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A HISTORICAL ACCOUNT OF PHYSICAL EDUCATION IN THE CAPE COLONY AND PROVINCE PRIOR TO THE SECOND WORLD WAR

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ABSTRACT

A large 'corpus' of both scholarly and informal literature, exploring the history of Physical Education (PE) in South Africa (SA), exists. These works reflect the racial schisms that dominated PE. This literature review traces a historical development that transcends traditional 'race' boundaries. A sport-historical investigation was undertaken based on literature in dissertations, academic and non-academic journals and general publications. By reworking the existing literature, the study revealed that PE was not introduced uniformly into all sectors of society. It showed how the playing of games remained the dominant form of physical activity at elite schools while the marginalised classes (poor, non-white and women), had Physical Training (PT) Drill. However, PE always had a low status on the school timetable. In Black schools, Drill and later PE was introduced mainly for the purposes of discipline and social control, as well as the commonly known idea of medical and health reasons, which were paramount.

Key words: Physical Education; History; South Africa; Cape Colony; Cape Province; Games; Gymnastics; PT drill.

INTRODUCTION

The study of the history of Physical Education (PE) in South Africa is a neglected field of research and only one doctoral dissertation in the 21st century could be found on the subject (Cleophas, 2009). To date, many research studies on South African PE operated within a
„race" based theme (Willemse, 1969; Potgieter, 1972; Agjee, 1981; De Klerk, 1986; Weixlederer, 1987; Vermaas, 1989; Cleophas, 2009). This study attempts to present a historical gaze at PE in South Africa that transcends „race" and also attempts to do justice to the ascertion of Floris van der Merwe that the history of any subject serves as a barometer for progress (Van der Merwe, 1999).

This study is presented in thematic rather than strictly chronological sequence because of overlapping leitmotifs during different periods. Presently, there is a virtual absence of PE historical issues in serious, detailed, informed and open discussion at national level in South Africa. This study addresses this vacuum by undertaking a social-historical survey of the subject from 1892, when the subject was introduced into the Cape Colony until the period prior to the outbreak of the Second World War. The first theme covers a world historical

perspective of PE in 19th to early 20th Century. In the second theme, attention is given to PT in the Cape Colony and Cape Province, centring on PT at schools (drill and gymnastics), and the playing of games at Cape schools.

A WORLD HISTORICAL PERSPECTIVE OF PE IN 19th TO EARLY 20th CENTURY

It is necessary to locate the origin of PE in the Cape Colony within world history in order to gain clarity on the topic under investigation. In this regard, a historical interpretation of the origin of the subject as presented by McIntosh (1968:11) is useful:

> During the 19th century there grew up in England two distinct traditions of PE. While each had its origin in earlier days neither had grown beyond the embryonic stage by 1800. In the Public Schools „organised games" began to appear early in the century. At first games were the spontaneous recreations of the boys and were for the most part disapproved of by masters. However, as the century wore on, „organised games" came to be recognised by authority and were regarded as a powerful force in the education of the sons of the middle and upper classes. They became a feature of all Public Schools, old and new, great and small… Organised games were indeed an intrinsic part of the education of the ruling classes… Outside the Public Schools a different type of PE grew up, springing from several roots – military drill, callisthenics and gymnastics. From them grew the system of physical training which, at the end of the century, was being adopted in the Public Elementary Schools.

During the period under review, there were therefore, two systems of PE in vogue in England: the public school system of organised games and the elementary school system of PT. Organised games concentrated on character training while PT focussed on discipline and the physiological effects of systematised exercise (McIntosh, 1968). The School Drill Manual, appearing in 1871, stated that a value of drill is "a moral lesson of prompt and ready obedience … [where] the practice of working together in bodies is cultivated" (Ex-Adjutant of His Majesty"s Infantry, 1871:vi).

Drill lessons in 19th century schools were never long ones and the exercises were never intended to be violent (Bates, 1897; Gladman, 1898). The intention was that drill should be accompanied by music in order to "aid to uniformity of movement essential for purposes of discipline" (Gladman, 1898:162). Drill was also characterised by notions of: "… children must not be allowed to overstrain themselves, steadiness of pace should be aimed at and the running should be on the toes; flat-footed running is both ungraceful and useless as a means of developing the lower limbs" (Gladman, 1898:163).

The playing of games had other objectives and two PE officials from the Birmingham Education Authority stated: "Games are universally accepted as important for character, social and physical training, more particularly in English-speaking countries … the development of the games spirit is a recognised cultural contribution by this country to the rest of the world" (Clark & MacCuaig, 1951:vi). Socially, the cult of athleticism (playing of organised games) was closely bound up with the rise of a new middle class to educational privilege and political power. Robust team games became an important part of the ethos of middle class schools from the 1830s onwards when Dr Arnold assumed principalship of Rugby School and boys took to team games that he allowed (McIntosh, 1963).

A feature of public schools, with their mainly upper class clientele, became the development of athleticism (McIntosh, 1952). One of the features of athleticism was its close connection with military training (McIntosh, 1957). This feature started to be replaced by a new school of thought in the British world of the 1930s that PE should replace the "old term, school drill

and encourage the concurrent development of a healthy physique, alert intelligence and sound character" (Newman, 1940:8).

On the other hand, Tom Brown‟s recollections of his school days at Rugby School illustrate the rough nature of games: "… two collar bones were broken this semester and a dozen fellows lamed. And last year a fellow had his leg broken" (Hughes, 1994:100). Physical drill developed a social status inferior to the better established upper class game of cricket and football. An English School Inspector, Gladman (1898:164), remarked, "Physical exercises can never fully replace good games". From this lowly status, gymnastics and drill never raised themselves in English Public Schools. In direct contrast, PT in elementary or poor schools had gymnastics and drill as its bedrock. This is especially true of the Swedish system of PE that formed the basis of physical drill (Gladman, 1898; McIntosh, 1968).

PHYSICAL TRAINING IN THE CAPE COLONY AND CAPE PROVINCE

During the 19th and early 20th Century, two main types of schools existed: mission and public. The former were attended by the poorer classes who happened to be (but not exclusively) Coloured, while public schools were those schools that catered for those communities who were financially able to establish schools and pay half the teachers‟ salaries (Malherbe, 1925).

The subject, Physical Training (PT), was first reported on by the Cape of Good Hope Education Department in 1892. After Thomas Muir assumed the position of Superintendent- General of Education the previous year, he introduced the subject (Van der Merwe, 1999). It is not clear what the Education Department‟s motive was for introducing the subject, but it coincided with a time when Cape Town was acquiring the social features of an industrialised society (Worden *et al*., 1998). These features included the rise of poverty levels that stretched across racial boundaries. The *Cape Argus* stated that poor White workers and their families were "compelled to live in towns amidst Coloured people and are sinking … into the social condition of the … Coloured population" (Worden *et al*., 1998:249). This gave rise to a demand for a healthy and disciplined labour force by capitalist industrialists during the 19th century that added to an interest in PT.

Through vacation courses that started in 1893 and lasted until 1908, teachers were exposed to the Swedish Gymnastic System (De Klerk, 1978). This was in response to the negative reports of the school inspectors. In 1892, school inspector Fraser reported that various forms of drill, physical exercises, callisthenics and unsatisfactory marching exercises were found in his circuit (Department of Public Education for the Colony of the Cape of Good Hope, 1893). Inspector Edward Noaks reported that physical exercises were taught effectively in two schools and a start had been made in another. Inspector Bartmann commented that callisthenics received attention in some first class girls‟ schools. He suggested the introduction of gymnastic exercises, especially where there were no adequate

open playgrounds, and a modified form of military drill in boys‟ schools. Muir‟s own impression was that drill and physical exercises were not nearly as common as he expected (Department of Public Education for the Colony of the Cape of Good Hope, 1893).

Physical training at schools (drill and gymnastics)

PT appeared to be more visible at mission and girls‟ schools than public schools for boys during the period under review. The practice of PT in all Cape colonial schools was under the charge of the class teacher, although nine or 10 girls‟ schools had trained female teachers from Europe on their staffs in 1909 (Willemse, 1969). A possible explanation for this is that public schools followed curricula based on Scottish lines in order "to provide a broad base of classical subjects upon which the student could later erect his own special study" (Thomson, 1961:25). It was only in 1901, four years after the opening of Rondebosch Boys‟ High School (RBHS) for Junior Boys, that W.J. Milne, the Departmental instructor, started attending "on certain days to give instruction in singing and drill" (Cornell, 1947:7). This was despite the fact that RBHS was an English boys‟ school whose principal, Robert Ramage, and "several of his senior boys were enrolled in the Rondebosch Town Guard during the South African War (1899-1902)" (Cornell, 1947:5).

THE ST. ANDREW'S GYMNASIUM, NEWLANDS

"The boys, with the exception of the European instructors, are largely recruited from the poorer quarters in Newlands. No better evidence than this photo is needed to testify to the good work that can be done" (APO, 1914:8).

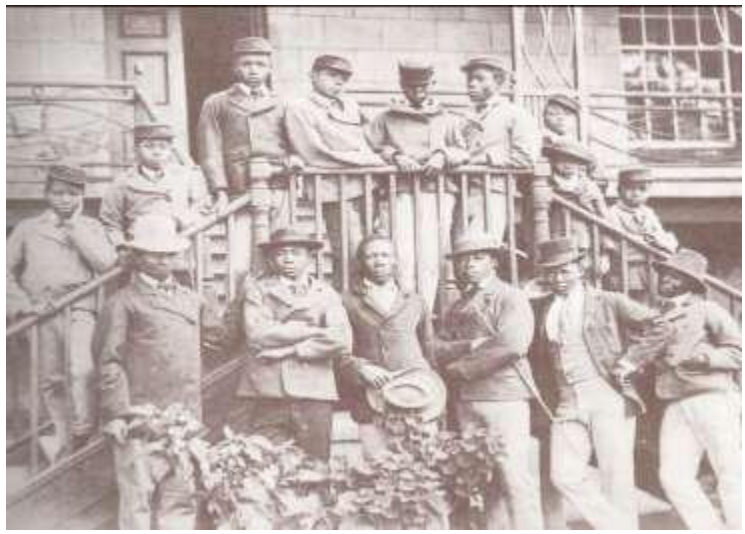
The boys‟ public schools received PT drill mainly through the cadet movement (Willemse, 1969). On the other hand, mission schools, such as St Andrew‟s Anglican in Newlands, focussed on gymnastic training with the aim of showing off "what good can be done" (APO, 1914:8). This was part of the Coloured petty bourgeoisie political strategy of social upliftment. The organisation representing the interests of Coloured teachers from 1913 onwards, the Teachers‟ League of South Africa (TLSA), pursued this strategy vigorously

until the 1940s. Thus John Abrahamse, despairing of the moral redemption of Coloured people, cried out during his presidential address of 1938 that, "We are knee-haltered because a large portion of our people drag us down into a mire of filth" (Adhikari, 2002:158).

A situation developed at the Zonnebloem Training School (commonly referred to as the Zonnebloem College), that had been established in February 1858 to anglicise the sons of traditional African chiefs, where the boys resisted PT (Odendaal, 2003). The boys and young men at Zonnebloem developed an aversion for PT, and Janet Hodgson referred to correspondence between Zonnebloem officials in her master‟s thesis as follows:

> Drilling was introduced into the curriculum; but it was the only discipline to which some of the elder boys did not yield to quite so cheerfully. It was suggested that their reluctance was more likely due to their not understanding the object of the exercise, rather than from any dislike of it; and that being so tractable, they would soon become reconciled to this activity (Hodgson, 1975:223).

Although Zonnebloem was considered a mission institution, it reflected the definition of an English Public School: "an endowed place of education of old standing to which the sons of gentleman resort in considerable numbers and where they reside from eight or nine to eighteen years of age" (McIntosh, 1957:178). Hodgson‟s account of the reluctance of the Zonnebloem boys to engage in drill could be explained by its inferior status compared to the playing of games.



The sons of chiefs, Zonnebloem College, Cape Town, 1863. Cricket was their favoured game (Odendaal, 2003:25).

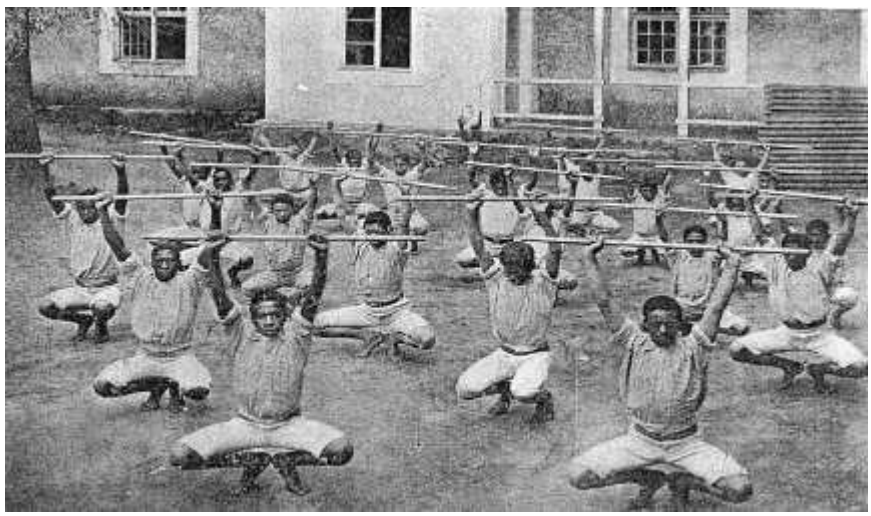
The idea of PT being an activity designated for the poorer classes has some justification by contemplating the participating schools in the Coronation Physical Training competition. This competition was organised by the Cape of Good Hope Education Department in 1902 and the participating units where drawn only from mission schools and the lower socio-

economic public schools for the purpose of showing off a youthful vigour of the British Empire (Cleophas & Van der Merwe, 2012). The practice of PT at the Genadendal Mission Training School (GMTS) had a different slant than the British model at the turn of the 20th Century. The GMTS, was a Moravian institution in the Cape Colony where African, Coloured and

White students attended. Here the Moravian authorities, under the directorship of T. Renkewitz, actively promoted drill in the late 19th and early 20th century. Renkewitz presented PT as physical exercises, not physical drill and the aim was not for discipline but:

> To give the scholars the full command of their limbs and not only to make their muscles strong and tough. The latter purpose is attained by making the boys practise all kinds of movements with pretty heavy iron dumbbells and iron rods. As to the former, we prefer making the movements without music as we are convinced of securing the aim better by the simple unexpected word of command, which compels them to move suddenly and without preparation. At the same time, we do not underrate the value of elegance … (Renkewitz, c.1904:85).

