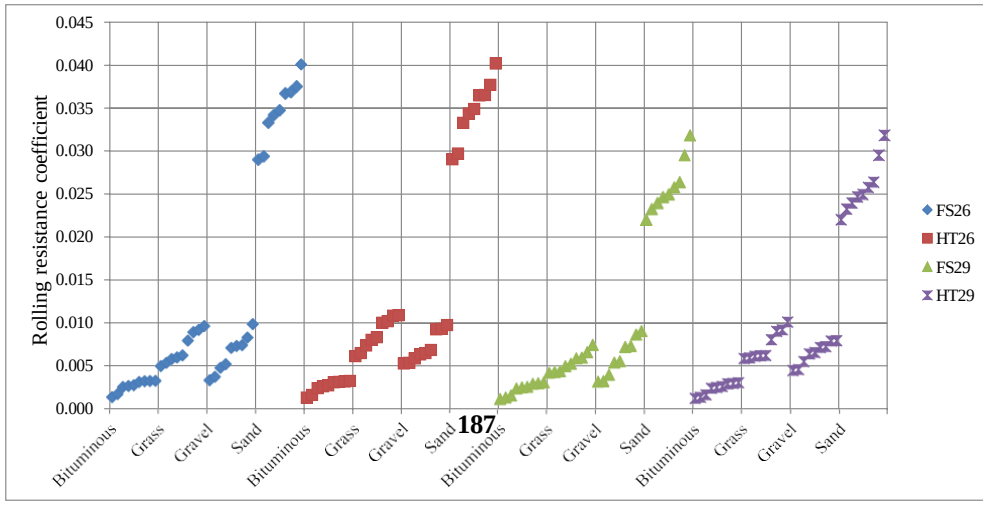

***FIGURE 6*: MEASURED ROLLING RESISTANCE FOR FOUR MOUNTAIN BIKES (indicating effects of wheel diameter and suspension type)**

Terrain surfaces

Analysis of the data in Table 2 and Figure 5 indicates that the bituminous surface had the lowest average rolling resistance coefficients, followed by the grass and gravel surfaces with similar values, and the sand surfacing with the highest average rolling resistance coefficient, being a factor of between 4.5 and 15 times higher than the other 3 surfaces.

Tyre inflation pressure

The data in Table 2 and Figure 5 indicate that higher tyre inflation pressure caused lower rolling resistance. This is in line with published data (Grappe, *et al*., 1999). Data in Table 2 are based on 3 repeats of each measurement.

***TABLE 2*: MEAN AND STANDARD DEVIATION OF ROLLING RESISTANCE COEFFICIENTS FOR ALL PARAMETERS**

Parameters	Mean rolling resistance coefficient	SD rolling resistance coefficient	Coefficient of Variation [%]
Surfacing			
Bituminous	0.002	0.001	29%
Grass	0.007	0.002	23%
Gravel	0.006	0.002	33%
Sand	0.030	0.006	18%
Tyre inflation pressure			
180kPa	0.012	0.011	91%
250kPa	0.012	0.011	94%
500kPa	0.011	0.012	114%
Cyclist mass			
70kg	0.011	0.012	107%
80kg	0.012	0.011	98%
90kg	0.012	0.011	93%
Wheel diameter			
26in.	0.013	0.013	100%
29in.	0.010	0.009	93%
Suspension type			
Hardtail	0.011	0.012	103%

Full suspension	0.012	0.011	95%

Cyclist mass

The average rolling resistance coefficient was not affected to the same degree by cyclist mass, as it was by the tyre inflation pressure and surface type. Although a general increasing rolling resistance coefficient trend was visible as the cyclist mass increased, it does not constitute a major increase. Therefore, cyclist mass appears to be a second order effect on rolling resistance.

Suspension type

Data from Figure 6 indicate that, in terms of rolling resistance and the 4 surfaces evaluated, there was not a measurable advantage in using a full suspension as opposed to a Hardtail suspension.

All parameters

When evaluating the average rolling resistance ranges for all 5 parameters examined, the terrain surface showed the largest effect on the rolling resistance, followed by the wheel diameter and tyre inflation pressure. Both the cyclist mass and the suspension type showed only second order effects on the rolling resistance. This may be partly attributed to the relatively small difference in the mass of the cyclists in the experiment.

As a final evaluation of the parameters, the correlation coefficients for the parameters evaluated were calculated against the rolling resistance, and the coefficients are shown in Table 3. The data confirmed that the surface was dominant in determining the rolling resistance, with the cyclist mass and wheel diameter showing relatively equal, but secondary importance.

***TABLE 3*: CORRELATION COEFFICIENTS BETWEEN ROLLING RESISTANCE AND SELECTED PARAMETERS**

Parameter	Correlation coefficient
Tyre inflation pressure	-0.052
Wheel diameter	0.027
Cyclist mass	0.028
Surfacing	0.814

Obstacle

The last test evaluated the effect of a 100mm high obstacle (rock) that the mountain bike had to negotiate during a typical coast-down test on the distance before the mountain bike came to a standstill. The objective was to determine to what extent a typical obstacle will affect the momentum of the cyclist. The percentage shorter distance that each of the mountain bikes travelled after traversing the obstacle is shown in Table 4. Higher values indicate that the mountain bike came to a standstill in a shorter distance after the obstacle (greater loss of momentum) than for lower values, with a 100% value indicating that the mountain bike

stopped at the obstacle. The obstacle test was only conducted on the bituminous surface.

***TABLE 4*: PERCENTAGE SHORTER DISTANCE TRAVELLED AFTER INTRODUCING OBSTACLE**

Tyre inflation pressure [kPa]	500			250		
	Cyclist mass [kg]			Cyclist mass [kg]		
	70	80	90	70	80	90
HT26	10%	12%	16%	19%	23%	28%
FS26	6%	8%	14%	14%	16%	20%
HT29	5%	5%	6%	7%	11%	16%
FS29	2%	3%	5%	6%	8%	10%

HT= High tyre inflation pressure FS= Full suspension

Analysis of the data in Table 4 indicates that the best combination for maintaining momentum after traversing over an obstacle was the high tyre inflation pressure, low cyclist mass and the full suspension 29in. wheel diameter option. The 29in. wheel diameter had an advantage over the 26in. wheel diameter, with even the low tyre inflation pressure of the Hardtail 29in. mountain bike being on par with the high tyre inflation pressure full suspension 26in. mountain bike.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are drawn:

- The 26in. wheel diameter (both suspension types) has a higher rolling resistance than the 29in. wheel diameter for the sand, grass and gravel surfaces, with the bituminous surface showing negligible differences;
- The sand surface had a rolling resistance coefficient factor of between 4.5 and 15 times higher than the gravel, grass and bituminous surfaces;
- No measurable advantage could be identified in using a full suspension as opposed to a Hardtail suspension in terms of rolling resistance on the four surfaces evaluated;
- Terrain surface showed the largest effect on the rolling resistance coefficients of the mountain bikes, surfaces and conditions evaluated, followed by the cyclist mass and wheel diameter, and finally the tyre inflation pressure; and
- The best combination for maintaining momentum after traversing over an obstacle is the high tyre inflation pressure, low cyclist mass and full suspension 29in. wheel diameter option.

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'DO WHAT YOU CAN WITH WHAT YOU HAVE WHERE YOU ARE': EXTRACURRICULAR PROVISIONING IN AN INNER-CITY ENVIRONMENT

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ABSTRACT

A growing body of scholarship links extracurricular participation as a supplement to the curricular programme to optimal learner development with benefits of increased retention for learners at risk of dropout. This article looks at how extracurricular participation is provided to learners residing in a constrained environment. A qualitative investigation was undertaken based on individual interviews conducted at five inner-city secondary schools in Gauteng. The findings show that structured extracurricular provisioning, albeit hampered by contextual constraint relating to scant finances, limited facilities and limited time, was beneficial to learners' holistic development. Perceived benefits for learners pertained to gained cognitive and social skills, a sense of belonging to the school, pastoral guidance, and the sheer joy of participation in the activities of their choice. The findings contribute to research which argues for sufficient implementation of extracurricular provisioning within context in view of the value of a holistic development of the child.

Key words: Extracurricular provisioning; Holistic development; School dropout; Retention; Inner-city environment.

INTRODUCTION

Learners‟ leisure time, once the school day is past, is as beneficial for development as participation in the formal curricular programme. Providing learners with a structured, context specific extracurricular programme that consists of physically and mentally stimulating activities contributes to their holistic development (Akos, 2006; Pitts, 2006). The fact that participation in extracurricular activities is voluntary influences the demand for intrinsic enjoyment in the activity while ensuring that applicable skill is developed with increased complexity and challenge under the guidance of competent adults acting *in loco*

parentis (Gilman *et al*., 2004).

Benefits for learners who participate in extracurricular activities relate to gaining life- and work-related skills while exploring their own identity and building resilience through effort and persistence (Hart *et al*., 2007; Hellison, 2011). These benefits are acquired by learners being linked to supportive adults outside the classroom and belonging to socially recognised and valued groups (Fredricks & Eccles, 2005). By minimising the time that learners are exposed to negative societal influences, the engagement in extracurricular activities, accompanied by the exposure to positive social networks, results in learners being less involved in delinquent activity in the external environment (Gilman *et al*., 2004; Darling *et al*., 2005; Akos, 2006).