The GMTS was under the directorship of Renkewitz from 1882 until 1904 and the instruction medium was exclusively English, although the Training School published a Dutch-Afrikaans newspaper, *De Bode*, since 1 December 1859 (Balie, 1988). When the South African War broke out on 11 November, many of the Moravian missionaries expressed in their diaries their sympathies with the Boers in their resistance to British imperialism (Krüger & Schaberg, 1984). Therefore, PT was presented as an activity that did not offend either the victorious British or the Boer sympathisers.



Boys doing PT drill at Genadendal Training School (Renkewitz, c.1904:87).

There was an increase in the number of pupils receiving instruction in physical training drill at mission schools by 1899, but only a third of all schools in the Cape Colony paid some attention to the subject (Department of Public Education for the Colony of the Cape of

Good Hope, 1900). Edward Noaks, whose inspectoral circuit included an area with several mission schools, reported that attempts to introduce half an hour of daily drill lessons in mission schools met with partial success (Department of Public Education for the Colony of the Cape of Good Hope, 1901). This was due to the teaching conditions in these schools. Most mission schools had overcrowded classrooms and teaching happened under conditions that were

detrimental to the health and progress of the pupils and teachers (WCARS Correspondence file, 4/2/1/3/1866, B779/49).

A major concern of the education authorities was maintaining discipline in mission schools and physical training drill was a suitable means of achieving this. Muir favoured physical training drill in helping to instil discipline in schools (Department of Public Education for the Colony of the Cape of Good Hope, 1903; Department of Public Education, 1913). It was during his tenure that the British used the school system as a means to break down Afrikaner nationalism and extend control over Black people (Christie, 1985).

Physical training drill, being part of this school system, could be used to teach non-white children obedience and at the time, most Coloured leaders supported this idea. The TLSA, stated through its president, Fred Hendricks, that Manual Training would help train the youth to discharge the duties of citizenship (APO, 1915). Manual Training was a system of practical education that included PT (Schreve, 1911). The idea of drill lingered in South African education until the 1940s where in "some schools, it consisted of ten minutes first thing in the morning … where the teacher has to deal with as many as seventy children" (Scott, 1947:12).

Ten minutes of drill in the morning at Zonnebloem Primary School in the 1930s (Photo: J.K.H. Hodgson).

Playing of games at Cape schools

The British games played in 19th century PT „lessons" at schools evolved into the 20th

century sport codes that became part of political struggles across the spectrum. The journalist, Gerhard Roux, mentions that sport became the unifying factor between liberal and right-wing students at Stellenbosch University after the Second World War (Roux, 2014). Games, and later sport, therefore became important political instruments for the British ruling class from the late 19th century onwards. English games were underpinned by 19th century Muscular Christianity (a philosophy that made exercise and fitness compatible with Christian life), that

shifted to a phenomenon where the educational value of sport was recognised (Siedentop, 1990).

A division between the emphasis on games (for children at elite schools) and PT (for those at lower socio-economic institutions), was evident. It is reported that George Ogilvie introduced games to an elite school in the Cape, the Diocesan College (Bishops), when he became principal in 1861, along the lines of Muscular Christianity (Dobson, c.1997). This is to be understood because Ogilvie attended the Winchester and Wadham Colleges (in Oxford) where ball games were part of the school culture (Van der Merwe, 2007). The same situation existed at Zonnebloem. At the turn of the 20th century, the Zonnebloem staff was made up entirely of Oxford or Cambridge graduates, with the exception of one (Cleophas, 2012). Odendaal (2003) reports that by 1864, the year in which over-arm bowling was finally legalised in England, Zonnebloem College had two cricket teams. Both schools, Zonnebloem and Bishops, employed a PT drill teacher only long after games were introduced. Zonnebloem introduced Physical Drill in 1904 when Charles O‟Hine came on to the staff and Bishops in 1927 when Mr Britton joined the teaching staff and introduced the Swedish system of gymnastics (Editorial, 1944; Willemse, 1969).

The South African College (SACS) is another elite school that traces its history to 1829 and a football match against Bishops as early as 1862, but no account exists of PT being taught at this institution during the 19th century (Babrow, 1979). When the Rondebosch Public School for Junior Boys was established in 1897, no evidence could be found that suggests PT was taught from the outset. However, when Alexander Hahn was appointed to the staff in April 1899, he "immediately interested himself in organising sports and games and his action received the hearty support of [the school] committee" (Cornell, 1947:5).

In January 1900, A.N. MacFarlane was appointed on the staff and he established soccer (Cornell, 1947). Bishops, along with other elite public schools (Green and Sea Point, the Normal College School, Paarl Gymnasium, St George‟s Grammar, SACS, Wellington Boys‟ High and Wynberg), established the Schools‟ Challenge Shield for rugby on 4 May 1898 (WPRFU, 1898a; Dobson, 1997). It could be argued that these schools favoured a football competition, as was the case in England, above swimming and athletics because of the former‟s ability to promote group loyalty and team spirit (McIntosh, 1968). However, many principals at mission schools imitated the British value system and with the support of the Perseverance and California Rugby Clubs, a few better-off schools in this category formed the Central School Sports Union (CSU) in June 1928 at the Wesleyan School in Mowbray, and initially it catered for rugby and cricket only (Moses, 1929).

The ruling class in the Cape Colony had applied segregation measures in the broader society and Coloured people found themselves excluded from mainstream sport

development. Therefore, the CSU was not part of the Schools‟ Challenge Shield because of a rule, in the constitution of the Western Province Junior Rugby Football Union that stated, “Affiliation to the Union shall be open only to teams consisting entirely of European players” (WPRFU, 1898b:n.p.).

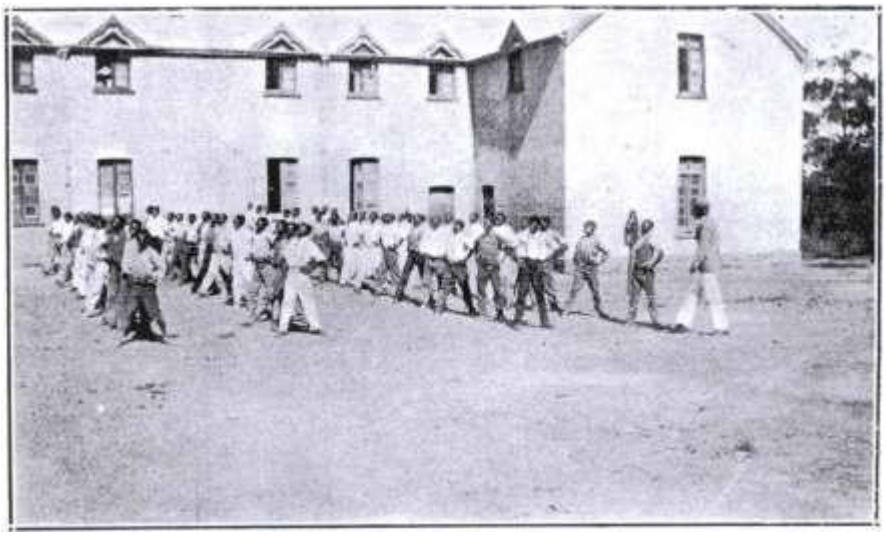
However, physical drill and gymnastics became gradually more visible at mission schools because from the last decade of the 19th century, an educated leisure class agitated for

enclosed fields that aimed to keep the masses away from the games of the social elite. During most of the 19th century, English games in the Cape Colony ran along the same haphazard, self-governing and self-maintained lines of American universities. These games were spontaneous and organised by the students themselves. Shortly after inter-college sport was introduced in America, non-playing supporters attended games on an organised basis and rowdyism and hooliganism frequently resulted afterwards (Munrow, 1957). A similar situation evolved in the Cape Colony but there, hooliganism became equated with racial descriptors. This is illustrated when a sport field was inaugurated in Stellenbosch in 1898. A writer in the *Stellenbosch Students' Quarterly* (P.K.A., 1898:21) wrote:

> In days gone by, our sporting predecessors had to content themselves with pitching their wickets and planting their goal posts on the *Braak*. As, however, this was a public square, the rights of the Chams had to be recognized … in fact … more preparations were made and more pains taken to wage a successful war against the bellicose champions of the said Chams than energy expended in attaining proficiency in the game of football… growing discontented with all this, they sought pastures new.

The reference to Cham or Ham, the son of the biblical Noah, is significant here because the Dutch Reformed Church in South Africa used this as a justification for the racial separation of people since (C)Ham was believed to be dark skinned and the father of the Black peoples of the world. Many Black people accepted their „racial difference‟ from other people and implemented class distinctions amongst themselves. Educational achievement became the most important single criterion by which urbanised Black people graded themselves (Pauw, 1963). Games Masters, who were a feature of school life, guarded these social restrictions. They were “in social status a gentleman and in athletic status an amateur” (McIntosh, 1957:188).

These masters instilled in their learners a passion for games and sport and resistance to any notion of achievement for personal glory. Therefore, Nelson Mandela stated in his autobiography that after he adapted to life at Clarkebury Institute, a boarding school in the Eastern Cape that he attended in 1934 and 1935, he participated in sport and games as often as he could, even though his performances were mediocre. He elaborated on this as follows: “I played for the love of sport, not the glory, for I received none. We played lawn tennis with homemade wooden rackets and soccer with bare feet on a field of dust” (Mandela, 1994:40).



Students at drill
Clarkebury in c.1929 (Clarkebury Mission Tembuland, 1930).

Roundabout this time colleges, schools, clubs and military regiments in England were increasingly seeking athletic knowledge for "a system of exercises designed to make the human body sufficiently supple and strong for the production of major feats of athletic achievement" (Heys & Webster, 1932:9). The 1920s and 1930s were therefore a period that witnessed the introduction of PE specialist courses at the Stellenbosch University and teacher training colleges in the Cape Province. This is the next theme in South African PE history could be explored.

Cape Town Teachers" Training College in c.1921 (Clarkson, 1994:17).

CONCLUSION

This article highlighted the rationale of drill exercises and gymnastics in a particular setting. PE was introduced into the South African curriculum as PT drill that was borrowed from the British system. This system comprised English ball games and military manoeuvres on the one hand and the gymnastic freestanding and apparatus work from continental origin on the other. In the English public or elite schools, ball games remained popular, while gymnastics and military manoeuvres never enjoyed the same status. The reverse was true for elementary or the poorer schools.

This study confirms Willemse‟s findings that although sporadic attempts were made to promote PT in the 19th century, this did not materialise. It was a dark period in the history of the subject in South Africa (Willemse, 1969). The early 20th century was characterised by an increasing interest in the gymnastics and drill aspects of PT. However, gymnastics and drill were more popular in mission schools, whereas the playing of games that later evolved into organised sport, were more popular at elite boys‟ schools.

The PT drill that was introduced in the mission schools had as its main aim discipline for the purpose of social control. Many pupils at these schools, therefore never valued it as highly as playing games. In addition, PT was more widespread in girls‟ schools. Boys‟ schools introduced PT much later into their curriculum and organised themselves around sport leagues in team games. Mission schools in the Western and Eastern Cape did the same. However, mission schools were marginalised from mainstream school sport competition and, therefore, PT and not school sport, provided purposeful movement participation opportunity for these learners.

REFERENCES

ADHIKARI, M. (2002). Hope, fear, shame, frustration: Continuity and change in the expression of Coloured identity in white supremacist South Africa, 1910-1994. Unpublished PhD dissertation. Cape Town: University of Cape Town.

AGJEE, M.D. (1981). The development of Physical Education in schools controlled by the Department of Indian affairs, Division of Education. Unpublished MEd thesis. Pretoria: UNISA.

APO (AFRICAN POLITICAL ORGANISATION) (1914). The St. Andrew‟s Gymnasium, Newlands. *Official Organ of the African Political Organisation*, VI: 8, 22 August.

APO (AFRICAN POLITICAL ORGANISATION) (1915). The Teachers‟ League. *Official Organ of the African Political Organisation*, VI: 5, 26 June.

BABROW, L. (1979). Sport at SAC & UCT 1829-1979. In A. Lennox-Short & D. Welsh (Eds.), *UCT at 150: Reflections* (pp.153-158). Cape Town: David Phillip.

BALIE, I. (1988). *Die geskiedenis van Genadendal, 1738-1988*. Cape Town: Perskor.

BATES, L. (1897). *Kindergarten guide*. London, UK: Longmans.

CHRISTIE, P. (1985). *The right to learn*. Braamfontein (RSA): Ravan.