Extracurricular participation is especially beneficial to high risk learners in poor environments. High risk learners, due to their exposure to antisocial behaviour in environments with multiple societal problems related to economic disadvantage, are less likely to drop out of school when they participate in an extracurricular activity (Eccles *et al*., 2003; Bloemhoff, 2006). Within the South African context 60% of schools are regarded as poor schools. These schools serve high risk learners in that more than half of the children entering these schools never complete their education, but leave school with Grade 9, a major point of dropout (DoE, 2006; Bloch, 2009; CREATE, 2009). As a structured extracurricular programme arranged within the context of a poor environment can contribute to these learners remaining in school, the investigation of such provisioning is considered important for improved retention.

PURPOSE OF THE RESEARCH

Several studies have been conducted within the South African context on the influence of specific extracurricular activities on learners‟ development (Chetty & Edwards, 2007; Burnett, 2010; Du Toit *et al*., 2011; Cowan *et al*., 2012). What has been less investigated is the extent and benefits of the extracurricular programme for pupils who are classified as high risk learners for school dropout due to the constraining conditions prevailing in their socio-economic environments. Therefore, this article focuses on the „what‟ and „with what effect‟ of the extracurricular programme for learners residing in a financially constrained environment. The aim was to elicit information regarding the activities that are contextually provided with the benefits of participation for learners. An understanding of the nature and value of an extracurricular programme that is provided in resource-constrained environments contributes to the discourse on extracurricular provisioning within context in pursuit of optimal learner development. The point of departure is ecological systems and self-efficacy theory as the theoretical framework underlying the qualitative investigation, which was based on individual interviews with 15 participants selected by means of purposive sampling. Findings from an analysis of the data are followed by a discussion of the nature of the extracurricular programme in terms of provisioning and constraints, with benefits for learners.

THEORETICAL AND CONCEPTUAL FRAMEWORK

The theoretical framework underlying the focus on extracurricular provisioning is supported by a clarification of the nature of a typical extracurricular programme with benefits of

participation for learners.

Ecological systems and self-efficacy theory as basis for extracurricular provisioning

Ecological systems theory proposes that human development occurs through an interactive, interrelated functioning of socially organised subsystems to support and guide, or hamper, optimal growth. Accordingly, learner development is seen as a process of reciprocal interaction between the individual learner and other human beings, objects and symbols in the immediate and distal environment and over an extended timeframe to result in competence or dysfunction (Bronfenbrenner, 1979; Gilman *et al*., 2004).

A learner‟s own biology, understood against the background of self-efficacy theory, is a primary factor for fuelling the own environment. Self-efficacy, based on outcome expectancy, underlies individuals‟ belief in their ability to execute a particular behaviour successfully (Bandura, 1997). In this regard, outcome expectancy pertains to the learner taking part in the extracurricular activity with the subconscious expectation that participation will lead to a specific outcome, such as improved quality of school and personal life due to improved knowledge and skills. Efficacy expectations determine individuals‟ efforts with a task and how long they will persist in the face of adversity or setbacks (Bandura, 1997). Due to the interactive functioning of ecological systems, interaction between self-efficacy factors in learners‟ maturing biology, their immediate family and community environment, and the societal landscape in which they are placed, fuels and steers their development (Bronfenbrenner, 1994; Bandura, 1997; Mahoney, 2000; Bloemhoff, 2006). These interactions, contingent on self-efficacy levels, result in learners identifying with their schools to develop an internalised sense of belonging as a feeling of being discernibly part of the school environment, which serves a special moderating purpose for high risk learners prone to school dropout (Gilman *et al*., 2004; Akos, 2006; Pitts, 2006).

Nature and characteristics of extracurricular provisioning

Extracurricular provisioning primarily arose from historical changes in the labour force associated with compulsory education and the declining need for child labourers at the turn of the 19th century, when the idea was introduced that more structured play activities are beneficial for children‟s development (Durlak *et al*., 2010). Structured play was accompanied by the realisation that through positive engagement with peers in the supportive company of adult guidance, skills, knowledge and behaviour in various personal, social, cultural, artistic, civic and sports settings are acquired (Fredricks & Eccles, 2005). Educators realised that for academically gifted learners extracurricular participation served to enhance their scholastic performance, whereas for academically challenged learners extracurricular participation functioned as a support to achieve within the school setting (Darling *et al*., 2005). For high risk learners prone to school dropout, school identity through active participation in extracurricular activities serves a special moderating purpose (Akos, 2006).

Salient features common to a structured extracurricular programme include aspects such as regular participation schedules, rule-guided engagement, direction by adult activity leaders, emphasis on activity-related knowledge and skill development, activity performance based on sustained active attention, activity etiquette and clear feedback on performance (Darling *et al*., 2005; Reeves, 2008; Cowan *et al*., 2012). An adherence to these features enables participants to socialise with peers and adults through goal setting and outcomes achievement

while practising proper behaviour relating to competing fairly, recovering with dignity from defeat and conquering with humility.

The format and functioning of extracurricular programmes vary with regard to location, size, funding, hours of operation, activities offered, structure of provisioning, and general mission and goals within the specific context. With reference to the work by Durlak *et al*. (2010) and

Reeves (2008), extracurricular programmes are based at school premises or various community facilities and, depending on school type and size, provide for fewer than 10 learners or up to several hundred learners of different ages. Extracurricular programmes are generally funded through a combination of government and local inputs with considerable variation in the amount of money available for activity offerings. In accordance with the curricular programme, the extracurricular programme is typically offered on weekdays during the normal school year, for several hours after the formal school day has ended. Depending on the specific context and goals with extracurricular engagement, some activities are offered on weekends with activity competitions and activity events typically scheduled for Friday afternoons and Saturday mornings.

Extracurricular offerings cover a wide spectrum of activities that are associated with some form of academic assistance, coupled with different types of personal, social, or cultural activities consistent with the goals of the specific extracurricular programme. Comprehensively considered, extracurricular activities are grouped into the following five categories (Eccles *et al*., 2003; Hart *et al*., 2007):

- Pro-social activities that include social welfare and community service type of actions;
- Performance activities that relate to music and drama;
- Team sport activities that include all the different kinds of sports provided within school context;
- School leadership involvement that pertains to learner leadership positions in extra-curricular activities; and
- Clubs and society involvement.

From these categories of extracurricular provisioning, a learner‟s voluntary selection and quality of participation remain contingent on the interrelated interaction between the activity, the social network that supports the activity and the personal characteristics of the participating learner (Gilman *et al*., 2004).

Benefits for learners

Participation in the school‟s structured extracurricular programme equips learners with competencies representing different categories of benefit, such as skill gain with prolonged effect, a sense of appreciation for belongingness and the ability to deal with challenges (Eccles *et al*., 2003; Darling *et al*., 2005; Akos, 2006; Fredricks & Eccles, 2008; Ratey & Hagerman, 2008; Du Toit *et al*., 2011; Hellison, 2011). These benefits are gained through participation in any of the five different categories of extracurricular groupings. The skills gain pertains to opportunities to increase interpersonal competence, school engagement, self-concept, academic performance and educational aspirations (Du Toit *et al*., 2011; Cowan *et al*., 2012). Due to habit formation, such as regular exercises that are needed for specific sport fitness or the prompting of logical argumentation through debate or chess games, future

developmental trajectories are established. The result is that learners who actively participate in the school‟s extracurricular programme tend to experience better quality of life in the workplace with the inclination of continuous sport engagement, or a continuous focus on logical thinking resulting in improved adult physical and mental health (Chetty & Edwards, 2007; Fredricks & Eccles, 2008). These benefits apply in all scenarios including the scenario

where learners take part in the extracurricular programme of their inner-city school environment.

Participation in pro-social activities, with as a primary goal the maintenance of a normative condition, extends school life as learners are capacitated with civic-related skills to coordinate efforts with others and interact with people from various backgrounds (Hart *et al*., 2007). Actively taking part, for example, in the school‟s environmental association that is focused on wildlife conservation through keeping the river clean in the near proximity of the inner-city school environment, results in a wide variety of skills that are gained with prolonged effect. Civic knowledge and engagement manifests in the prolonged effect of promoting the tendency to continue working collectively for a common purpose and to voluntarily practise a responsible role in the adult community (Zaff *et al*., 2003). Examples of such behaviour relate to scenarios, such as ensuring regular meals to the needy in an inner-city environment or taking responsibility for the sustained conservation of the immediate physical environment.

Membership of a socially recognised group through extracurricular participation results in connections with exemplary peers and the acquisition of social capital. The productive structuring of time through peer-established norms reflecting school and society-based values influences learners‟ personal perspectives and self-worth (Darling *et al*., 2005; Ratey & Hagerman, 2008; Reeves, 2008; Cowan *et al*., 2012). The fostering of belongingness and association with peers different from those encountered in the family life, such as peers from different ethnic groups that are typical of the heterogeneous nature of inner-city environments, enhances emotional connectedness to the school and promotes positive social relations across ethnic groups (Darling *et al*., 2005; Pitts, 2006; Hatzigeorgiadis *et al*., 2013). Interaction with competent adults serving as role models supports learner identity for enhanced social opportunity (Gilman *et al*., 2004; Fredricks & Eccles, 2005; Durlak *et al*., 2010).