CLARK, G.S & MACCUAIG, D. (1951). *Games worth playing: For school playground and playing fields*. London (UK): Longmans.

CLARKEBURY MISSION TEMBULAND (1930). *The deathless years: A centenary souvenir, 1830-1930*. Clarkebury: Wesleyan Methodist Church of South Africa.

CLARKSON, A.F. (1994). Cape Town College of Education, 1894-1994. *Rostrum*, 16(2): 16-18.

CLEOPHAS, F.J. (2009). Physical education and physical culture in the Coloured community of the Western Cape, 1837-1966. Unpublished PhD dissertation. Stellenbosch: Stellenbosch University.

CLEOPHAS, F.J. (2012). Running a history programme outside the classroom: A case study of athletics at Zonnebloem College. *Yesterday and Today*, 8(December): 63-87.

CLEOPHAS, F.J. & VAN DER MERWE, F.J.G. (2009). Physical education and physical culture in the Coloured community of the Western Cape, 1837-1966: A literature review. *African Journal for Physical, Health Education, Recreation and Dance*, 15(1): 102-121.

CLEOPHAS, F.J. & VAN DER MERWE, F.J.G. (2012). Exercising „race" through the Coronation Physical Training Competition. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 34(1): 43-56.

CORNELL, D.E. (1947). *The history of the Rondebosch Boys' High School. The story of 50 years of constant progress.* Cape Town: R.B.H.S. War memorial Fund Committee.

DE KLERK, R. (1978). *Geskiedenis, stelsels en strominge in Liggaamlike Opvoedkunde*. Potchefstroom (RSA): Pro Rege.

DE KLERK, R. (1986). Die bydrae van enkele Liggaamlike Opvoedkundiges tot die ontwikkeling van die vak in Suid-Afrika vanaf die begin van die twintigste eeu. Ongepubliseerde DEd-proefskrif. Potchefstroom: Potchefstroomse Universiteit vir Christelike Hoër Onderwys.

DEPARTMENT OF PUBLIC EDUCATION (1913). Report of the Superintendent-General of Education for the year ending 30th September 1911. Cape Town: WA Richards.

DEPARTMENT OF PUBLIC EDUCATION FOR THE COLONY OF THE CAPE OF GOOD HOPE (1893). Report of the Superintendent-General of Education for the year 1893 with tables and appendices. Cape Town: WA Richards.

DEPARTMENT OF PUBLIC EDUCATION FOR THE COLONY OF THE CAPE OF GOOD HOPE (1900). Report of Superintendent-General of Education for the year 1899. Cape Town: WA Richards.

DEPARTMENT OF PUBLIC EDUCATION FOR THE COLONY OF THE CAPE OF GOOD HOPE (1901). Report of Superintendent-General of Education for the year 1900. Cape Town: WA Richards.

DEPARTMENT OF PUBLIC EDUCATION FOR THE COLONY OF THE CAPE OF GOOD HOPE (1903). Report of Superintendent-General of Education for the year 1901. Cape Town: WA Richards.

DOBSON, P. (c.1997). *Rugby at SACS*. Cape Town: SACS.

EDITORIAL (1944). Oscar Charles Hine: Warden of Zonnebloem (Obituary, 16 May 1943). *Zonnebloem College Magazine*, 9: 4.

EX-ADJUTANT OF HIS MAJESTY"S INFANTRY (1871). *School drill: A manual for the use of teachers*. London (UK): The Home and Colonial School Society.

GLADMAN, F.J. (1898). *School method: Notes and hints*. London (UK): Jarrold.

HEYS, J.A. & WEBSTER, F.A.M. (1932). *Exercises for athletes*. London (UK): John F. Shaw.

HODGSON, J.K.H. (1975). A history of Zonnebloem College, 1858-1870, Vol. 1 & 2. A study of church and society. Unpublished MA thesis. Cape Town: University of Cape Town.

HODGSON, J.K.H. Photo collection of Zonnebloem College historian, Cape Town.

HUGHES, T. (1994). *Tom Brown's schooldays*. London (UK): Penguin.

KRÜGER, B. & SCHABERG, P. (1984). *The pear tree bears fruit. The history of the Moravian Church in South Africa: Western Cape Province, 1869-1980*. Genadendal: Moravian Book.

MALHERBE, E. (1925). *Education in South Africa, Volume 1, 1652-1922*. Cape Town: Juta.

MANDELA, N. (1994). *Long walk to freedom*: *The autobiography of Nelson Mandela*. London (UK): Little Brown.

MCINTOSH, P.C. (1952). *Physical Education in England since 1800*. London (UK): G. Bell.

MCINTOSH, P.C. (1957). Games for two nations in one. In J.G. Dixon, P.C. McIntosh, A.D. Munrow & R.F. Willets (Eds.), *Landmarks in the history of Physical Education* (177-206). London (UK): Routledge and Kegan.

MCINTOSH, P.C. (1963). *Sport in society*. London (UK): C.A. Watts.

MCINTOSH, P.C. (1968). *Physical Education in England since 1800*. London (UK): G. Bell.

MOSES, E. (1929). The Schools' Sports Union. *Educational Journal of the Teachers' League of South Africa*, 7(96): 5.

MUNROW, A.D. (1957). Physical Education in the United States of America. In J.G. Dixon, P.C. McIntosh, A.D. Munrow & R.F. Willets (Eds.), *Landmarks in the history of Physical Education* (pp.149-176). London (UK): Routledge and Kegan.

NEWMAN, G. (1940). Syllabus of physical training. In Board of Education (Ed.), *Syllabus of Physical Training for schools, 1933* (pp.5-8). London (UK): His Majesty‟s Stationery Office.

ODENDAAL, A. (2003). *The story of an African game: Black cricketers and the unmasking of one of cricket's greatest myths, South Africa, 1850-2003*. Cape Town: David Philip.

P.K.A. (1898). The new athletic field. *Stellenbosch Students' Quarterly*, December: 21-23.

PAUW, B.A. (1963). *The second generation: A study of the family among urbanized Bantu in East London*. London (UK): Oxford.

POTGIETER, J.R. (1972). The evolvement of Physical Education in South Africa. Unpublished MA thesis. Edmonton (Canada): University of Alberta.

RENKEWITZ, T.G. (c.1904). *The training school of the Moravian Missionary Society at Genadendal, South Africa: A brief sketch illustrated by photographs*. Genadendal: Genadendal Printing Press.

ROUX, G. (2014). Lesse by ‟n meester-mediaman. *Die Matie*, 4: 14, 26 Februarie.

SCHREVE, T. (1911). Schoolcraft. *Teachers' Review*, 5(1): 3-5, August.

SCOTT, M.I. (1947). Drill in primary schools. *Vigor*, 1(1): 12-13.

SIEDENTOP, D. (1990). *Introduction to physical education, fitness and sport*. Mountain View, CA: Mayfield.

THOMSON, D.H. (1961). *The story of a school: A short history of the Wynberg Boys' High School*. Cape Town: Wynberg Boys‟ High School.

VAN DER MERWE, F.J.G. (1999). *Sportgeskiedenis: 'n Handleiding vir Suid-Afrikaanse studente*. Stellenbosch: FJG Publikasies.

VAN DER MERWE, F.J.G. (2007). *Sport history: A textbook for South African students*. Stellenbosch: FJG Publications.

VERMAAS, E. (1989). Liggaamlike Opvoedkunde aan die Universiteit van die Oranje-Vrystaat: 1947 tot 1986. Ongepubliseerde MA-tesis. Bloemfontein: Universiteit van die Oranje Vrystaat.

WCARS (WESTERN CAPE ARCHIVES AND RECORDS SERVICES). Correspondence file, 4/2/1/3/1866, B779/49.

WEIXLEDERER, M. (1987). Physical Education in black education: A situation analysis. Unpublished report. Stellenbosch (RSA): Institute for Sport and Movement Studies.

WILLEMSE, J.W. (1969). Die invloed van die Sweedse stelsel van formele oefeninge op die ontwikkeling van liggaamlike opvoeding in Suid-Afrika. Ongepubliseerde MEd-tesis. Potchefstroom (RSA): Potchefstroomse Universiteit vir Christelike Hoër Onderwys.

WORDEN, N.; VAN HENNINGEN, E. & BICKFORD-SMITH, V. (1998). *Cape Town*: *The making of a city*. Cape Town: David Phillip.

WPRFU (WESTERN PROVINCE RUGBY FOOTBALL UNION) (1898a). Minutes of an emergency committee meeting held at the Thatched Tavern on Wednesday 4 May.

WPRFU (WESTERN PROVINCE RUGBY FOOTBALL UNION) (1898b). Rules of the Western Province Junior Rugby Football Union. Cape Town: WPRFU.

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PERCEPTUAL-MOTOR INTERVENTION FOR DEVELOPMENTAL COORDINATION DISORDER IN GRADE 1 CHILDREN

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ABSTRACT

Although different approaches, such as the bottom-up and the top-down approach, have been used as interventions to treat Developmental Coordination Disorder (DCD), there is controversy about the effectiveness of these approaches as interventions. The purpose of this study was to determine if a perceptual-motor intervention would improve the symptoms associated with DCD. Children (N=76) with DCD between the ages of five and eight years, participated in this study. The study had a pre-/post-test experimental design (n=36) with a control group (n=40). The Movement Assessment Battery for Children-2 was used to assess the motor proficiency levels of the children. The intervention comprised a 10-week programme of two 30-minute sessions per week. The dependent variables were all measurable on an interval scale. The Mann-Whitney U-test was used. After the intervention, one subtest, balance, showed a significant change (p=0.050), while manual dexterity (p=0.797) and aiming and catching (p=0.252), showed no significant changes. These three components contributed to the total test score, which revealed no significant difference (p=0.068) in the overall motor proficiency levels of the experimental group and the control group.

Key words: Perceptual-motor; Motor proficiency; Developmental coordination disorder; Intervention; Movement Assessment Battery for Children-2.

INTRODUCTION

Developmental Coordination Disorder (DCD) is recognised as one of the most common developmental dysfunctions during childhood (Ellinoudis *et al*., 2009), and a large number of children are identified with DCD between five and 11 years of age (APA, 2013). The literature indicates wide debate with regard to the prevalence of DCD (Giagazoglou *et al*., 2011), and varies according to the diagnostic criteria that are used (Carslaw, 2011). According to Gaines and Missiuna (2007), as well as Prado *et al*. (2009), DCD affects 5 to 6% of school-age children, while Wilmut *et al*. (2007) indicated the prevalence of DCD to be between 5 to 10%. However, it is estimated that 5 to 19% of children in America and Europe are struggling with DCD (Miller *et al*., 2001; Henderson & Henderson, 2002). In South Africa (Bloemfontein, Free State province), the prevalence was also high, with 15% of children having moderate to severe motor difficulties (De Milander *et al*., 2014).

According to Henderson and Henderson (2002), children will not outgrow this disorder, as was previously believed; however, children can be assisted by means of a five-step assessment process (Barnett, 2008). This process entails firstly the use of questionnaires

for

screening and identification of children with motor difficulties. The second step is the use of norm-referenced tests for measuring the child‟s motor performance, which are administered by professionals. The third step of this motor assessment process entails making a formal diagnosis of DCD. This is done by measuring the qualitative and quantitative performance in motor tasks. The fourth step focuses on understanding the nature of the condition. Finally, the fifth step is the planning of an intervention programme.

It follows that intervention programmes are a vital element of the assessment process for improving DCD. Sugden and Chambers (1998) proposed that most interventions are successful with a good number of children diagnosed with DCD. Researchers conventionally made use of a process-orientated approach by means of sensory integration and perceptual motor training in children with DCD (Bernie & Rodger, 2004; Sugden *et al*., 2008). The process-orientated approach is also known as the bottom-up or developmental approach. The aim of this approach is to improve the underlying process, which is not developed fully for the child‟s age. This includes sensory functions, attention and planning, which are considered prerequisite for the attainment of motor skill. This approach can, therefore, be considered to eliminate motor deficiencies (Sugden & Chambers, 2003; Bernie & Rodger, 2004).

According to Auxter *et al*. (2005), the underlying principle of this approach is to ensure that the supporting building blocks and integration processes are functioning optimally in order to facilitate skill development. This approach aims to improve children‟s processing abilities or performance components, and many therapists are still practising this as an intervention (Missiuna *et al*., 2006; Sugden *et al*., 2008). According to Hamilton (2002), the most frequently used interventions were sensory-integration therapy, kinaesthetic training, as well as perceptual-motor therapy, and all of these produced positive results more often than not.

Johnstone and Ramon (2011) state that perceptual-motor skills permit sensory information to be obtained successfully and to be understood, by reacting appropriately. Thus, “perceptual” refers to obtaining information and “motor” deals with the outcome of the movement (Gallahue & Ozmun, 2006). According to Gallahue and Ozmun (2006), perceptual-motor activities require children to use cognitive functions (memory, attention and awareness), and the body together in order to accomplish tasks. Johnstone and Ramon (2011) also state that meeting children‟s gross motor needs will improve their academic readiness, as well as their overall behaviour. Neural pathways are built by means of physical activity. This process refers to the connections by which information travels through the brain. A child with more neural pathways will be able to learn more easily, thus early intervention is very important in order to develop perceptual-motor skills.

A perceptual-motor intervention targets components such as laterality (unilateral, bilateral and cross-lateral activities), balance, body image, tracking, spatial relations (body, spatial, directional and temporal awareness), locomotor and manipulative skills (Gallahue & Ozmun, 2006; Johnstone & Ramon (2011). Taking part in perceptual-motor activities enables children to develop greater levels of body control and encourages greater effort in all areas of the school curriculum. Children with sufficient perceptual-motor skills enjoy

better coordination, greater body awareness, stronger intellectual skills and a more positive self-image (Johnstone & Ramon, 2011).