Active participation in extracurricular activities provides opportunities to express personal talent and master challenging skills consistent with the encompassing school value system. Learners‟ commitment to the learning process embedded in the specific activity, accompanied by social support in the form of verbal persuasion, leads to their self-efficacy being motivated for conquering challenges to realise specific outcome expectancy (Bandura, 1997; Ratey & Hagerman, 2008; Cowan *et al*., 2012), such as successful sports team performance, convincing drama productions or sustained green-living.

Benefits for learners at risk of school dropout

Learners from low socio-economic status (SES) backgrounds, where parents are trapped in poverty, are often prone to involvement in antisocial behaviour (Eccles *et al*., 2003; Chetty & Edwards, 2007). Factors such as physical neglect, psychological scars, live-for-the-moment mentality, teenage pregnancies, family disintegration, gang formation and peer pressure for substance abuse threaten these learners‟ development possibilities (Bloch, 2009; Burnett, 2010). These conditions relate to the fact that children who are raised in poverty are much

less likely to enjoy the crucial needs of a reliable primary caregiver who provides unconditional love and support, harmonious and reciprocal interactions and enrichment through personalised and increasingly complex activities. The deficits resulting from this

negligence inhibit the production of new brain cells which alter the path of maturation, thus hampering emotional and social development to predispose the disadvantaged child to emotional dysfunction (Jensen, 2009). The result is a sustained reproduction of exclusion and marginalisation fuelled by delinquency, school failure and eventual school dropout (Swift, 2003; Gilman *et al*., 2004).

School dropout is also predicted by the degree to which learners feel connected to the social fabric of the school (Akos, 2006; Hatzigeorgiadis *et al*., 2013). Social exclusion based on SES-related factors such as families‟ evaluation of education, the non-availability of learning resources at home, and teachers‟ expectations of learner competency, causes learners from low SES environments to feel inadequate. Consequently, such learners often display a tendency to drop out of school (Hassan, 2009). This tendency is reflected in the socio-economic gradient that represents a gradual and increased feeling of isolation experienced by children from low SES families with these children encountering decreasing self-efficacy levels as they grow older (Caro *et al*., 2009).

In cosmopolitan inner-city environments there is a greater likelihood of school dropout associated with low SES conditions. Some of the reasons for this state of affairs are that children from minority groups often have to grow up in single-parent homes and ethnic minorities are vulnerable to mistreatment prompted by prejudice and xenophobia (Browne *et al*., 2009). In the Gauteng inner-city environment representing the conditions applicable to the circumstances of the conducted study, school functioning is related to provisioning to multi-ethnic working class expectations with poverty rates varying between 20% and 39% per year (Carnoy & Chisholm, 2008). Violence, which is closely related to poverty, is often modelled in schools in Gauteng inner-city environments by learners representing different ethnic groupings and who are exposed to violent behaviour at home. Feelings of inadequacy related to low SES conditions accompanied by an exposure to violence at school, combined with a lack of emotional and spiritual support at home, exacerbate learners‟ experience of isolation and insecurity with the obvious tendency to drop out of school (Van der Westhuizen & Maree, 2009). Participation in extracurricular activities conditioned by delinquent peer group support can increase retention through the facilitation of learners‟ school identity and improved quality of subjective well-being (Mahoney, 2000; Gilman *et al*., 2004; Hellison, 2011). The result is that learners at risk of school dropout form a positive connection with the school and its values through extracurricular participation, which may otherwise not be realised. These positive connections also apply to low SES circumstances prevailing in the multi-ethnic inner-city school environment of Gauteng (Chetty & Edwards, 2007; Bloemhoff, 2009).

RESEARCH DESIGN FOR EMPIRICAL INVESTIGATION

To understand the extent and value of extracurricular provisioning to learners residing in a financially constrained environment, an interpretive paradigm was applied using individual in-depth interviewing. Concurring with Henning *et al*. (2004) and Denzin and Lincoln (2011), the qualitative case study genre was selected for an in-depth understanding of the situation of those involved, as well as of the meaning they derived from their situation. Since the focus

lay in the process rather than the outcomes, the study entailed a rich description of the context

and operation of the case (Johnson & Christensen, 2004), namely extracurricular provisioning in financially constrained conditions.

Participants in the study

Five secondary schools from an inner-city environment in Gauteng were selected as research sites. All 5 schools fell under the category of low-fee private schools catering for learners from black middle-class families with a large component from black working-class families. The schools were fully accredited and registered with the Department of Education and, apart from school fees from private households, are financially supported by contributions from charity organisations. The 5 research sites have, on average, 900 learners and 25 teachers per school. The selection of the specific 5 schools was largely pragmatic as they cater for learners who are exposed to socio-economic constraints typical of inner-city environments. The selection was also motivated by convenience in terms of accessibility (Cohen *et al*., 2011). Other schools, including township schools, would face different challenges in providing an extracurricular programme within a socio-economically constrained environment; but this does not diminish the achievements of the 5 selected schools in terms of extracurricular provisioning within constrained environments, or the validity of the research. This investigation acknowledges the distinctiveness of any school environment in providing a viable extracurricular programme based on doing what is possible within context to ensure optimal learner development.

Purposive sampling of information-rich participants entailed an active involvement in the management of the extracurricular programme of the school in terms of being ultimately accountable for the programme or facilitating the functioning of extracurricular provisioning. On this basis, the following persons participated in the investigation: the 5 school principals of the selected research sites; the 5 teachers (1 per school) who were in charge of organising and coordinating culture-related extracurricular activities; and 5 teachers (1 per school) who were coaches in charge of organising and coordinating sports. All of these participants shared a common indicator for selection, namely that of being actively engaged in ensuring the proper functioning of the extracurricular programme at the respective schools.

The suggestions by Toma (2011) on rigour in the research approach and being aware of the threat to content validity when organisers of the extracurricular programme make effect claims about benefits experienced by learners participating in the programme. Thus, the judgement claims of the 15 managers in terms of each participant‟s response to the same question asked was triangulated. With follow-up prompts for increased clarity was arranged through intensive engagement (each interview lasted at least 1½ hour), which served to distinguish between specific and vague statements. This eliminated inconsistencies in pursuit of determining the participants‟ objective opinions of what they observe, on a continuous and prolonged basis, as perceived benefits for learners participating in the school‟s extracurricular programme. In line with the suggestions made by McMillan and Schumacher (2006) on observer bias, the accuracy of the sources were assessed by considering the researchers personal assumptions and predispositions with regard to the benefits of extracurricular participation in ascertaining the accuracy of participant responses in terms of being observant and thoughtful. There were regularities and recurring patterns in the data as a result of the comparison of the data from the 15 interviews that represented different participants from

different situations and with different interpretations of reality. This rigour produced a comprehensive and context-rich set of findings relevantly linked to theory. All 15 interviews were guided by the same themes, namely the scope and magnitude of extracurricular provisioning, the perceived benefits for learners and the challenges with provisioning.

Qualitative analysis procedures

The qualitative content analysis based on Tesch‟s model to ensure that all the perspectives and issues that arose from the data were included in the report. In brief, this meant that each interview was transcribed for an immersion into the data and as an initial segmentation of the data into units of meaning (De Vos, 2005). This was followed up with open coding by reading and re-reading each interview to ensure an overview of as much contextual data as possible, so as to achieve an inductive selection of codes determined at sentence level (Henning *et al*., 2004). After axial coding, selective coding was used to ensure that themes from the labelled categories were constructed and extracted to represent the interpreted and rationalised data as research findings (Henning *et al*., 2004). Based on Guba‟s trustworthiness model as explained by De Vos (2005), the authenticity of the findings in terms of truth value, applicability, consistency and neutrality was ensured. The research findings from the empirical investigation were triangulated with the research findings from literature. The anonymity of participants and the confidentiality of their disclosures were guaranteed at all times during the research project.

FINDINGS

The categories that emerged from an inductive analysis of the data from the interviews transcribed verbatim are subsequently presented under themes as research findings. These themes concur with factors relating to the extent and value of extracurricular provisioning as identified in the literature. The themes pertain to the scope and magnitude of offerings; the preference for culture-related activities; parent involvement with the extracurricular programme; benefits for learners; and challenges with provisioning. A discussion of these themes was substantiated by verbatim excerpts from the interviews. For the sake of confidentiality and authenticity, the 10 teachers are distinguished as T1, T2 and so on, and the 5 school principals as P1, P2 and so on.

Scope and magnitude of offerings

Although participants viewed teaching and learning as their primary purpose and the major focus of their attention, the extracurricular programme was considered to be important insofar as being *‘a supplement to assist the learner to be a well-rounded person’* (P5). School principals agreed that the limited availability of outdoor facilities in the inner-city environment determined the extracurricular programme in terms of the kind of activities offered and the time schedules made available for those offerings. In this regard, School Principal 2 echoed the attitude and approach prevailing at all 5 research sites, namely that of *‘do what you can with what you have where you are’*. Extracurricular offerings pertained to the culture-related indoor activities of drama, music, dance and the school choir. Other indoor activities represented debating, chess and table tennis. Pro-social activities represented a soul buddy club with extended actions within the inner-city environment, such as *‘visit an orphanage regularly’* (T3) and *‘collect money for meals for homeless adults’* (T1). Apart

from athletics, outdoor sport included netball and soccer *'because it is easy to secure pitches and teams to compete against in these two activities'* (P2). The offering of soccer was motivated by learners who have *'a natural preference for soccer rather than rugby'* (T7), and the financial constraints hindering the offering of cricket of which *'the sports equipment is expensive'* (T10).