Due to a lack of support for the bottom-up approach, new approaches emerged known as the cognitive or top-down approach (Bernie & Rodger, 2004). More researchers are in favour of this approach (Sugden *et al*., 2008). These new approaches were based on theoretical concepts of motor learning and cognition. Motor learning is based on a conscious understanding of the processes involved when a motor problem needs to be solved. Thus, the interaction between the task and environment, as well as the child needs should be taken into consideration (Perry, 1998). Cognitive approaches use direct skill teaching, but differ in the sense of the unique problem-solving framework, attempting to help children generalise from the learning of one skill to the next (Missiuna *et al*., 2006). According to Missiuna *et al*. (2006) and Sugden *et al*. (2008), although the task-specific approach aims at increasing various participations for children, it is preferable to consider how children can perform a specific task in a variety of real-life situations, rather than in one specific setting. Consequently, one should consider how to modify the task or to adapt the environment in order for children to participate and improve their learning capabilities.

PURPOSE OF RESEARCH

It is clear that controversies exist between these different approaches and there is still not enough evidence to substantiate that one specific intervention approach is superior to another (Miller *et al*., 2001; Miyahara *et al*., 2008). It is thus proposed that these two approaches (bottom-up and top-down) should be merged in order to care for children with DCD (Peters & Wright, 1999; Davidson & Williams, 2000). Thus, the aim of this study was to determine the efficacy of a perceptual-motor intervention for improving the motor proficiency levels of children classified with DCD.

METHODOLOGY

Participants

Initially 13 schools in the Bloemfontein area were targeted to take part in the research project, but only 7 schools eventually agreed to participate. The Department of Education of the Free State province, as well as the principal of each school gave permission for the research to be conducted on the school premises during the Physical Education periods. Approval had been obtained from the Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS57/2012). The participants were treated in accordance with the ethical guidelines outlined by the Ethics Committee of the Faculty of Health Sciences. The parents/legal guardians of the participants completed an informed consent form for each child participating in this study. In addition, the children signed an assent form.

Recruitment was targeted at children with DCD via the 7 participating schools who had permission to take part in the study (inclusion criteria). Exclusion criteria included a child in the age group outside the expected range (younger than five and older than eight), parental permission not granted, the informed consent form not fully completed, or parents indicating that they would be relocating during the study. Children who were absent during the testing procedure were also excluded due to incomplete testing. Additionally, the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5) (APA, 2013),

was used to exclude children if they had associated symptoms according to the criteria for DCD as stated in the DSM-5. Children with motor difficulties should not meet criterion C (disturbance is not

due to a general medical condition, for example, cerebral palsy, hemiplegia, or muscular dystrophy and does not meet criteria for a pervasive developmental disorder), or criterion D (if mental retardation is present, the motor difficulties are in excess of those usually associated with it). None of the children met the criteria and, therefore, all of them were included for further data analysis.

Study design

A pre-/post-test quasi-experimental design with a control group was applied as an empirical study, which made use of quantitative and qualitative data. The study involved 1 testing procedure by means of the Movement Assessment Battery for Children-2 (MABC-2 Test), in order to identify DCD among Grade 1 children. The participants were tested at their schools during the physical education periods by Kinderkineticists-in-training who were trained in the use of the instrument. Each Kinderkineticist-in-training was responsible for one subtest in order to have consistency across the study.

The cut-off scores used in this study were based on the recommendations of Henderson *et al*. (2007), which are as follows: performance at or below the 5th percentile is classified as severe motor difficulties; performance from the 5th to the 15th percentile is classified as moderate motor difficulties; and performance above the 15th percentile is classified as no motor difficulties. All the children took part in some form of intervention for 30 minutes twice a week over a period of 10 weeks. The control group followed a school programme (physical education classes), presented by personnel from the school. The personnel made use of the Curriculum Assessment Policy Statement (CAPS), according to the Department of Basic Education. The CAPS document with regard to Physical Education states that they should develop children‟s gross- and fine motor skills in addition to perceptual development (Department of Basic Education, 2011). The personnel focused on perceptual activities, which include aspects such as locomotor, rhythm, balance and laterality.

The experimental group followed a specific perceptual-motor intervention (see Appendix) implemented by a Kinderkineticist familiar with the motor development of young children. The perceptual-motor intervention was divided into four categories, namely unilateral-, bilateral-, contra-lateral- and combined activities. These categories consisted of spatial awareness; eye-hand as well as eye-foot coordination; body awareness; gross motor coordination; motor planning; directionality and dynamic balance in order to improve DCD. It can be concluded that both interventions include activities for perceptual-motor development, thus both groups followed a bottom-up approach. A post-test using the same procedure as the pre-test took place after the intervention process in order to observe if there was any improvement.

Measuring instruments

According to Henderson *et al*. (2007), the Movement Assessment Battery for Children-2 (MABC-2 Test) requires children to perform a series of motor tasks in a specified manner. In addition to age-related norms, the test also provides qualitative information on how children should approach and perform the tasks. The MABC-2 Test is used to assess the

subject‟s motor proficiency levels and to diagnose DCD in children. The first assessment component of this test battery contains 24 items organised into 3 sets of 8 tasks. Each set is designed to use

with children of a different age band. For the current study, age band 1 and age band 2 were used.

The 8 tasks are grouped under 3 headings, namely manual dexterity (MD), balance (B) and aiming and catching (AC) (Henderson et al., 2007). Age-adjusted standard scores and percentiles are provided, as well as a total test score for each of the 3 components of the test. The total test score can be interpreted in terms of a "traffic light" system. The green zone indicates performance in a normal range (>15th percentile), while the amber zone indicates that a child is at risk and needs to be carefully monitored (5th - 15th percentile). The red zone is an indication of definite motor impairment (≤5th percentile). Thus, high standard scores on the MABC-2 Test represent good performance. The MABC-2 Test is a valid and reliable tool to use with a reliability coefficient for the total test scores of 0.80 (Henderson *et al*., 2007).

Statistical analysis of data

Microsoft Excel was used to capture data from the MABC-2 Test electronically. A statistician performed data analysis using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS version 16.0, SPSS Inc., Chicago, IL). Regarding the size of the subgroups (Table 2), a non-parametric statistical technique was used to explore the objective stated. This was due to the small sample size, which could cause doubt regarding the assumptions of normality and homogeneity of variances. A bigger sample size could, however, not be obtained in order for the central limit setting to be implemented. The dependent variables are all measurable on an interval scale and, therefore, the Mann-Whitney U-test (Howell, 2012), being a counterpart of the *t*-test for independent variables, was considered. The 2 groups‟ were compared on the pre-recordings on the 4 dependent variables with the use of the Mann- Whitney U-test, where after it was recorded for the post-recordings. A probability level of
0.05 or less was taken to indicate statistical significance.

RESULTS

TABLE 1. **FREQUENCY DISTRIBUTION OF PARTICIPANTS**

Gender	**Race**		Total
	Caucasian	Black	
Boys	18 (56.3%)	24 (54.6%)	42 (55.3%)
Girls	14 (43.7%)	20 (45.4%)	34 (44.7%)
Total	32 (42.1%)	44 (57.9%)	76 (100%)

Table 1 shows that the group of 76 children (between the ages of 5 and 8 years) was made up of more boys (55.3%) than girls (42.1%). With regard to race, there were more Black children (57.9%) than Caucasian children (42.1%). The group consisted of 76 children, 36

of who formed the experimental group and the remaining 40 the control group (Table 2). With regard to gender, the control group consisted of 14 girls (18.4%) and 26 boys (34.2%), compared to the 20 girls (26.3%) and 16 boys (21.1%) in the experimental group.

TABLE 2. **EXPERIMENTAL AND CONTROL GROUPS: FREQUENCY DISTRIBUTION OF PARTICIPANTS**

Group	Caucasian boys	Caucasian girls	Black boys	Black girls	Total
Experimental	6 (33.3%)	10 (71.4%)	10 (41.7%)	10 (50.0%)	36 (47.4%)
Control	12 (66.7%)	4 (28.6%)	14 (58.3%)	10 (50.0%)	40 (52.6%)
Total	18 (23.7%)	14 (18.4%)	24 (31.6%)	20 (26.3%)	76 (100%)

The results in Table 3 indicate that there was no significant difference between the control group and the experimental group at the pre-test done before the intervention commenced, with regard to the various subtests, namely manual dexterity (p=0.737), aiming and catching (p=0.527), and balance (p=0.582), as well as the total test score (p=0.372).

Manual dexterity (MD) involves the coordinated use of the hands, guided by the visual system, within time limits (Henderson *et al*., 2007). For this subtest the post-test average scores for the experimental and the control group improved in the total group, Caucasian children and Black children, as well as for the girls and boys. The results for the total group indicate that, although there was no significant difference (p=0.068) between the two groups after the intervention, the average scores for both groups did increase. The increase was found with regard to the total group and for boys, girls, Caucasian children and Black children independently. Furthermore, although both groups improved on their average scores, the improvement was found to be greater in the experimental group than in the control group.

Aiming and catching (AC) entails coordinating body movements when receiving moving objects, as well as performing throwing tasks accurately (Henderson *et al*., 2007). Similar to the results of the subtest for manual dexterity, the post-test average scores for aiming and catching increased for both the control and the experimental group. The increase was also obtained in all the categories researched and again the improvement was found to be greater in the case of the experimental group. It is interesting to note that the boys had a higher average pre-test score (Mean=9.31) than their female counterparts (Mean=8.45). These results support the fact that boys have better ball skills than girls.

The *balance* subtest (B) involves static and dynamic balance, where the child has to keep the body upright against gravity while standing on one leg and performing hopping and jumping movements (Henderson *et al*., 2007). In the case of the total group, balance is the only subtest indicating a significant difference between the pre- (p=0.582) and the post-test (p=0.050). The experimental group (Mean=8.86) had a significantly higher average score than the control group (Mean=7.80) at the post-test (Table 3).

TABLE 3. **PRE- AND POST-TEST SCORES FOR EXPERIMENTAL AND CONTROL GROUPS: TOTAL GROUP, BOYS & GIRLS, CAUCASIAN & BLACK CHILDREN**

Variable	Test	Gr.	**Total Group** (N=76) M±SD	*U*	p	**Boys** (n=42) M±SD	*U*	p	**Girls** (n=34) M±SD	*U*	p
MD	Pre	Exp	4.14±1.48	688.5	0.737	3.75±1.34	196.0	0.751	4.45±1.54	121.5	0.522
		Con	3.99±1.51			3.90±1.45			4.14±1.66		
	Post	Exp	6.42±2.43	611.0	0.252	5.87±2.36	205.0	0.937	6.85±2.46	100.5	0.169
		Con	5.75±2.42			5.77±2.60			5.71±2.13		
AC	Pre	Exp	8.83±1.95	660.5	0.527	9.31±2.41	205.5	0.947	8.45±1.43	126.5	0.641
		Con	9.05±2.06			9.42±1.65			8.36±2.59		
	Post	Exp	10.64±2.49	695.5	0.797	11.25±2.79	187.0	0.581	10.15±2.16	132.0	0.796
		Con	10.33±2.79			10.54±2.98			9.93±2.43		
B	Pre	Exp	7.25±1.34	668.0	0.582	7.13±1.36	186.5	0.570	7.35±1.35	135.0	0.877
		Con	7.17±1.88			6.96±1.68			7.57±2.21		
	Post	Exp	8.86±2.73	533.0	**0.050**	8.50±2.78	177.0	0.416	9.15±2.72	82.0*	0.043
		Con	7.80±2.97			8.08±3.12			7.29±2.70		
TTS	Pre	Exp	5.42±0.77	642.0	0.372	5.25±0.93	203.5	0.899	5.55±0.61	117.0	0.436
		Con	5.25±0.84			5.27±0.78			5.21±0.98		
	Post	Exp	7.97±2.72	546.0	0.068	7.69±2.36	172.0	0.348	8.20±3.02	89.5	0.077
		Con	6.82±2.71			7.00±3.01			6.50±2.14		
Variable	**Test**	**Gr.**	**Total Group** (N=76) M±SD	*U*	p	**Caucasian children** (n=32) M±SD	*U*	p	**Black children** (n=44) M±SD	*U*	p
MD	Pre	Exp	4.14±1.48	688.5	0.737	5.06±1.53	107.0	0.445	3.40±0.94	223.5	0.685
		Con	3.99±1.51			4.44±1.50			3.69±1.47		
	Post	Exp	6.42±2.43	611.0	0.252	7.63±1.78	99.5	0.287	5.45±2.48	234.5	0.896
		Con	5.75±2.42			6.75±2.52			5.09±2.16		
AC	Pre	Exp	8.83±1.95	660.5	0.527	8.56±2.39	95.5	0.224	9.05±1.54	225.0	0.716
		Con	9.05±2.06			9.38±2.19			8.83±1.99		
	Post	Exp	10.64±2.49	695.5	0.797	10.94±2.57	125.5	0.926	10.40±2.46	234.0	0.886
		Con	10.33±2.79			10.69±2.55			10.08±2.96		
B	Pre	Exp	7.25±1.34	668.0	0.582	6.81±1.38	87.0	0.128	7.60±1.23	219.5	0.622
		Con	7.17±1.88			6.06±1.18			7.92±1.91		
	Post	Exp	8.86±2.73	533.0	**0.050**	9.31±2.92	72.0	**0.035**	8.50±2.58	215.0	0.552
		Con	7.80±2.97			7.31±2.41			8.13±3.30		
TTS	Pre	Exp	5.42±0.77	642.0	0.372	5.63±0.50	81.0	0.080	5.25±0.91	223.5	0.668
		Con	5.25±0.84			5.06±0.85			5.38±0.82		
	Post	Exp	7.97±2.72	546.0	0.068	9.00±2.78	76.5	**0.050**	7.15±2.43	206.0	0.419
		Con	6.82±2.71			7.19±2.37			6.58±2.94		

Gr= Group; M= Mean; SD= Standard Deviation; p≤0.05; Exp= Experimental Gr.; Con= Control Gr. MD= Manual dexterity; AC= Aiming and catching; B= Balance; TTS= Total test score

Similar findings were obtained for the Caucasian children. The experimental group (Mean=9.31) achieved a significantly higher average score than the control group

(Mean=7.31), indicating that their balancing skills improved significantly (p=0.035). In addition, the girls also improved on their average score, the experimental group (Mean=9.15) performing better than the control group (Mean=7.29), resulting in a significant difference (p=0.043) between the two groups. This indicates that the perceptual-motor intervention did aid in the improvement of the balancing skills of some of the children. However, no significant differences were observed for the Black learners or the boys (Table 3).

The sum of the three categories of the MABC-2 Test produced the *total test score* (TTS). Although the average total test score improved in all the categories, the only significant difference was found for the Caucasian children. The results in Table 3 indicate that the experimental group (Mean=9.00) had a significantly higher total test score than the control group (Mean=7.19) in the post-test. Thus, a significant difference (p=0.050) was observed. The results indicate that the perceptual-motor intervention did improve the overall motor proficiency of Caucasian children.

The distribution of the children according to the traffic light system (degree of motor difficulty), before and after the perceptual-motor intervention is shown in Figures 1. Note that only children classified as borderline or with severe motor impairment took part in the intervention. As stated previously, the total test score is derived from the 3 subtests and can be interpreted in terms of a traffic light system. The green zone indicates performance in a normal range, the amber zone indicates a child as being at risk and the red zone is an indication of definite motor impairment. After the pre- and post-tests, the total test scores of the 76 children were interpreted and placed according to the traffic light system.

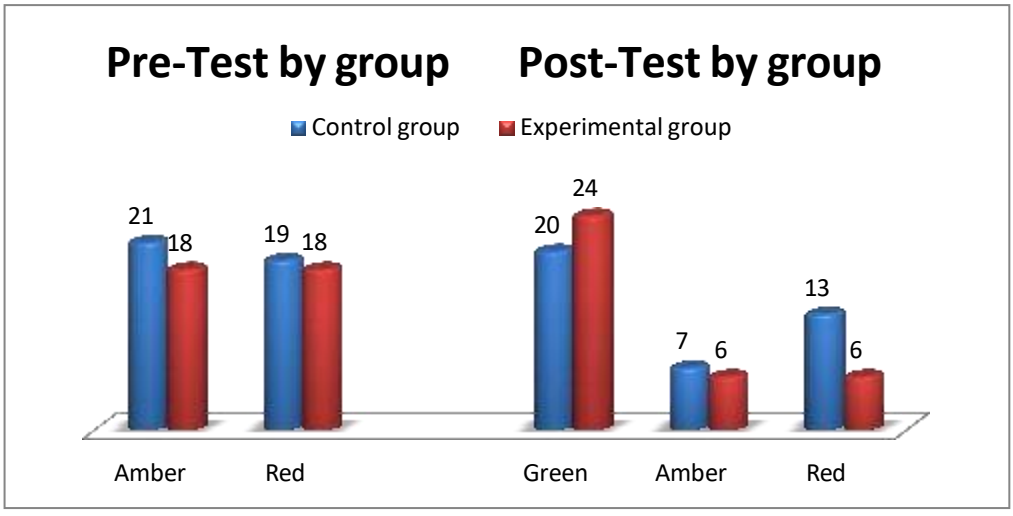

FIGURE 1. **TEST PLACEMENTS USING TRAFFIC LIGHT SYSTEM BY GROUP**

Figure 1 indicates the placement in terms of the traffic light system prior to and after the intervention. The results clearly indicate that all the participants had some form of motor

problems prior to the intervention. Of the control group, 21 children fell in the amber zone and 19 children in the red zone. Of the experimental group, 18 children fell in the amber zone and another 18 in the red zone.

In addition, subsequent to the intervention, the experimental group performed better than the control group. The distribution according to the traffic light system was as follows: the majority of the children in the control group improved, with 20 children placed in the green zone (no motor difficulties). Similar results were observed for the experimental group, where 24 children improved after the intervention and could be placed in the category, „no motor difficulty". Furthermore, the results show that seven children from the control group and six of the experimental group remained in the amber zone. Finally, of the 19 children in the control group who were initially in the red zone, 13 remained after the intervention. This confirms that children will not outgrow their motor problems. Of the intervention group, only six children remained in the red zone. The findings of this study indicate that the motor proficiency levels of children with DCD improved not only due to their participation in a perceptual-motor intervention, but also by taking part in physical education classes presented by their teachers (Figure 1).

DISCUSSION

There has been an abundance of published research concerning various interventions for children with DCD. According to Smits-Engelsman *et al*. (2013), interventions in general have proved to be beneficial for children with DCD, implying that any intervention is better than no intervention at all. It must be mentioned that literature available with regard to the bottom-up approach has become somewhat outdated. This might be due to the criticism towards this approach (Bernie & Rodger, 2004), since more researchers are in favour of the top-down approach (Sugden *et al*., 2008). A combined systematic review and meta-analysis was conducted by Smits-Engelsman *et al.* (2013), reviewing studies published between 1995 and 2011 on various interventions for children with DCD. The researchers concluded their study indicating that the comparison between various interventions showed strong effects for the task-oriented intervention (dw=0.89), in addition to physical and occupational therapies (dw=0.83), whereas the process-oriented intervention was weak (dw=0.12).

The results with regard to *manual dexterity* indicated no significant difference (p=0.252) between the two groups after the intervention was completed. This is similar to a study conducted by Pienaar and Lennox (2006), who determined that the fine motor skills of children between five and eight years from two farm schools did improve, but not significantly. Furthermore, Peens *et al.* (2008) also found no improvement after a motor intervention. In the current study, the perceptual-motor intervention did not focus on fine motor development; however, both groups did improve. This might be due to the exposure in the classroom, where children took part in writing and cutting activities, as well as beading.

With reference to *aiming and catching*, it is interesting to note that the control group had a higher average score during the pre-test, although the difference was not significant (p=0.527). Both groups improved with regard to aiming and catching. Although the

intervention group improved more based on the average score, the results do not indicate a significant difference (p=0.797) between the pre- and post-tests of the two groups. The findings of Pienaar and Lennox (2006) were of a similar nature. In contrast, Peens *et al*. (2008) used a motor-based intervention and found a significant improvement. Another reason for improvement in both groups might be the fact that these children participated in a variety of object manipulative skills at school and in sports.

The results for *balance* indicate a significant difference (p=0.050) between the two groups after the intervention was completed. The improvement of the experiemtal group correlates with the findings of Pienaar and Lennox (2006), as well as that of Peens *et al*. (2008), who found that a motor intervention improved the balance sub-test of the Movement Assessment Battery for Children. The results of this study indicate that the perceptual-motor intervention contributed to the improvement of balance.

Although there was an improvement in the average score of the *total test score*, there was no significant difference (p=0.068) between the groups after the intervention. It was also apparent that the participants of the current study were a heterogeneous group and it is necessary to address the individual needs of each child. Missiuna *et al*. (2006) also confirm this statement. Based on the current study, a perceptual-motor intervention did not lead to a significant improvement with regard to overall motor proficiency. This correlates with Pienaar and Lennox (2006), who also found no significant difference in motor performance after conducting a motor intervention with 32 children between five and eight years of age. In contrast, Peens *et al*. (2008) found that a motor-based intervention did improve the total test score of 20 children between the age of seven and nine years.

The results of the current study show that the children who followed the perceptual-motor intervention, conducted by a Kinderkineticist-in-training familiar with the development of children, had a 67% improvement (24/36). Furthermore, the results indicate that the physical education classes conducted by the teachers also improved the motor proficiency of the children in the control group by 50% (20/40). This indicates that a majority of the children in both groups achieved scores above the 15^{th} percentile during the post-test. The improvement illustrates that interventions conducted by other people, such as teachers, can also be helpful.

This statement is supported by findings from Sugden and Chambers (2003), observing that interventions done by parents and teachers can also be successful. The researchers found that a seven-week intervention (task-orientated approach), conducted by parents and teachers helped the majority of children to obtain scores above the 15^{th} percentile. Miyahara *et al*. (2008) made use of university students in a clinical setting to apply a task-orientated approach and found that 40% of the participants improved beyond the cut-off scores. Intervention by means of a combination of the bottom-up and top-down approaches through intense physical activity conducted by Watemberg *et al*. (2007), concluded that 50% of the participants with DCD scored above the cut-off scores (>15^{th} percentile) after a four-week intervention.

The implications of the results indicate that although both groups improved in general with regard to the average scores, the experimental group improved more compared to the control

group. Therefore, the results indicate that a perceptual-motor intervention can be used as an appropriate intervention for children identified with DCD.

CONCLUSIONS

When children are identified with DCD, it is important to implement intervention programmes. Intervention programmes have proven to enhance the motor proficiency of these children (Peens *et al*., 2008). The results of the current study suggest that a perceptual-motor intervention did not improve the motor proficiency levels of children with DCD. From the point of view of a therapist, no two children are the same, especially children identified with DCD, since they are not a homogeneous group.

LIMITATIONS

One of the major limitations was the fact that the control group was exposed to physical education classes. This could have contributed to the improvement of their motor proficiency levels and influenced the results. Since this was a population-based sample, criterion B of the diagnostic criteria for DCD, which states that the academic performance of the children should also be considered (APA, 2013), was not used. It should also be recognised that the current study recruited children from the Bloemfontein metropolitan area only. Hence, a replication of this study in different provinces and regions in South Africa is recommended to provide more generalised and robust results. Another limitation of the study was the fact that the children were tested on age band 1 (age six) during the pre-test. The majority of the children turned seven during the intervention, and, therefore, had to be tested on age band 2, implying that they had to perform more difficult activities than for age band 1.

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REFERENCES

APA (AMERICAN PSYCHIATRIC ASSOCIATION) (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Association.

AUXTER, D.; PYFER, J. & HUETTIG, C. (2005). *Principles and methods of adapted physical education and recreation* (10th ed.). Boston, MA: McGraw-Hill.

BARNETT, A.L. (2008). Motor assessment in developmental coordination disorder: From identification to intervention. *International Journal of Disability, Development and Education*, 55(2): 113-129.

BERNIE, C. & RODGER, S. (2004). Cognitive strategy use in school-aged children with developmental coordination disorder. *Physical and Occupational Therapy in Pediatrics*, 24(4): 23-45.

CARSLAW, H. (2011). Developmental coordination disorder. *InnovAiT: RCGP Journal for Associates in Training*, 4(2): 87-90.

DAVIDSON, T. & WILLIAMS, B. (2000). Occupational therapy for children with developmental

coordination disorder: A study of the effectiveness of a combined sensory integration and perceptual-motor intervention. *British Journal of Occupational Therapy*, 63(10): 495-499.

DE MILANDER, M.; COETZEE, F.F. & VENTER, A. (2014). Developmental coordination disorder in grade 1 learners. *African Journal for Physical, Health Education, Recreation and Dance*, 20(3): 1075-1085.

DEPARTMENT OF BASIC EDUCATION (2011). "Curriculum and Assessment Policy Statement (CAPS), Life Skills – Foundation Phase: Physical Education", pp. 7. Online: [http://www.mml/co.za/docs/FP_CAPS/Life-Skills-CAPS-FP-Feb2011]. Retrieved on 16 March 2015.

ELLINOUDIS, T.; KYPARISIS, M.; GITSAS, K. & KOURTESIS, T. (2009). Identification of children aged 7-12 with developmental coordination disorder by Physical Education teachers using the test "Movement Assessment Battery for Children". *Hellenic Journal of Physical Education and Sport Science*, 29(3): 288-306.

GAINES, R. & MISSIUNA, C. (2007). Early identification: Are speech/language-impaired toddlers at increased risk for developmental coordination disorder? *Child Care, Health and Development*, 33(3): 325-332.

GALLAHUE, D.L. & OZMUN, J.C. (2006). *Understanding motor development: Infants, children, adolescents, adults* (6th ed.). Boston, MA: McGraw-Hill.

GIAGAZOGLOU, P.; KABITSIS, N.; KOKARIDAS, D.; ZARAGAS, C.; KATARTZI, E. & KABITSIS, C. (2011). The movement assessment battery in Greek preschoolers: The impact of age, gender, birth order, and physical activity on motor outcome. *Research in Developmental Disabilities*, 32(6): 2577-2582.

HAMILTON, S.S. (2002). Evaluation of clumsiness in children. *American Family Physician*, 66(8): 1435-1440.

HENDERSON, S.E. & HENDERSON, L. (2002). Toward an understanding of developmental coordination disorder. *Adapted Physical Activity Quarterly*, 19(1): 11-31.

HENDERSON, S.E.; SUGDEN, D.A. & BARNETT, A.L. (2007). *Movement assessment battery for children-2* (2nd ed.). London, UK: Harcourt Assessment.

HOWELL, D.C. (2012). *Statistical methods for psychology* (8th ed.). Johannesburg: Wadsworth.