All 5 research sites rented the same municipal stadium situated in the inner-city environment on a yearly basis to offer these sport activities. Each school had 2 one-and-a-half hour sessions, 2 afternoons per school week, in which these sport activities were offered with class teachers acting as team coaches. The convenience of the municipal stadium whose „*grounds are not so far from our school'* (P5) enabled learners to safely participate in the sport activities offered. Two sport tournaments, 1 for athletics and 1 for soccer and netball, were organised every year with each school having participants for all the sports items agreed upon by the participating schools. Teacher participants felt strongly about measures *'to tap the financial support which companies are willing to provide'* (T8), to arrange for extra funding so as *'to extend the range of extracurricular activities'* (T6) and *'to hire professional experts to present the extracurricular activities'* (T9). If this were feasible, it would improve the quality of extracurricular provisioning and *'release teachers to focus on their teaching'* (T9).

Preference for culture-related activities

Learners preferred participation in culture-related activities rather than sport offerings. Consequently there was much enthusiasm for dance and music due to *'a culturally-oriented natural affinity for song and dance'* (T3). For that reason and to enhance intrinsic motivation for participation in these activities, research sites focused on exciting provisioning as *'learners ENJOY dancing and singing'* (T1). Considering that *'the school environment can become boring if you close the entrance to the school and not allow learners to go on the streets'* (T2), the value of participation in the school choir was considered constructive to *'occupy many learners'* (T4). Music as an extracurricular activity was also incorporated into the formal school day for remedial purposes. Since many of the learners experienced constrained conditions at home, music was used as a soothing strategy to ease learners‟ emotions and to get them receptive to formal instruction. In this regard School Principal 1 explained: *'You find that many learners come with stress from home and just with that little song it puts their emotions at ease, now they can focus.'*

A highlight of the extracurricular programme– and something that was celebrated at all 5 research sites – was the annual heritage day of traditional folk dance and song with learners designing their own costumes to depict the cultural demographics of South Africa. Under the supervision of teachers and learner leaders *'the school hall [was] decorated as a cultural village'* (T5) where learners showcased the different cultures in terms of customs, food, dress, language and beliefs, accompanied by song and dance. Learners competed in their different grades and *'the overall best costumes and expression of cultural knowledge win the competition'* (T5). At 1 research site, and thanks to the teacher in charge, a fashion design enthusiast who arranged for external support, learners attended classes in costume design and modelling techniques. Casting agencies who attended the school‟s annual heritage day provided promising learners with after-school modelling and fashion design contracts. Teacher 1 emphasised that *'many companies and businesses are willing to donate money for*

fashion designing skills' to contribute to the development of a *'pool of future designers'*. Apart from gaining constructive competencies and enjoying the heritage day celebrations, learners were introduced to the reality of a multicultural society because *'learners grow up in city flats, they seem to lose touch with the real roots and backgrounds of their ancestors, so this is their only opportunity to get to know about the different cultures in South Africa'* (P1).

Parent involvement with the extracurricular programme

Parents were informed about their children‟s participation in the extracurricular programme by means of *'a written memorandum'* (T7) and they were requested to give *'their signed approval for their children's participation'* (T7), especially when participation *'involves travelling from the school premises'* (P4). Some parents of Grade 12 learners preferred their children not to participate in extracurricular activities, but rather focus on preparing for the final Grade 12 examinations to achieve good results which were considered to be *'a gateway to labour market propositions … bursaries for further studies'* (P3).

Although parents were financially responsible for their children‟s commuting to and from the extracurricular activities, many parents *'struggle to pay the fees for their children's transport'* (T9). A feasible arrangement entailed a subsidised extracurricular fee which, „*combined with the money from fundraising efforts'* (T9), provided for viable extracurricular possibilities. The primary contribution of parents to the extracurricular programme remained their encouragement of their children to participate in these activities. In this regard, it was stressed that *'a supportive parent allows his child to participate in the activities of his own choice and then supports … encourages his choices'* (T10). Participant school principals reported parents‟ approval of the extracurricular programme offered at their respective schools since *'parents are happy that their children have activities to choose from*‟ (P3) and *'parents are satisfied with the variety of activities at our school'* (P1).

Perceived benefits for learners

Participants agreed that their prolonged observation of learners who participated in extracurricular activities was that these learners developed healthy bodies and minds that contributed to constructive routines and abstention from substance and alcohol abuse. Extracurricular participation improved discipline among learners, which influenced the school‟s image positively in that *'learners acquire new skills and restrain from acts like fighting, sex and alcohol abuse*‟ (P4). Added to a healthy body and a disciplined mind was the perceived feeling of well-being and pure joy experienced by learners who participated in extracurricular activities. In this regard a soccer coach declared, *'My players LOVE their soccer'* (T7). The soccer coach based this observation on the fact that players were never absent from practices and always wanted to continue practising even when the practice time had expired. Participants agreed about the perceived positive influence of the extracurricular programme on learners‟ quality of school life because learners‟ good memories of school related to *'their participation in music and sports'* (P2), which contributed to *'learners becoming truly fond of their school'* (P3). One participant explained that their school offered table tennis in the school hall for 1 hour after school every school day. The „*boys enjoy staying after school to play a game or five'* to such an extent that „*we* [teachers] *have to chase them to eventually go home'* (T6). As a result of their participation in extracurricular activities the learners became permanently attached to their school, as demonstrated by school leavers

who regularly returned to enquire about the well-being of *'the present choir'*(T4) or to ask,

'how does the chess team perform now?' (P2).

With regard to perceived self-worth, extracurricular participation enhanced self-actualisation in that learners who struggled with the curricular programme were often recognised through excelling in extracurricular performance. In this regard it was pointed out that „*if a learner cannot concentrate in class, you may find that the same learner is a champion on the soccer pitch'* (T9). The same applied to culture-related activities, such as drama which developed learners‟ creativity for clear expression so as to *'use their imagination to visualise what they do not see'* (T2) and which served as an alleviating strategy *'to transcend inner-city sombreness'* (T2).

Participants also emphasised the perceived pastoral value of extracurricular participation in that learners approached their coaches for life guidance and counselling. Through extracurricular participation learners were encouraged to persevere and to stay focused. In this way they were equipped with competencies *'to survive in life'* (T7) and *'to deal with their problems in a better way'* (P1). In many instances the fact that *'learners have problems and cannot open up in class or come to the office, but can talk to you* [coach]*openly during sport sessions*‟ (T10) resulted in teachers liaising with parents in a mutual effort to improve learners‟ well-being. The extracurricular environment also created opportunities for teachers to provide advice on problems learners experienced in their private lives. In this regard Teacher 6 explained, *'Two boys were about to fight on the pitch; I pulled* them apart, *we talked and I found out that they were fighting about a girl. We resolved the problem there and then because it was just a misunderstanding between two boys'* (6).

Challenges with provisioning

A main obstacle with extracurricular provisioning related to the challenge of balancing constrained finances and the available facilities with the demand *'to ensure that Grade 12 pass rates are successful'* (P3). The ideal of the school principals, with their staff, was to have a school environment in which learners could participate in a wide range of extracurricular activities with ample and sophisticated facilities and sufficient attendance to the curriculum programme for optimal learner development. However, School Principal 4 explained the reality of constrained funds linked to the demand to adhere to standardised academic outcomes as follows: „*Our hands are tied, we are independent, but poor, without any subsidy from the Department we have to use the resources we collect from learners' fees wisely because we deal with the first goal of paying teachers and buying text books to achieve a desired pass rate for matric'.*

Participants were aware of their learners‟ low SES circumstances and the threat that these conditions hold for learner retention and optimal development. Participants acknowledged the high levels of violence in the inner-city environment to which their learners were exposed and the lack of critical support and stimulation at home. All the participants were under the impression of the intensified demand of these SES conditions on curricular and extra-curricular provisioning to cater for learners‟ proper holistic development. In this regard, they emphasised that linked to limited extracurricular provisioning was the prevalence of high levels of learner absenteeism due to *'boredom with the school environment'* (T8) as a result

of an apathetic approach to life associated with *'home background greyness'* (T2). Participants felt that sufficient provisioning in terms of the time spent on the extracurricular offerings – however limited these offerings might be - could contribute to ameliorating

learners‟ negative circumstances associated with low SES conditions. However, to remain viable with regard to the core function of teaching and learning, the schools were compelled to limit the time spent on the extracurricular programme in order to cover the curriculum and achieve acceptable pass rates. In this regard, School Principal *2* admitted their dilemma: *‘Sports would have kept learners around, but the congested school curriculum does not allow more emphasis on sports.’* As is the case at all schools worldwide, the contribution of extracurricular offerings to learners‟ holistic development needs to be balanced with maintaining sufficient emphasis on academic achievement. However, for learners from low SES environments, academic achievement is even more crucial as it is a means of gaining social mobility in order to end prolonged exclusion and marginalisation.