JOHNSTONE, J.A. & RAMON, M. 2011. *Perceptual-motor activities for children: An evidence-based guide to building physical and cognitive skills.* Champaign, IL: Human Kinetics.

MILLER, L.T.; POLATAJKO, H.J.; MISSIUNA, C.; MANDICH, A.D. & MACNAB, J.J. (2001). A pilot trial of a cognitive treatment for children with developmental coordination disorder. *Human Movement Science*, 20(1-2): 183-210.

MISSIUNA, C.; RIVARD, L. & BARTLETT, D. (2006). Exploring assessment tools and the target of intervention for children with developmental coordination disorder. *Physical and Occupational Therapy in Pediatrics*, 26(1-2): 71-89.

MIYAHARA, M.; YAMAGUCHI, M. & GREEN, C. (2008). A review of 326 children with developmental and physical disabilities, consecutively taught at the Movement Development Clinic: Prevalence and intervention outcomes of children with DCD. *Journal of Developmental Physical Disabilities*, 20(4): 353-363.

PEENS, A.; PIENAAR, A.E. & NIENABER, A.W. (2008). The effect of different intervention programmes on the self-concept and motor proficiency of 7- to 9-year-old children with DCD. *Child Care, Health and Development*, 34(3): 316-328.

PERRY, S.B. (1998). Clinical implications of a dynamic systems theory. *Neurology Report*, 22(1): 4-10.

PETERS, J.M. & WRIGHT, A.M. (1999). Development and evaluation of a group physical activity programme for children with developmental co-ordination disorder: An interdisciplinary

approach. *Physiotherapy Theory and Practice*, 15(4): 203-216.

PIENAAR, A.E. & LENNOX, A. (2006). Die effek van ‟n motoriese intervensieprogram gebaseer op ‟n geïntegreerde benadering vir 5- tot 8-jarige plaaswerkerkinders met DCD: Flagh-studie. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 28(1): 69-83.

PRADO, M.S.S.; MAGALHÃES, L.C. & WILSON, B.N. (2009). Cross-cultural adaptation of the Developmental Coordination Disorder Questionnaire for Brazilian children. *Brazilian Journal of Physical Therapy*, 13(3): 236-243.

SMITS-ENGELSMAN, B.C.M.; BLANK, R.; VAN DER KAAY, A.C.; MOSTERD-VAN DER MEIJS, R.; VLUGT-VAN DEN BRAND, E.; POLATAJKO, H.J. & WILSON, P.H. (2013).
Efficacy of interventions to improve motor performance in children with developmental coordination disorder: A combined systematic review and meta-analysis. *Developmental Medicine and Child Neurology*, 55(3): 229-237.

SUGDEN, D.A. & CHAMBERS, M.E. (1998). Intervention approaches and children with developmental coordination disorder. *Neurorehabilitation*, 2(4): 139-147.

SUGDEN, D.A. & CHAMBERS, M.E. (2003). Intervention in children with developmental coordination disorder: The role of parents and teachers. *British Journal of Educational Psychology*, 73(4): 545-561.

SUGDEN, D.A.; KIRBY, A. & DUNFORD, C. (2008). Issues surrounding children with developmental coordination disorder. *International Journal of Disability, Development and Education*, 55(2): 173-187.

WATEMBERG, N.; WAISERBERG, N.; ZUK, L. & LERMAN-SAGIE, T. (2007). Developmental coordination disorder in children with attention-deficit-hyperactivity disorder and physical therapy intervention. *Developmental Medicine and Child Neurology*, 49(12): 920-925.

WILMUT, K.; BROWN, J.H. & WANN, J.P. (2007). Attention disengagement in children with developmental coordination disorder. *Disability and Rehabilitation*, 29(1): 47-55.

Appendix: **Perceptual-motor Intervention Programme for Experimental Group**

Week 1: Unilateral activities

Skills developed	**Activity**
Laterality, motor planning, gross motor coordination	Do a unilateral crawl from cone to cone by using your right hand and right leg at the same time and then your left hand and left leg at the same time. As you pass each cone, say what is shown on the card for that cone. Once you reach the last cone, do a backward unilateral crawl to your original starting point by using your left hand and left leg at the same time and then your right hand and right leg at the same time.
Laterality, locomotor skills, spatial awareness, motor planning	Hop along the mat using only your left foot. With each hop, say what is shown on the card for the square you are landing in. Repeat the activity using only your right foot. Continue in this way hopping along the mat on your left foot, then hop on your right foot, then back to the left, and so on.

Spatial awareness, eye-hand coordination, body awareness, gross motor coordination	Crawl around the outside of the hoop while rolling the ball around inside the hoop with the fingertips of one hand; repeat the activity using the elbow; reverse the direction of the crawl, using the other side.
Laterality, locomotor skills, motor planning	Hop to the first of 3 rings, saying the letter shown on the card for each ring as you land in it. Then hop to the next ring and say what is shown in the picture on the card. Continue on to the next letter-picture sequence.

Week 2: Bilateral activities

Skills developed	**Activity**
Locomotor skills, motor planning, spatial awareness	Frog-jump randomly from cone to cone. When you get to each cone, touch it and say the colour and number shown on its card.
Locomotor skills, motor planning, spatial awareness	Touch your body parts with your hands and name the different parts.
Laterality, motor planning, gross motor coordination	Stop on the stomp board with feet at once to project the beanbag into the air. Catch the beanbag with 2 hands and say the colour of the beanbag. Try 5 times. Repeat the activity, clap once and catch the beanbag with 2 hands. Try 5 times.
Spatial awareness, gross motor coordination	Starting at the first hoop, say the shape and colour shown on the card in the hoop. Then use a 2-handed dribble to dribble the ball in the hoop 5 times, counting from 1 to 5 as you dribble. Move to the next hoop and repeat.

Week 3: Cross-lateral activities

Skills developed	**Activity**
Locomotor skills, motor planning, spatial awareness	Crawl from cone to cone. Along the way touch each cone and say the number shown on the card for that cone.
Cross-laterality, directionality, balance, eye-hand coordination; midline crossing	Hold the ball and walk forward on the line using a crossover step: On each step with your right foot, step to the left of the line; do the same with the opposite foot; continue this pattern to the end of the line. After each step, bounce the ball with either hand.
Eye-hand coordination, gross motor development	Stop on the stomp board with right foot to project the beanbag into the air. Catch the beanbag with the left hand and count. Try 10 times. Repeat the activity, with the opposite foot. Progression, clap once and catch the beanbag. Try 10 times; repeat the opposite side.
Dynamic balance, spatial awareness	Walk forward on the beam from one end to the other. Along the way, step over the hurdle and through the hoop.

Week 4: Combined activities

Skills developed	**Activity**
Laterality, locomotor skills, motor planning	Step onto the box; jump from the box over the hurdle and into hoop 1, from 1 to 2 and step through the last hoop.

Locomotor skills, motor planning, eye-hand coordination	Jump on the mini trampoline for 5 times; lie facing forward on our tummy on the scooter board and use both arms together to propel yourself forward to the rope; jump over the rope from front to back and then back to front 5 times; walk to the hoop and bounce the ball in the hoop 5 times with both hands together.
Cross-lateral awareness, dynamic balance, eye-hand coordination	Walk on the rungs of the ladder; leap into and then out of each hoop; stomp on the board with your right foot to launch the beanbag, the catch it with your left hand; opposite side as well.
Cross-lateral awareness, dynamic balance, eye-hand coordination	Lie on your tummy on the scooter board; use alternating hands to propel yourself forward through the tunnel; kneel on the scooter board and use alternate hands to weave through the cones; sit on the scooter board and use alternating feet to propel yourself backward through the space between the noodles or ropes.

Week 5: Unilateral activities

Skills developed	**Activity**
Laterality, locomotor skills, motor planning, spatial awareness	Hop sideways through the mat using only your left foot. With each hop, say what is shown on the card for the square you are landing in. Repeat with right foot.
Laterality, motor planning, gross motor coordination	Lie on your torso on the scooter board and use the rope to pull yourself forward with only your right hand; repeat using left hand; sit on the scooter board and pull with right and then left hand.
Laterality, eye-foot coordination	Walk between the 2 rows of bricks, kicking the black ones over with your left foot and kicking the white ones over with your right foot.
Laterality, motor planning, coordination	Toss the disc into the target using your right hand and stepping with your right foot, do the same with your left hand and foot.

Week 6: Bilateral activities

Skills developed	**Activity**
Laterality, locomotor skills, motor planning	Start at the pointed end of the mat; jump across this first section of the mat with both feet and say the number shown on the card for that sections; move to the next section to the right and jump across every remaining sections until you reach the end. Do not need to make the distance.
Motor planning, gross motor coordination, locomotor skills	Do frog jumps from one shape to another; after each jump and starting with A, work your way through the alphabet, start again if you get to the end; repeat by jumping sideways.
Eye-hand coordination, tracking skills	Sit facing the wall and roll the ball to the wall with 2 hands, after each roll, say the alphabet, roll as many times as possible in the allotted time; stand on line and toss the ball with 2 hands against the wall, let it bounce 1 time after hitting the wall, catch with 2 hands, repeat the toss but catch without the bounce.

Locomotor skills, motor planning, spatial awareness	Jump over the line on the floor with both feet; with hands on your hips, jump over the line slowly for 5 times and the quickly; jump across the line high, then turn around and jump across the line, repeat and jump low; repeat the activities and recite the alphabet while jumping.

Week 7: Cross-lateral activities

Skills developed	**Activity**
Cross-lateral awareness	Take a 3m approach, run up to the ball without slowing and use your right foot to kick the ball at the brick between the cones; when kicking with your right foot, extend your left arm forward; repeat with your left foot and right arms; repeat 5 times.
Laterality, motor planning, gross motor coordination	Lie on your tummy on the scooter board and push yourself from cone to cone, alternate side in pushing, as you pass each cone, say what is shown on the card; repeat the activity by sitting on the scooter board.
Laterality, motor planning, gross motor coordination	Crawl from beanbag to beanbag, putting each one in the bucket with the matching colour. When picking up a beanbag from the floor, use whichever hand is closest to it and use that same hand to put the beanbag in the bucket.
Cross-lateral awareness, dynamic balance	Start at a line 3m from the mat and leap across the mat; start at the narrow end and work your way to the wide end; emphasise using good leaping form; on landing say what is shown on the card for the section.

Week 8: Combination activities

Skills developed	**Activity**
Eye-hand coordination, unilateral awareness	Hop from shape to shape, at each shape bounce the ball in the shape 5 times with your right hand and then the left hand; while bouncing the ball say the shape and colour.
Eye-hand coordination, motor planning, dynamic balance	Hop 5 times in each hoop; get on the beam and slide sideways to the right to the end of the beam, as you go bounce ball once in each hoop with right hand, repeat with the left hand.
Bilateral awareness, eye-hand coordination, motor planning	Jumping from hoop to hoop by taking off and landing with both feet simultaneously; lie on your tummy on the board and use both hand at the same time to propel yourself forward to the beanbag; toss and catch the beanbag 5 times with both hands.
Cross-lateral awareness, motor planning	Crawl up the incline mat onto the step box; jump off the box into the hoop on the floor; step through the vertical hoop and say “through”; crawl under the hurdle and say “under”.

Week 9: Unilateral activities

Skills developed	**Activity**

Locomotor skills, motor planning	Hop from cone to cone, at each cone, say the letter or picture shown on the card for that cone. Repeat activity using your other foot.
Spatial awareness, gross motor coordination	Roll the ball to the wall with your dominant hand; be sure you step forward with the same foot as the hand you use to roll the ball, while it rebounds off the wall, say the letter shown on the card posted on the wall, catch the ball on the rebound, repeat with non-dominant hand.
Laterality, eye-hand coordination	Toss the scarf up into the air with your right hand, then catch it with your right hand using the lion‟s claw catch; as you toss the scarf, say "toss up" and catch "catch down"; repeat with the left hand until music stops.
Balance	Put your belly on the ball and try to balance yourself without touching the floor; with belly on ball, lift right arm and right leg and try to balance, repeat with left side.

Week 10: Bilateral activities

Skills developed	**Activity**
Laterality, locomotor skills, motor planning	Jump forward from hoop to hoop while saying 1 letter in alphabetical order after each jump; repeat activity backwards.
Laterality, dynamic balance	Hold a noodle horizontal in both hands with palms up at chest level and walk forward for the length of the beam; carry a noodle over your head with both hands and walk forward for the length of the beam.
Eye-hand coordination, spatial awareness, coordination	While standing, place the ball on the floor between your legs and roll it (with both hands together) at a cone, say the letter on the cone, retrieve the ball and repeat until you have rolled the ball 5 times; turn and face away from the cone, roll the ball backward between your legs at the cone.
Directionality, locomotor skills	Activity may be done without the inclined mat, use a mat to crawl up to the jump box; get on the jump box and assume proper jumping position, with knees bent and your arms extended behind your body, jump into the hoop, making a quarter-turn to the right, repeat it to the left.

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EXERCISE FOR YOUNG MALE ATHLETES

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ABSTRACT

The aim of this study was to investigate the listening to motivational music and lactate and cortisol response to a single circuit resistance exercise (CRE) in male handball players. Sixteen handball players were randomly assigned to two equal groups of eight participants that trained with the intensities of 60% (G60) and 80% (G80) of their 1RM. G60 and G80 performed the exercise with (G60-M and G80-M) and without (G60-nM and G80-nM) music. Serum cortisol, epinephrine, norepinephrine, growth hormone (GH) and lactate levels were measured before (BE), immediately (IAE) and two hours after the exercise (2AE). In all groups, GH and lactate increased from BE to IAE and decreased from IAE to 2AE ($p \leq 0.05$). Serum cortisol levels decreased from BE to IAE and BE to 2AE in the group G60-M ($p \leq 0.05$). Listening to motivational music during CRE had no effect on GH, epinephrine and norepinephrine, yet decreased responses of lactate and cortisol were observed, which might be one of underlying mechanisms of fatigue reduction. More studies are needed to understand the exact mechanisms about the hormonal responses to music listening during exercise.

Key words: Music; Circuit resistance exercise; Growth hormone; Catecholamine; Lactate; Cortisol.

INTRODUCTION

Resistance exercise has been shown to elicit significant acute hormonal responses (Kraemer & Ratamess, 2005). In peripheral tissues, cortisol stimulates gluconeogenesis in the liver and lipolysis in adipose cells. At the same time, increased protein degradation and decreased protein synthesis in the muscles cells result in greater release of lipids and amino acids into the blood circulation (Koelsch *et al*., 2011; Yamasaki *et al*., 2012). Epinephrine (EN or adrenaline) and norepinephrine (NE or noradrenaline) are derived hormones from

phenylalanine secreted from adrenal medulla (Guyton & Hall, 2006). After these hormones bind to membrane receptors α or β, epinephrine and norepinephrine stimulate glycogenolysis, gluconeogenesis and lipolysis in the liver and muscle cells (Bottaro *et al*., 2009).

Growth hormone (GH), also known as somatotropin or somatropin, is a peptide hormone that stimulates growth, cell division and regeneration. Its metabolic effects include lipolysis stimulation and proteolysis suppression (Bottaro *et al*., 2009). During muscular exercise involving high power output, including resistance exercise, in which the energy demand is high, glucose is degraded to pyruvate, and lactate is produced from the pyruvate faster than its removal from the tissues, so blood lactate concentration increases (Guyton & Hall, 2006).

Nowadays, the study of using music while exercising is a rapidly growing field (Chtourou, 2013). Music has been shown to have a variety of positive influences on health, such as stress reduction, relaxation, pain management, neural cognition, cardiac function, amongst other effects (Chtourou *et al.*, 2014). However, increasing interest has been centred on understanding the physiological mechanisms underlying the effects of listening to music and, more recently, the suggested role of music in modulating the metabolic responses of humans (Yamasaki *et al*., 2012). Research has established that music influences the hypothalamic- pituitary-adrenal (HPA) axis, the sympathetic nervous system (SNS) and the immune system, which have key functions in the regulation of metabolism and energy balance (Yamasaki *et al*., 2012).

During exercise, music is commonly used for motivational purposes, to counterbalance emotional and physical fatigue, and improve performance (Chtourou *et al*., 2012a; Chtourou *et al*., 2012b; Jarraya *et al*., 2012). Recent studies have highlighted the role of music regarding physiological mechanisms by increasing exercise performance, including improving the blood lipid profile and facilitating post-exercise recovery (Costa *et al.*, 2011). Brownley *et al*. (1995) found that after intensive training, serum cortisol levels were higher following concurrent motivational music listening compared with relaxation music or no music at all (Brownley *et al*., 1995).

Many research studies have investigated the effects of one session of resistance exercise on blood hormone levels (Bush *et al*., 1999; Ghaderi *et al*., 2009; Rahimi *et al*., 2010b; Chtourou *et al*. 2014). In practice, many sportspersons listen to music while they perform their resistance training sessions. However, no previous study has investigated the effects of listening to music on physiological responses during resistance training.

AIM OF STUDY

The aim of this study was to investigate the effects of motivational music listening during single circuit resistance exercise (CRE) on the levels of serum cortisol, GH, NE, EN and lactate in young sportsmen, specifically league handball players.

METHODOLOGY

Subjects

Sixteen young male handball players (age: 19.3±0.4 years; height: 182±2.5cm; weight: 77.3±2.6kg; BMI: 23.3±1.7kg/m^2), volunteered to participate in this study after receiving a detailed explanation of the experimental procedure. The players were members of a city's team, and some played in the Premier League of the Province. They normally train 4 days per week for 2-hour sessions from around 17h00 to 19h00. In addition, they played 1 game a week. The players were divided in 2 equal groups, namely a training (music) and a control (no music) group with 8 subjects in each group.

Research design

Three days before starting with the intervention the predicted maximum strength, as one repetition maximum (1RM) for the upper and lower extremities, was estimated for all of the participants according to the National Strength and Conditioning Association guidelines and calculated using the Brzycki (1993) equation ([1-RM=Weight/(1.0278 – (0.0278 × Number of repetitions)]). They completed a medical examination and a medical questionnaire to ensure that they were not taking any medication and were not using steroids. The subjects were informed of the experimental risks. They then signed an informed consent document prior to the investigation. They were requested to abstain from intense physical activity for 48 to 72 hours before the measurements. The Regional Research Ethics Committee of the Islamic Azad University, Mahabad Branch, Iran approved the study protocol and experimental procedures in accordance to the principles of the Declaration of Helsinki.

Exercise testing procedures

Prior to the intervention all participants, since they were inexperienced and not familiar with resistance training, underwent a familiarisation session of the equipment that would be utilised during the study during a control day (i.e., about 1 week before the actual measurements). In addition, they listened to motivational (fast-tempo) music during the familiarization session. Before the start of each resistance training session, a gentle aerobic warm up for 5 minutes and then 5 to 10 repetitions at 50% of the 1RM was performed.

The resistance training session consisted of 10 free-weight circuit resistance exercises: (bench press, leg press, sit-ups, leg pull, knee extension, trunk extension, seated row, back feet (leg curl), overhead press and calf-press). All subjects participated in 2 resistance training sessions. In each session, the subjects were divided randomly into 2 groups (60 and 80% of 1RM). This meant that 1 group was exposed to a lower exercise intensity (60% 1RM), with and without music, and the other group was exposed to a higher exercise intensity (80% 1RM), with and without music. Four conditions were used, but 2 groups were present (G60- nM, G80-nM, G60-M and G80-M). Demographic characteristics of the subjects of each group are shown in Table 1.

The resistance exercise sessions took place in the morning between 08h30 and 12h00 to avoid the effects of circadian rhythms on performance (Chtourou & Souissi, 2012; Chtourou *et al.*,

2014). At least 48 hours, but not more than 72 hours,of recovery time was allowed between

each training session.

TABLE 1. **DEMOGRAPHIC CHARACTERISTICS OF THE SUBJECTS**

Group	Age (yrs)	Height (m)	Body Mass (kg)	BMI (kg/m^2)
G60 (n=8)	18.3±0.4	185±2.7	80.5±1.3	23.5±2.2
G80 (n=8)	20.4±0.5	179±2.4	74.2±1.4	23.2±1.2

The protocols consisted of 3 rounds with 2 intensities of 60 and 80% of 1RM. For the lower exercise intensity (60% 1RM), 10-12 repetitions was considered with 60s-rest period between the sets. For the higher exercise intensity (80% 1RM), 6 to 8 repetitions were used with 90s- rest period between the sets, and 5 minutes active recovery between rounds for both protocols. Circuit RE workouts of the subjects in each group are shown in Table 2.

TABLE 2. **PROGRAMME OF CIRCUIT RESISTANCE EXERCISE (CRE)**

Row	Exercise	60% of 1RM	80% of 1RM
1	Chest press	3:W-10-12	3:W-6-8
2	Foot press	3:W-10-12	3:W-6-8
3	Sit-ups	3:35	3:25
4	Leg pull	3:W-10-12	3:W-6-8
5	Front hip	3:W-10-12	3:W-6-8
6	Trunk extension	3:35	3:25
7	Seated row	3:W-10-12	3:W-6-8
8	Knee extension	3:W-10-12	3:W-6-8
9	Overhead press	3:W-10-12	3:W-6-8
10	Calf	3:W-15-20	3:W-15

W: Sets 3:35= 3 sets of 35 repetitions

Music selection

Considering the nature of the study, the music used was of a motivational nature. The motivational music was selected according to the tempo (>120bpm), which has been reported to increase energy expenditure and reduce tension (Karageorghis *et al*., 2006; Karageorghis *et al*., 2009; Chtourou *et al*., 2012b). The identification and selection of the applicable music, based on the number of beats per minute, was carried out under the supervision of a music expert. Music was played using DVD player model no. 7600 (SAMSUNG, Japan), and an audio amplifier instrument (Faratel Co model no. 180, Iran). The music was played

continuously from the start to the end of the exercise session. Table 3 provides the details of

the experimental music tracks.

TABLE 3. **MUSIC SELECTIONS FOR EXPERIMENTAL CONDITIONS**

Artist	Track title	Album title	Year
Modern Talking	You're my heart	Back for good	1998
Modern Talking	Brother Louie	Back for good	1998
Modern Talking	Cheri cheri lady	Back for good	1998
Modern Talking	You can win if you want	Back for good	1998
Modern Talking	Atlantis is calling	Back for good	1998
Modern Talking	Geronimo's Cadillac	Back for good	1998
Modern Talking	In 100 years	Back for good	1998
Modern Talking	Love is for ever	Year of the dragon	2000
Modern Talking	China in her eyes (Bonus)	Year of the dragon	2000
Modern Talking	Don't take away my heart	Year of the dragon	2000
Modern Talking	When the sky rained fire	Victory	2002

Blood collection and analysis procedures

At the exercise sessions, blood samples (5ml) were drawn from an antecubital vein into 10ml serum vacationer tubes 10 minutes before warm-up (Pre), 5 minutes after exercise (Post) and again two hours after exercise (2Post) for the purpose of measuring serum growth hormone (GH), cortisol, epinephrine and norepinephrine, and blood lactate concentrations, while the subjects were in a sitting position. The blood samples were transferred to the laboratory according to validated procedures.

All of the collected samples were stored at -20°C until the assay. Moreover, to avoid any disturbing effect, the blood sampling was conducted in the same conditions for all participants. Serum epinephrine (EN) and norepinephrine (NE) were measured using a kit (EIA, IBL International GmbH, Flughafenstr. 52A, D-22335 Hamburg, Germany, Sensitivity 0.002ng/mL), by Hyperion system. Serum cortisol concentrations were determined using enzyme immuno-assay (RADIM SpA-Via del Mare, 125-00040 Pomezia [Roma] Italia). The GH serum concentration was determined by ELISA kit (Diagnostic Biochem Canada Inc., London, Ontario, Canada, Sensitivity 2ng/mL). Lactate concentration was measured by an automated ultraviolet (UV) enzymatic method (Hitachi instrument, model 717, Germany). To eliminate inter-assay variance, all samples for a particular assay were thawed once and thereafter analysed in the same assay run. All samples of each subject were analysed on the same day.

Statistical analysis

Data are displayed as the Mean±SD. Data normality was assessed through the Kolmogorov-Smirnov test and all variables showed normal distributions. Once the assumption of normality

was confirmed, parametric tests were performed. While between-group comparisons were analysed using one-way ANOVA. The LSD post-hoc test was used for pair wise comparisons. When ANOVAs revealed a significant difference, post-hoc multiple comparisons using the LSD test were conducted. Statistical significance was accepted at $p<0.05$.

RESULTS

The statistical analysis revealed that in the ***G60-nM*** condition, serum concentration levels of *GH* and *lactate* were significantly higher from BE to IAE (p=0.002, p=0.000). However, there was a significant decrease from IAE to 2AE (p=0.002, p=0.000) (Figure 1 to Figure 5). There were no significant changes in serum *cortisol* levels from BE to IAE (p=0.40) and IAE to 2AE (p=0.50) (Figure 2), and no significant differences in the levels of *norepinephrine* and *epinephrine* from BE to IAE (p=0.77, p=0.30), and IAE to 2AE (p=0.80, p=0.99) (Figure 3 to Figure 4). In the ***G80-nM*** condition, levels of *GH* and *lactate* increased significantly from BE to IAE (p=0.004, p=0.000), however, there was a significant decrease from IAE to 2AE (p=0.007, p=0.000) (Figure 1 to Figure 5). No significant differences were observed in serum *cortisol* levels from BE to IAE (p=0.50) and BE to 2AE (p=0.6) (Figure 2), as well as in the case of levels of *norepinephrine* and *epinephrine* from BE to IAE (p=0.2, p=0.8) and IAE to 2AE (p=0.5, P=0.39) (Figure 3 to Figure 4).

In ***G60-M*** condition, levels of *GH* and *lactate* were significantly increased from BE to IAE (p=0.000, p=0.009). However, there was a significant decrease from IAE to 2AE (p=0.000, p=0.028) (Figure 1 to Figure 5). Serum *cortisol* concentration decreased significantly from BE to IAE and BE to 2AE (p=0.009, p=0.008), but the changes were not significant from IAE to 2AE (p=0.8) (Figure 2). In the case of *norepinephrine* and *epinephrine* levels, no significant differences were found from BE to IAE (p=0.67, p=0.94) and IAE to 2AE (p=0.68, p=0.33) (Figure 3 to Figure 4).