It was found that the functioning of the extracurricular programme at the research sites‟ inner-city environment was inhibited by scant funds, limited facilities and limited time as additional time needed to be spent on the curricular programme.

DISCUSSION

As a supplement to the curricular programme, participation in the extracurricular programme benefited learners‟ holistic development. For learners, extracurricular participation went beyond physical and cognitive skill acquisition to include psycho-social resilience and the emotional security of a sense of belonging. For learners at risk of school dropout, emotional resilience contributed to the forming of positive connections with the social fabric of the school, thus encouraging perseverance and retention. In line with ecological systems theory (Bronfenbrenner, 1979), and with extracurricular provisioning as a case in point, the school principals and staff of the researched sites managed viable provisioning with the structured extracurricular programme. Participation in the inner-city school‟s extracurricular programme enabled learners from low SES conditions to develop optimally within the specific context.

Learners participated in the activities of their choice offered from an extracurricular „menu‟ consisting of athletics, soccer, netball, drama, music, dance, school choir, debating, chess, table tennis, and the soul buddy club. In line with the synthesis of Eccles *et al*. (2003) and Hart *et al*. (2007), these offerings symbolised a balanced programme of extracurricular possibilities representing activities from all the different categories of extracurricular provisioning. From these offerings learners gained constructive knowledge, skills and behavioural competencies that included personal, social, cultural, artistic, civic and sport empowerment.

It was evident that the learners did not only gain skills through extracurricular participation. They also experienced a sense of belonging to the school setting, enjoyed receiving pastoral guidance and indulged in the sheer pleasure of participating in the activity of choice. The fun of participating in a cultural exhibition was accompanied by job-related skill attainment in fashion design and modelling with the benefit of exposure to societal multicultural functioning. Through expressing their own thoughts in drama-related activities they could conceptually interpret reality and accommodate diversity. Participation in pro-social activity

introduced them to the reality of their civic world and fostered an altruistic approach to life. Exposure to concerned and continuous pastoral guidance by adults acting in *loco parentis* enhanced the learners‟ well-being and their connectedness to positive school life. In many instances learners‟ challenges with the curriculum programme were counteracted by their

giftedness in extracurricular activities, which resulted in an affirming of their self-value and positive self-concept. The constraints of low SES family background conditions and inner-city sombreness were alleviated by the pleasure of consistent whole-school participation in music-related activity.

In line with the findings of Gilman *et al*. (2004), the success of the extracurricular programme presented at the research sites was contingent on learners‟ intrinsic interest in the offered activities. Successes were largely inhibited by scant financial resources, limited facilities and limited time allocated to the extracurricular programme. Curricular demands in terms of sufficient time for teaching and learning to achieve acceptable standards of academic performance inhibited adequate extracurricular provisioning. However, regardless of contingencies and inhibiting factors, the extracurricular programme was presented viably to benefit learners who resided in an inner-city environment and were prone to high risk of school dropout.

CONCLUSIONS

With reference to the influence of ecological systems‟ interactive functioning on learner development (Bronfenbrenner, 1979), participation in the extracurricular programme by learners residing in an inner-city environment was constrained by scant financial resources, limited facility availability and the demand for curricular-related academic achievements. Despite these constraints, it was found that learners benefited holistically from participation in the structured extracurricular programme which, albeit limited with regard to number and frequency of activity provisioning, still embodied a balanced „menu‟ representing the different categories of extracurricular provisioning possibilities. Through an approach of doing what is possible within the context of an inner-city environment, extracurricular provisioning enabled learners to physical and cognitive skill-gain supplemented by emotional security and a sense of school belongingness. These benefits, which equipped learners with psycho-social resilience to persevere, resulted in improved retention that enhanced optimal development within the specific setting.

The findings have implications for extracurricular provisioning in constrained environments. Such school principals, together with their staff, face the challenge of ensuring a contextually viable extracurricular programme to benefit learners for optimal development. It is suggested that further research be conducted on extracurricular provisioning in environments with different kinds of constraints, with an exclusive focus on the perspective of the user, namely the learner, for a comprehensive understanding of this topic. Insights into extracurricular provisioning could contribute to the discourse on sustainable provisioning for securing an enabling environment for learners to realise their potential to the full.

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A RITUAL PERSPECTIVE ON THE COMRADES MARATHON

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ABSTRACT

The Comrades Marathon is a dominating event on the annual sport calendar in South Africa. The race challenges its participants in terms of a combination of constraints, such as the spatial, physical, temporal and the psychological. An auto-ethnographical research methodology is applied in combination with literature on

ritual and sports, such as distance running, karate, the Olympic Games and triathlon. It is argued that the historical Comrades event is rife with elements of a ritual nature and ritual engagement. Throughout the race, participants in the world's greatest ultra-distance race experience notions of isolation and liminality, emotional and psychological instability, inscription and mental growth, a sense of profound camaraderie, symbolic awareness and the euphoria of the final reward. It is argued that these notions are typical of ritual action and that the Comrades race acts as a vehicle for such ritual transformations.

Key words: Comrades; Distance running; Ritual; Passage; Liminality; Heroes; Cyclical.

INTRODUCTION

> *'For humanity to survive, it will have to invent a new religion. The religion has been invented, it is the religion of the runner'* (Fixx, 1980:6).

In addition to sport science and sport medicine, other sport discourses focussed on a plethora of fields, such as the role of politics (Grundlingh *et al*., 1995; Walters, 2006; Labuschagne, 2010), the promotion of national and ethnic identities (Goethals, 1996; MacAlloon, 1996) and sport history (Walters, 2006) have been dominant. Sport, play, leisure and games have always interested anthropologists studying 'ethnic' or non-complex communities (Gluckman & Gluckman, 1977; Gutman, 1978; Birrell, 1981; Blanchard, 1995; Klein, 2002). The role of ritual and ceremony in sport featured from time to time in anthropology, yet its role in sport, such as athletics, rose to prominence the last three decades (D'Aquili *et al*., 1979; Callen, 1983; Carter & Krüger, 1990; Donahue, 1993; Granskog, 1993; Laughlin, 1993; Migliore, 1993; Rowe, 1998; Klein, 2002; Hockey, 2009). Sport and events, such as wrestling, triathlon, karate, the Olympic Games, pistol shooting and distance running received research attention in these contributions. In South Africa literature on distance running received particular impetus with the contributions of Noakes (1992) and Fordyce (1996).

One particular distance running event which has dominated the South African sport scene since the 1980s, is the Comrades Marathon[1]. It has become a regular date on the South African sport calendar as a spectacle for the consumption of public television, roadside viewers and helpers and more than 12 000 runners. It draws the admiration of many South Africans and the event has catapulted itself into international fame by becoming the biggest ultra-running[2] competition in the world in terms of number of athletes, sponsorships and media attention.

Why does the institution of the Comrades drag runners, families and friends and non-runners into this large spectacle and whirlpool of endurance and pain? In order to understand and conceptualise the ritual dimension of the Comrades, one needs to unpack a number of its foundation pillars.

It is firstly necessary to reflect on the origin and popularity of road or distance running, the so-called running boom, on the international scene (Fixx, 1979) and its effect in South Africa. The running boom in South Africa led to many runners aspiring to compete in running distances beyond the standard marathon. This obsession with ultra-running points to the unique origin, history, identity and symbols, which the Comrades represents. This 'package' provides the core ingredients for the urge and compulsion for runners to participate in the

Comrades. This quest displays repetitive and cyclical actions and performances which are typical of ritual behaviour. It will be illustrated that the Comrades road race bears the characteristics of a mass ritual for both runner and non-runner within a ritually charged space and place.

RESEARCH METHODOLOGY: ANTHROPOLOGY OF RITUAL AND RUNNING ON THE INTERSECT

Personal interest in the anthropology of running and ritual is twofold. The first interest originated from my own experience[3] as an average or 'non-elite' distance runner (Schomer & Connoly, 2002). Reportage and the fieldwork experience on the topic is self-reflexive and autobiographic to the extent what anthropologists term 'auto-ethnography' (Hockey, 2009), hence the usage of the first-person narrative throughout the text. Running with the studied community who becomes one's research participants provide an ideal setting or locale for the process of participant observation, which is crucial in the qualitative research environment (Granskog, 1993). This interest in ritual research emanates from on-going research on male and female initiation rituals among some of the black communities in South Africa (Van Vuuren & De Jongh, 1999; Van Vuuren, 2012). One is struck by the similarity in a range of dynamics of ritual and ritual engagement in both non-complex and modern societies and these also manifest in the sport of distance running and the Comrades. This similarity stimulated further research.

[1] The term marathon is strictly speaking only reserved for the distance of 42.2km.
[2] In South Africa, ultra-running is considered to be road running distances above 50km, such as 56km and 64km races, the Comrades (90km) and 100 miler (160km) events such as the Washie 100 miler.
[3] Permanent Green numbers were awarded for both the Comrades (in 1991) and Korkie Marathon (56km) (in 1992).

The views of a range of research participants (Comrades and non-Comrades runners), seconds[4] and supporters (spouses, family members, club members and friends), non-runners, spectators (roadside onlookers and television audiences) and members in the administration of the event are reflected in this article. Many of the insights for this article originate from close interaction with particular runners. Segments of the information were obtained at the actual time of participation in the Comrades and other races (1980-1996), while other interviews were held recently (2000 onwards). Training runs in groups, formal club runs (mid-week time trials, weekend distance runs) are invaluable opportunities for obtaining runners‟ views on the sport. During training most runners are more relaxed, less competitively minded, and often prepared to reveal the personal and „hidden‟ in their running lives.

Pseudonyms are used to protect the true identity of research participants in case studies. The time span (1980s to present) provided a period and chronology whereby patterns of the running-ritual experience over three decades could be scrutinised. It helped in identifying the notion of change in the social construct of the race over the same period.

RITUAL, SPORT AND RUNNING IN ANTHROPOLOGY

Although 19th century anthropologists described 'primitive' religious systems and the rituals

which support these, it was Van Gennep (1907[1996]) whose threefold model was influential. This model included rites of separation (the pre-liminal), rites of incorporation (the liminal) and rites of transition (the post-liminal) (Van Gennep, 1996). This was followed by Eliade, who in 1949 [1996] proposed a model of religion which resembles a three-dimensional architectural model. The sacred mountain where heaven and earth meet sits at the centre of the world and whereby every temple, palace or royal residence can be considered as a sacred mountain, which becomes a Centre. The Centre is the zone of reality and the road to the Centre is arduous, difficult and resembles a pilgrimage and a ritual, "Attaining the centre is equivalent to consecration and initiation" (Eliade, 1996:196).

Since the late 1950s, the contributions of Victor W. Turner (1957, 1967, 1979, 1989) were seminal. Turner's fieldwork in Zambia (from 1950 onwards) led him to develop the concept of social drama, during which community disputes are resolved by engaging ritual, theatre (Turner, 1979). Using Turner, Rowe (1998) suggests that what liminal ritual does for non-complex societies, liminoid phenomena does for theatre, entertainment, sport, art and literature. Ancient sport was highly ritualised, while modern sport is more secular; however, secularity is not a tool of distinction for sport ritual.

The academic link between sport and ritual, according to Krüger (1990), rose to significance when Sir Julian Huxley organised the Royal Society in London around the theme 'Ritualisation of behaviour in animals and man' in 1965 to which Turner was a principal contributor. The domains of the biological, psychological and the cultural were scrutinised and defined in terms of a pan-species schema. The ritual emphasis of modern sport can be

[4] *Seconds* are roadside helper-drivers who assist runners by providing liquids and temporary medical assistance, or in the case of competitive runners, provide information on the course and on other competitors. In the modern race seconds became faced out or were barred from providing assistance.

identified in the notions of regularity (Miracle & Southard, 1993), emotionality, drama and symbolism. In addition, both modern sport and 'primitive' ritual have mythic themes at the core and share the so-called 'magic circle', which are all bound by symbolic ideas. According to Kiler (Krüger, 1990), the performers (sportspersons in sport events) are 'immersed' in the executions of their difficult tasks. Within the nation state context, national and trans-national identities are coordinated and choreographed in ritual mode (Krüger, 1990). The leitmotifs of ritual are also present in modern sport. Synchronisation is one such landmark theme, which serves to dissolve potential conflicts applying synchronisation (Krüger, 1990). Synchronisation is a core element in the ritual repertoire, yet the notions of resolve and dissolve were suggested by Turner with the idea of communal social drama (Turner, 1957).

Ritual displays prominent cyclical notions. Global sport events are classic cyclical occurrences (Donohue, 1993; Granskog, 1993; MacAloon, 1996), which feed into the above smaller cycle, for instance the quadrennial Olympic (Gluckman & Gluckman, 1977) and Common Wealth Games, Soccer, Rugby and Cricket World Cups and annually the Comrades Marathon and Tri-Nations Rugby event. Krüger (1990) also argues that modern society experiences repetitive cyclical stress and some form of relief comes with seasonal sport. In traditional and non-complex societies (Africa) and medieval Europe, ritual was always closely linked to ecological, seasonal and celestial phenomena, such as harvest time, the position of the moon, circumcision in Africa during winter, and so forth. Canadians cannot wait for the ice hockey season in winter, South Africans associate rugby with winter and

cricket with summer and distance runners with 31 May on Comrades day.

The learning experiences of ritual which are gained in sport are integrated into real life. Sportspersons often concede that sport provide them with new thresholds (Turner, 1967, 1989), new moral codes (Donohue, 1993), wisdom (Donohue, 1993; Eliade, 1996), conditioning (Miracle & Southard, 1993), and so forth. A number of studies on sport ritual focussed on the impact of trance (Granskog, 1993) and its role in the neurobiological processes. D'Aquili *et al*. (1979) and Miracle and Southard (1993) provided us with insights into secretions, such as endorphins (Strahich, 1982) and opioids which condition the 'detachment from the physical world' and provide a 'pain-free state' such as experienced in the 'jogging craze' (Krüger, 1990).

National sport have consistently created new heroes and idols whose seemingly invincible winning record, heroism and endurance became powerful inspirations to ordinary people and amateur athletes and sports people. The modern Olympic Games (since 1896) is rife with ritual such as laurels and medals to the victors, specially composed music, the Olympic flame (since 1832 , the bell on the last lap (since 1932 , and the display of ancient Greek mottos and flags (Walters, 2006). The hero motif in sport ritual (compare Granskog, 1993; Laughlin, 1993; Migliore, 1993; Rowe, 1993; Fordyce, 1996), was central from the beginning when Spiridon Louis won the marathon event in 2:58:50 in 1896. Welcomed by the Greek King George I, he was spontaneously hailed as a national hero. At the closing ceremony 100 000 spectators saw how medals and laurels were awarded, pigeons carrying blue and white streamers released and flower petals threw in the air. The newly haled hero Louis led the lap of honour (Walters, 2006). The 1936 Berlin Games was pickled in Nazi ritual symbolism and signage. “The swastika and Olympic rings made easy companions on the crowded Berlin streets” (Walters, 2006:81).

INSTITUTION OF THE COMRADES MARATHON: A BRIEF HISTORY

Background

It is generally accepted that road running was conceived around the Olympic marathon (since 1896), but dates back to 490BC when Pheidippides as a foot courier brought the message of the Athenian victory over the Persian army on the Plain of Marathon. He ran more or less 26 miles the distance between Marathon and Athens to bring the news of the victory. Some sources claim that he actually ran much further to break the news to the Athenians, namely 150 miles in 48 hours (Fixx, 1980). These trained foot couriers (called *hemerodromoi*) ran vast distances and often carried lighted torches. This ancient tradition was revived when Charles Rowell in 1880 ran non-stop for five days. In 1927 Arthur Newton set a new world record over 100 miles in a time of 14 hours 43 minutes (Fixx, 1980). The same Arthur Newton won the Comrades Marathon a record five times and is considered as one of the Big Six in the history of the race. A 56km road race between Hillcrest and Pietermaritzburg was named in his honour. Apart from the original initiative by Vic Clapham, it was possible that Newton had much to offer with the early development of ultra-running and the organisation of the Comrades. For the purpose of this article, a few highlights between 1921 and 2013 are discussed.

Symbolic Comrades race

After returning from East Africa in 1918, World War I veteran Vic Clapham approached the

League of Comrades of the Great War for permission to hold a race between Pietermaritzburg and Durban. Permission was only granted in 1921. The 48 men who turned up for the inaugural race on Empire Day on 24 May were mostly ex-infantry men (Alexander, 1985). Bill Rowan won the first race in a time of 8 hours 59 minutes. In 1923 'little Miss' Frances Hayward became the first unofficial female finisher in 11:35 (Alexander, 1985). After the 1925 race, the mercurial fourth-time winner Arthur Newton and a friend measured the entire course for the first time pushing a heavy wood and brass, government tested measuring wheel all the way between Pietermaritzburg and Durban (Alexander, 1985). In 1931 the Gunga Din Shell hole (of the MOTHS[5]) donated a trophy for the best team performance. A tin helmet was mounted on a wooden base for the purpose (Alexander, 1985). So stretched out on the long road were the few runners in the 1935 race that Morris Alexander wrote on his agony during the race: "It (pain) went on for hours. True to his word, perky little Liege Boulle overhauled me, on Cowies Hill. He was the first runner I had seen for twenty miles" (Marais, 1983:28).

The same Alexander also designed the black and gold Comrades blazer and the idea of permanent evergreen numbers for the completion of 10 races. Upon finishing, the athlete is channelled into a separate space or pen placed on a special green number podium and the runner then receives two different sized green numbers which are upon announcement of the name and number of the athlete awarded by a former winner[6]. Under his chairmanship, the first die to strike medals was imported from England. On Monday 24 May 1948 another

[5] MOTHS=Memorial Order of the Tin Hats.

[6] The author received his green number from Manie Kuhn who won in the legendary 1967 tussle with a stumbling Tommy Malone.

Comrades tradition started with Max Trimborn's cock crow to signal the start of the race (1985), a tradition which was described by Alexander (1985:140) as follows about the 1953 race: "He then (at the stroke of six) gave his traditional, raucous cock crow which along with the City Hall chimes and the firing of the starter's pistol had heralded Comrades Marathon starts for twenty years".

The award for completing the race in time is of course the medal system, which has become much more diversified since the early 1920s. Even by the early 1990s there were only three categories of medals: gold for the top 10; silver for sub-7.5 hours; and bronze for sub-11 hours. In 2003, the cut-off time was extended to 12 hours followed by a more diversified and meritorious medal system. The categories are: Gold for the first 10 (men and women separately); Wally Hayward medal, silver with a golden edge/ring for the 11th position up to sub-6.5 hours; silver from 6.5 to sub-7.5 hours; Bill Rowan medal; bronze with a silver edge for 7.5 hours to sub-9 hours; bronze for 9 hours to sub-11 hours; and the copper Vic Clapham medal for 11 hours up to sub-12 hours.

The race grew from 104 starters and 80 finishers in 1960 to 1241 runners in the fiftieth race, called the Golden Jubilee, on 31 May 1975 (Alexander, 1985). The race in the 1990s onwards doubled in the size of the field with 14 000 to 15 000 runners. For the 2013 race (89.2 km) of the Comrades, 14 336 runners started on the morning of 31 May and 10 188 finished the race under 12 hours. This vast number of runners was almost 400 times more than the 48 entrants who lined up on the morning of 24 May 1921 (Anonymous, 2013).

THE RACE AND RACE DAY

Weather plays a significant role in the minds and bodies of most runners. While a few runners are all-weather runners, most are not. Obviously extreme cold and hot conditions, wind and humidity have a huge influence on the hydration of the running body and eventually the mind. These variables might be perceived as constraints since they affect most forms of outdoor sports. In addition, I would like to add the constraints of the body, the mind, the temporal and the spatial. The race experience that awaits the down-Comrades runner from Pietermaritzburg to Durban can be illustrated as follows (Fordyce, 1996)

The proverbial bull-ring or arena at the start of the Comrades, are the two City Halls, Durban for the up-run and Pietermaritzburg for the down-run. The entire venue is lit up, a large banner welcomes runners and temporary steel barricades demarcate the various starting categories. The deafening sound of thousands of Indian Myna birds in the surrounding trees inform the runners that the 'time has come'. Runners queue for last-minute stops at portable toilets, loved ones are hugged and receive final orders where to meet their athletes (compare Granskog, 1993). Legs and shoulder muscles are rubbed and the mixed odour of Deep Heat, sweat (compare Van Eeden, 2000) and breath awaits the runner and provides the seasoned runner with a sense of *déjà vu.* Some runners go through routine stretching exercises, others pray silently, more are loud and rowdy and a few are dead silent. The countdown starts and the public address system plays the famous Max Trimborn cockerel recording, the sound of the theme song from 'Chariots of fire' starts. Finally, the mayor fires the gun and the runners are away for an ordeal which lasts between five and half (winners) and 12 hours (final cut off). The Pietermaritzburg start is normally colder than the Durban one and runners are

dressed in additional throw-away apparel ranging from old vests to make-fit plastic rubbish bags.

In both directions the runners deal with the notorious Big Five (hills) of Comrades. On the downhill these are in order Polly Shorts (at 8km, 755m above altitude)[7], Nchanga (40km, 793m), Botha's (50km, 772m), Fields (65km, 542m) and Cowies (70km, 366m). The order is in reverse on the up run, turning Polly Shorts into the most challenging. About the stretched out Harrison flats (30-40km), Fordyce once remarked that „it is the only part of the route which is uphill from both sides. On the up run I found the meandering road past the chicken farms to be particularly depressing".

Running up Nchanga hill (on the down run) runners are met by thousands of cheering and singing local Zulu villager spectators from the nearby Valley of a Thousand Hills (compare Fordyce, 1996). Derek van Eeden's poem, 'Gogo, Gogo why you yo-yo?', (Van Eeden, 2000:61) is captivating:

"After the maddening undulations of Harrison's Flats,
After the Zulus ululating, exhorting at Bayats*
After Inchanga's wild, wooded, wattled plunge,
The leaders close on Drummond Town."
[*a famous landmark store]

Drummond is also the halfway mark where race organisers announce the runners' progress: Wally Hayward once read the time at the halfway mark where cheering crowds, water spray

and a large banner greet the halfway runners in dramatic way. For some it is a milestone, a relief, for others it's debilitating, for those who set goals and did not make it, it becomes arduous to re-organise their mind set and proceed. Landmarks in the Comrades often seem more valuable than kilometre markers. One such landmark is the Alverstone radio mast as its sudden appearance tells you that the summit of the ever-winding, grinding and invisible Botha's Hill has finally been reached. Running through Hillcrest village, the school band of Kearsney College becomes a wonderful memory.

Pain and agony normally sets in after Drummond, for others later. Before the era of portable toilets along the roads, runners had to arrange their own 'bush calls' or ablutions, which were inconvenient and most cumbersome since place and the nature of the road called for little choice. Fields Hill is particularly notorious on the down run. Running downhill for 3km after 65km is no mean feat: hamstrings cramp and the muscles above the knee contract severely. There is a common saying that the bottom of Fields is scattered with silver medals, meaning runners whose hopes on a silver medal ended. From Pinetown most runners walk in to get some relief from the murderous pounding on legs and feet and general muscle fatigue. Walking at a steady pace is advisable to not sacrifice precious time. A fellow club mate WRCP once advised novice runners: 'Walk with dignity!'

The race after Cowies Hill becomes less scenic and arboreous. When entering the outskirts of the Durban Metro, most runners are in agony and simply want to get it over. The endless street running is debilitating for many and the many left and right turns and curbing demand

[7] Polly Shorts hill is a downhill experience towards Durban and not any challenge.

what Fordyce termed 'vasbyt' (Fordyce, 1996). The first signs of arrival at the finish at Kingsmead cricket stadium are the sudden presence of parked vehicles along the road, followed by the sound of the crowds and the public address systems, and finally the towering flood lights. The sensation of lawn under one's feet introduces the end, followed by the narrow tunnel around the field with crowds peeling over the barriers. Some runners try to detect the familiar faces of loved ones and others are overcome with ecstasy, joy, emotion, pain and relief.

Being stopped by officials finally means that the race has come to an end. The medal, the track suit badge and ribbon, which show the year of the race on it, is but a small reward. How Comrades runners deal with the constraints of time, space, the mind and body and weather invites further discussion.

DISCUSSION

Why can the Comrades and other distance road races be viewed as ritual experiences? In terms of the spatial constraint of the marathon runner, one recognises the notions of isolation, separation and estrangement, which so often occur during ritual and rites of passage (Turner 1967). Van Gennep's (1996 [1907]) classic threefold schema is relevant. The loneliness of the long-distance runner fits the concept of a rite of separation - from the known, house, hotel room, family and friends. Granskog (1993), in competing in the Hawaiian Iron Man, experienced this moment of separation as traumatic.

The Comrades is also a ritual of transition, a transfer into a new order, and simultaneously a

rite of incorporation into the order of Comrades medallists, the Comrades legacy and the mythological past. Running the Comrades repetitively comprise a rite of intensification. The notion of territorial passage through real and symbolic portals and gates features prominent during the Comrades passage. The road is bumpy and transformed into a challenging ritual corridor (the narrow and bumpy old road [R103], sidewalks, the halfway funnel, the crowd), which drags and sucks the runner through the halfway mark at Drummond, down Fields Hill (the notorious Wall[8]). Upon entering the stadium runners are literally squeezed along a narrow corridor up to the finish line underneath the banner (Van Gennep, 1996).

At the core of the psychological constraint for the Comrades runner is the question: Why do you do it? Personal reasons are numerous ranging from a life time wish to peer pressure. The „self" features prominently and many runners run to prove 'something' to themselves. This 'something' is what Eliade terms the elective Centre, a symbolic *axis mundi* (Eliade, 1996). The journey to the Centre is arduous, painful, dangerous and often likened to pilgrimage. Achieving the end result after 90km enriches the mind and mental capability, inscribes the body (Turner, 1967; Granskog, 1993) and its potential, charges the memory, and serves as part of a quest for the 'essence in life' as a fellow runner once explained. The banner, the medal and the Green Number emerges at the Centre. Sport depends on life goals, both personal and ritual, and provides the ideal incubator (Laughlin, 1993).

[8] The notorious Wall at 20 miles (32km) for the standard marathon runner (Merrill 1981:43-46) appears much later during Comrades: it may hit the runners at halfway, or at 60km or even much later.

Comrades runners experience a sense of being liminal, betwixt and between, not here and not there, in limbo, 'no longer classified and not yet classified' (Turner, 1967) thus, for the runner being in the race, but not there yet. The moment when the gun is fired the marathon runner steps into this unknown fold, which lasts for 90km. Senses of loneliness, marginality and liminality are experienced. The outside world for the Comrades runner disappears as she/he enters the starting arena and last until the finish line is crossed.

The road is the trajectory towards eventual success which hinges entirely on mind and body being synchronised; it is a sense of indistinguishable „raw material" (Turner, 1967). Runners often claim to have lost control of body and mind. The notion of trance in ritual is dominant and studies in neurobiological science provided us with insights into secretions, such as endorphins and opioids which condition „detachment from the physical world" (Callen, 1983; Krüger, 1990). The novice runner in particular has no comprehension of what lies ahead or to what transformations she/he will be exposed. The process of inscription might emerge after each kilometre sign and after each major stage, namely halfway, the Fields Hill, and so forth. The runner will also experience new thresholds of pain and discomfort, which were not there before.

Case study:
AH was a top standard marathoner and among the top five steeplechase runners on the track in the 1980s. He decided to try the Comrades and added the extra mileage on the road after the track season. He was ready on all counts, fearing only the distance and time on foot. Hoping for a place in the top 15, he had a good race until arrival at Pinetown, where he cramped and was forced to walk. This was the most humiliating experience of his life, having never walked in any race before, he was so ashamed in front of the crowds, he decided to pull

himself together and ran the rest of the race in great pain, still finishing among the top 20.

The gradual inscription in body and mind steadily fills this void (compare Bronwell, 1993). Ritual liminality equals hardship and discomfort to the runners who endure pain and discomfort. Karate inflicts pain and discomfort, creation of disorientation (Turner, 1967), confusion or „the inculcation of wonder" (Donohue, 1993).

The growth metaphor is a central theme in ritual. The term for the Ndebele girls" initiation is descriptive, namely *Ukuthombisa* or „to cause to grow" or „to germinate". The runner"s mind and body can be compared to a clean page on which the deeper meaning, dogma and didactics are gradually inscribed, they are sacrificed. One becomes an infant again and learns to become natural (D"Aquili *et al*., 1979; Donohue, 1993). Senses of enlightenment, physical control and spiritual serenity are created and aroused. During running, time stops, you lose sense of routine and breakfast time, tea breaks, midday, 11 to 12 hours on foot for the Big C - compared to nine hours at office. The only time is the ritual clock of the race. With reference to karate-do, Donohue's (1993:121) observation is appropriate: "Karate dojo creates a timeless world, a refuge from the mundane, and a sense of promised liberation". Ritual liminality is a process of growth and the mentioned emotions contribute to these didactics. The initiate runner grows in terms of the awareness of her/his own physical and mental capacity, as well as dealing with fellow runners (Turner, 1967).

Binary categories are rooted in ritual conditions (Turner, 1989), such as hot and cold, wet and dry, ease and pain, uphill and downhill, self and others, tears and laughter, and are constantly part of the runner's world over this stretch of 90km. Amidst these emotions, runners develop invaluable camaraderie, not only among known friends and fellow club members but among strangers. Some of us seldom run with the same companion(s) for the entire race. As the race intensifies after halfway and the gruelling part manifests, new running partnerships are often born out of mutual hardship between two or three runners without a word being spoken or names exchanged; a joint suffering in silence. Yet, at the finish line mutual gratitude is acknowledged and identities are exchanged (compare Granskog, 1993).

The various „runners busses" provide a solid structure for sharing pain, discomfort, support and knowledge (course info). "This comradeship transcends distinctions of rank, age, … cultic group, even of sex" argued Turner (1967:100). A ritual has the capacity to dissolve rank, fame and binary oppositions, which are built along grades of privilagation. Granskog (1993) refers to the eradication of existing status levels. The bonds which are built might become permanent. The only notions of rank and hierarchy exist inside the ritual structure (Turner, 1967) and it manifests as athlete versus race organisers, marshals and traffic officers, and the horror of facing the official who fires the gun, which signals the final cut-off.

A ritual is charged with symbols which trigger the human senses. Visual symbols of the body include race numbers, running shoes and club colours. For the regular Comrades runner, along the same route, landmarks are crucial mnemotechnic devises which provide both comfort and discomfort. Along the route, the kilometre markers, feeding stations, the halfway and finish banners, the crowds, landmarks on either side of the road are symbols which regularly engulf the runner. The olfactory is stimulated: body odours, muscle gels, etcetera. Symbols during the ritual have the capacity to unify diverse phenomena (Turner, 1967): bodily odours, the music of 'Chariots of Fire', road markers, the medal. They also condense all actions into a single item. Consider the Comrades runner"s body: it is a vehicle for club

colours, a number, running gear, physiological processes, a mental condition, it is transported over 90km, crosses the finish line and a medal is hung around its neck (Granskog, 1993).

The Comrades race portrays strong roots of the mythological and heroic figures. The logo of the Comrades Marathon Association depicts elements of the historical Moth organisation, the medals, the Greek god Mercury and an Olympic type laurel. After 1972, runners in the USA idolised Frank Shorter. In South Africa, distance runners idolised figures such as Wally Hayward, Ian Jardine, Allan Robb, Bruce Fordyce, Sam Tshabalala and others[9]. These heroes lived up to the Comrades idea and their biographies and lifestyles became consumed and idealised. Charles Laughlin (1993) who elaborated on the epiphanic[10] dimension during ritual mentioned that sport and gaming frequently draw from the cosmos, dreams, enactments and

[9] Wally Hayward in 1990 returned to and finished his fifth Comrades when he was close to 80-years-old. Ian Jardine was blind and one of the most seasoned ultra-runners in South Africa. A running club for blind runners was established in his honour. Alan Robb completed his 40th race in 2013 and won an unequalled 12 gold medals. Bruce Fordyce won the race for a record and consecutive nine times and still runs. Sam Tshabalala was the first black runner to win the Comrades only to survive miraculously from a car accident months later. He recovered astonishingly and could return to running.
[10] epiphanic= the manifestation of a god or demi-god.

its transpersonal inventory. Totemic animals are examples in clubs and associations: the Chicago Bears (USA grid iron rugby), Moroka Swallows or „The Birds" (soccer), Harlequin Harriers and Germiston Callies Harriers (marathon) and the Sharks (rugby); national plants (Proteas), heroes, princes and enemies are also popular.

The notions of regularity, cyclicity, rhythm, repetition, synchronised and choreographed bodily movement are pertinent features during ritual (compare Krüger, 1990). Fellow runners admit that after time and experience they behave in non-ratiocinative ways during races, training and even during the pre-race period. Donohue's (1993) inventory of the typical features of karate-do is comparable to ritual behaviour in distance running. These include regular training, practising of a strictly stylised form, abandoning the outside world, special clothing and hierarchical relations. The dedicated Comrades athlete executes to precision race dates, morning and afternoon runs, follows a specific dietary programme, update the running logbook with regularity. The running logbook becomes a sacred script for self-belief and motivation. Its daily entries become inscribed in both memory and body. A well-kept logbook feeds into the motivational system of any runner in her/his preparation even up to the morning of the start of the Big C. „You have done the mileage, believe in your logbook!", EW once told novice runners at the pre-Comrades race talk at Harlequin Harriers.

The neurological efficacy of ritual is probably less comprehensible to most runners. The mind-over-body matter pervades many conversations among Comrades athletes and how they overcame pain, agony and disappointment.

Case study:
Jeff H is a gifted runner who in 1991 planned a sub-6.5 hour race. He did the mileage and was on all accounts able to achieve this. I was stunned when upon my passage (after 4.5 hours) through Drummond to find Jeff seated in a camping chair, a blanket draped around his shoulders, shoes off and enjoying a cup of soup which was offered by an elderly couple. Even more surprising, he had the couple laughing at his typical wit. I could not help to stop

and enquired about his well-being, and weather he bailed, for we both knew what his initial goal was. His remark: 'Don't worry I'm contemplating a new race, I'll be back soon' – which he did and he still finished well under nine hours.

Miracle and Southard (1993) argued that the human brain provides for sustainable bodily rhythm which synchronises the motor subsystem by using „ritual patterns‟ (1993). Pre-race drills are sound examples: laying out kit on the night before the race, pasta diets and parties, ablution routine, tying shoe laces, coffee or a full English breakfast. Even the training day of a runner becomes ritualised. Driving home from office various running related decisions are made or anticipated: which distance and route, phoning running partners to confirm and gearing up become routine (compare Hockey, 2009).

Some runners admit that the foundation for ritual-like routine and habit is laid at club level. At Harlequin Harriers in Pretoria on a Thursday evening after the time trial, the aspirant and novice Comrades runner is formally introduced to members and matters, such as membership obligations, club colours, training routines and race schedules. Once on the training run, the do‟s-and-do-not‟s of long-distance running is conveyed by seasoned runners up to the penultimate pre-Comrades meeting when the Comrades talk takes place. Club-life is highly

routinized and it prepares the runner for the Comrades and comradeship (Goodger, 1986; Hockey, 2009).

CONCLUSION

Comrades‟ runners have to cope with pain, dehydration, muscle fatigue, mental toughness, the course, the weather, the time barrier and the consequences of over- or under-training. The ability to transcend these constraints borders on the humanly impossible. Yet the environment within which coping methods are created is almost unknown to most runners. This environment can be compared to an initiation enclosure or lodge, the 90km road between Durban and Pietermaritzburg. The initiates are the runners and the crowd on the outside of the initiation lodge and the officialdom are the instructors who supervise the rules. This is the ritual arena and many initiates stand to be „kicked out‟ from participation as early as the halfway mark, while others will not make it to the finish line when the gun is fired at 18:00. Most runners who receive their ritual rewards (medals, trophies, prize money) recognise that the notions of spatial separation and isolation, self-discovery, growth, transcription and transition, rhythm and regularity, symbolism, heroism, mental state and how to deal with pain, and others played a significant role during the Comrades. We still need to investigate how these ritual notions and characteristics balance each other out and what the contribution of each component entails.

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