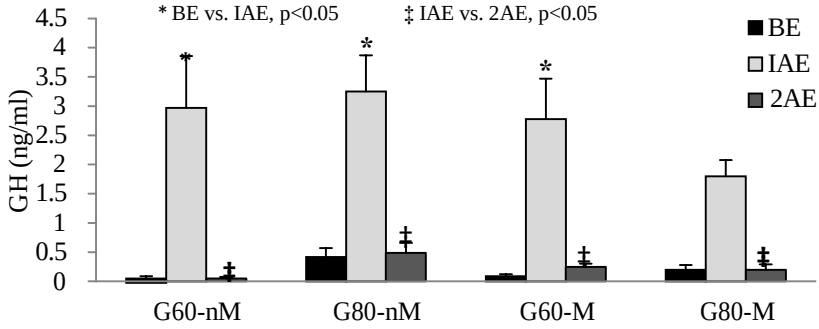
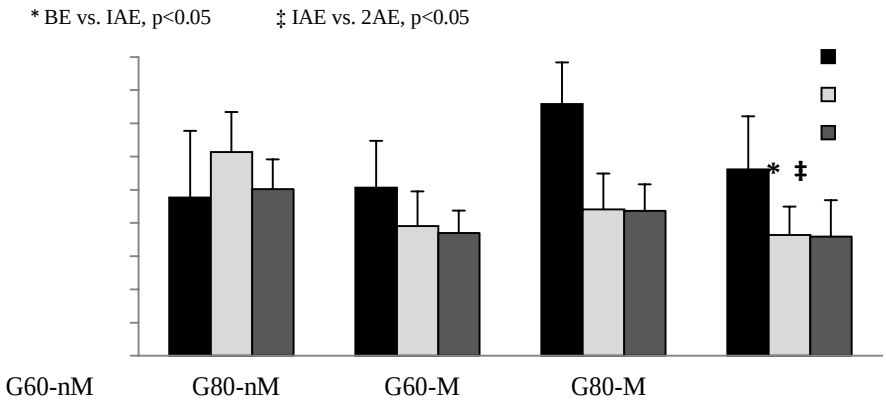


FIGURE 1. **GH LEVELS (MEAN±SD) BEFORE (BE), IMMEDIATELY (IAE) AND 2 HOURS AFTER EXERCISE (2AE)**

In the ***G80-M*** condition, levels of *GH* and *lactate* were significantly higher from BE to IAE (p=0.013, p=0.000) and significantly lower from IAE to 2AE (p=0.013, p=0.000) (Figure 1

to Figure 5). Serum *cortisol* concentration decreased from BE to IAE (p=0.15) and BE to 2AE (p=0.12) (Figure 2), but these changes were not significant. *Norepinephrine* and *epinephrine* did not increase significantly from BE to IAE (p=0.23, p=0.58) nor did they decrease significantly from IAE to 2AE (p=0.30, p=0.87) (Figure 3 to Figure 4).


* BE vs. IAE, p<0.05
‡ IAE vs. 2AE, p<0.05
* ‡
G60-nM
G80-nM
G60-M
G80-M

BE IAE 2AE

FIGURE 2. **CORTISOL LEVELS (MEAN±SD) BEFORE (BE), IMMEDIATELY (IAE) AND 2 HOURS AFTER EXERCISE (2AE) WITH G60-nM,**

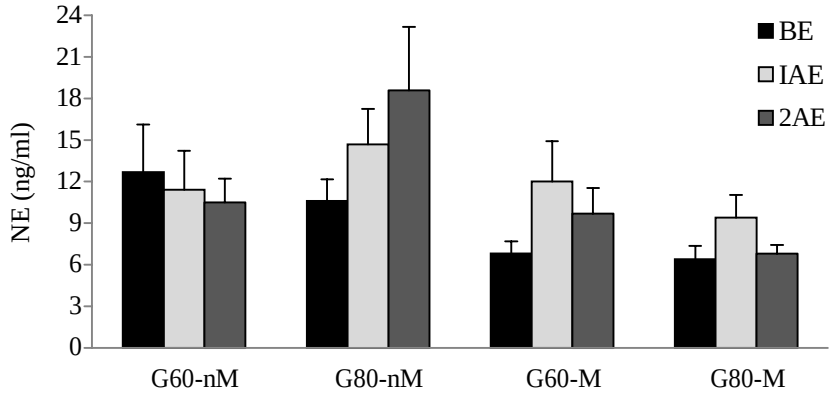
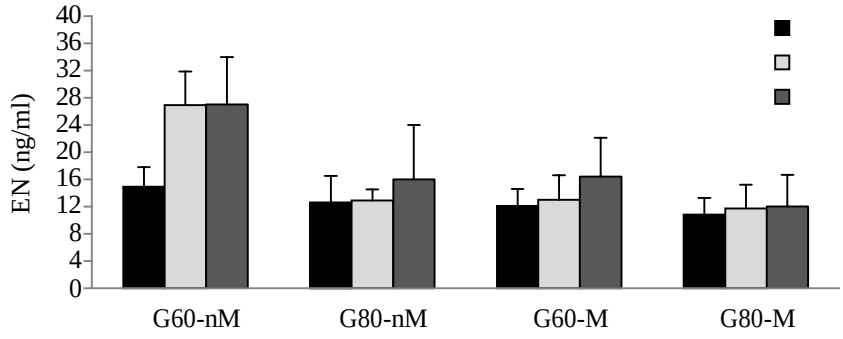
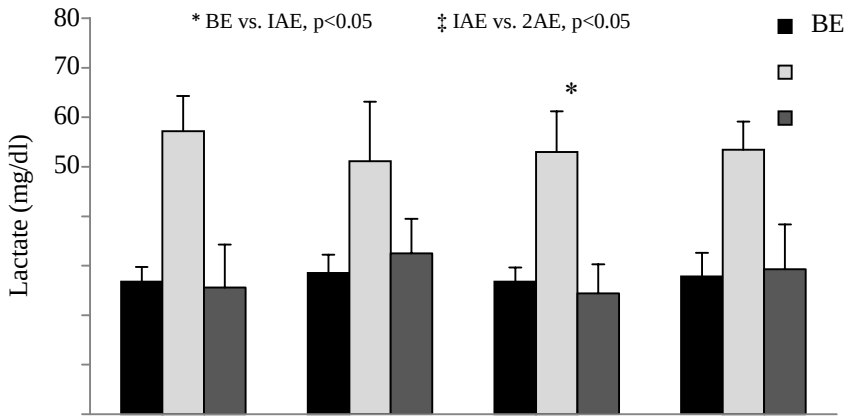


FIGURE 3. **NOREPINEPHRINE LEVELS (MEAN±SD) BEFORE (BE), IMMEDIATELY (IAE) AND 2 HOURS AFTER EXERCISE (2AE)**



BE IAE 2AE

FIGURE 4. **EPINEPHRINE LEVELS (MEAN±SD) BEFORE (BE), IMMEDIATELY (IAE) AND 2 HOURS AFTER EXERCISE (2AE)**



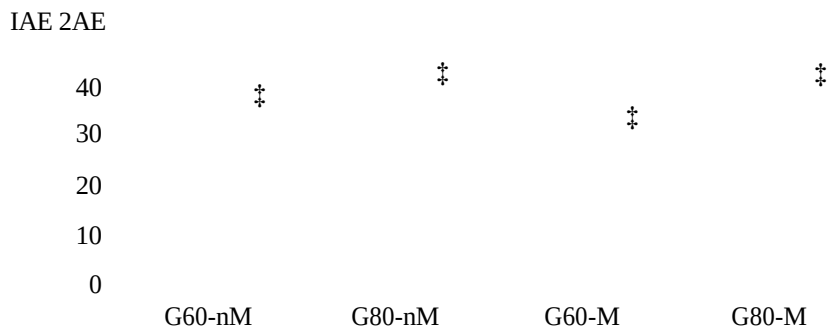


FIGURE 5. **BLOOD LACTATE LEVELS (MEAN±SD) BEFORE (BE), IMMEDIATELY (IAE) AND 2 HOURS AFTER EXERCISE (2AE)**

DISCUSSION

This is the first study that has investigated the effects of listening to motivational music on hormonal responses to a single bout of circuit resistance exercise (CRE) in young sportspersons. In all conditions, GH levels increased significantly from BE (before exercise) to IAE (immediately after exercise) and decreased significantly two hours later. In all conditions, changes of serum lactate were similar to the GH changes during the study. In the case of G60-M, serum cortisol concentration levels decreased significantly from BE to IAE

and from BE to 2AE (two hours after exercise). EN and NE levels did not change in any of the conditions.

Sadegi-Boroujerdi and Rahimi (2008) showed significant elevation of GH after a single bout of resistance exercise (5 sets of 10 RM bench press and squat). A similar response of GH was observed in another study (Bottaro *et al*., 2009). Rahimi *et al*. (2010a) reported a significant increase in GH levels after one session of resistance exercise at an intensity of 85% of 1RM. Hymer *et al*. (2001) reported meaningful elevation of GH after six sets of 10 repetitions with an intensity of 75% of 1RM. These findings indicate that resistance exercise with intensity above 60% of 1RM induces an elevation of GH. This increase in GH is metabolically potentially beneficial, because GH plays an important role in the stimulation of lipolysis, glycolysis, and glycogenolysis, as well as muscle hypertrophy (Guyton & Hall, 2006). According to the results of the present study, the GH response is higher in protocols that produce higher lactate levels, and thus are relying more on glycolysis (Kraemer *et al*., 2003). Hypoglycaemia, hypoxia, protein catabolism and acid-base shifts are other factors affecting GH levels (Kraemer & Ratamess, 2005).

Most research studies have been carried out on the effect of music on physiological and hormonal responses, more specifically, cortisol (Hymer *et al*., 2001; Kraemer *et al*., 2003; Ghaderi *et al*., 2009; Koelsch *et al*., 2011; Yamasaki *et al*., 2012). Cortisol is one of the important stress hormones secreted in response to physical and psychological stress (Ghaderi *et al*., 2009). The data of the present study indicated that, in the case of G60-M, serum cortisol concentrations were significantly lower from BE to IAE and from BE to

2AE compared to G80-M and no-music conditions (G60-nM and G80nM). These changes of serum cortisol concentrations were not significant when compared among all the conditions. In clinical situations, listening to music reduces cortisol concentrations before, during and after surgery (Koelsch *et al*., 2011; Yamasaki *et al*., 2012). Mottahedian-Tabrizi *et al*. (2012) studied the effect of listening to music on the cortisol concentrations and blood glucose levels in patients with spinal cord injuries. They reported that listening to music prevented the increase of cortisol in these patients after the surgery.

Ghaderi *et al*. (2009) examined the effect of motivational and relaxation types of music on the endurance performance, rating perceived exertion (RPE) and salivary cortisol concentration in male athletic students. Findings indicated that five minutes after exercise, RPE and salivary cortisol concentrations with relaxation music were significantly lower compared to listening to motivational music or no music during exercise. Jurcau and Jurcau (2012) investigated the effect of listening to music on cycle ergometer performance and salivary cortisol concentrations. The test exercise was performed at a pedalling rate of 60rpm, starting with a power of 30 watts for three minutes, followed by a gradual increase of power by 30 Watts every three minutes until exhaustion. The authors reported that in the non-trained subjects, listening to music decreased salivary cortisol concentrations after the exercise.

The results of the present study showed that increased physiological stress resulted from the mix of music listening, and lower exercise intensity probably reduced the production of cortisol by the adrenal gland and increased clearance of this hormone from the blood stream. However, more studies are needed to understand the mechanisms of this response.

Epinephrine and norepinephrine play a role in dealing with resistance training needs and are necessary for enhancing power, muscle contraction, accessing energy and several other functions including the increase of other hormones like testosterone (Kraemer & Ratamess, 2005). In the present study, listening to music produced non-significant changes in the levels of serum epinephrine and norepinephrine in all groups/conditions. Okada *et al*. (2009) suggested that music therapy in patients with cerebrovascular diseases reduce the risk of heart diseases by lowering epinephrine and norepinephrine.

In the present study and in all conditions, unlike norepinephrine, epinephrine no significant increases from pre-exercise to two hours post-exercise were found, which is a sign of the delayed effects of this hormone compared to norepinephrine during exercise and recovery stages. In general, one session of resistance training (no music) increase the levels of serum epinephrine and norepinephrine, which depend on the contractile force of muscle, the amount of contracted muscle, training volume and rest between sets (Bush *et al*., 1999). One of the mechanisms presented by research findings is the increase of GH concentrations, which reduces the need of epinephrine and norepinephrine secretion from adrenal cortex for stimulation of lipolysis, glycolysis and glycogenolysis (Koelsch *et al*., 2011). Moreover, before physical exercise, and more specifically intense efforts, the levels of epinephrine and norepinephrine increase quickly which are related to predictive/anticipative mechanisms to start the activity. This reaction is part of the psychological adjustment of the body for beginning a strenuous/stressful task (Kraemer & Ratamess, 2005). It is concluded from this study that epinephrine and norepinephrine response to CRE are not influenced by listening to music.

In all the conditions, serum lactate levels was shown to be significantly higher when measured after exercise, compared to pre-exercise conditions and lactate levels also decreased significantly two hours post-exercise compared to IAE levels. A significant difference was observed between conditions of G60-nM and G60-M and G80-nM and G80-M from BE to IAE and from IAE to 2AE. These changes were proportional to GH changes in the present study and supported the theory that one of the mechanisms of the increase of GH during exercises is the increase of H^+ due to the production of lactic acid (Hoffman, *et al*., 2003). In sportspersons, motivational music listening significantly increased the training volume and consequent lactate concentrations, while RPE was significantly lower during the first 15 minutes of recovery (Eliakim *et al*., 2012), which were similar to the findings of the present study (Ghavam-Bakhtiar *et al*., 2012). Sadegi-Borujerdi and Rahimi (2008) also reported an increase in lactate and GH levels after one session of resistance training in men. In another research study, lactate and GH levels significantly increased after resistance training at an exercise intensity of 85% of 1RM (Rahimi *et al*., 2010a).

The findings of this research indicate that listening to music reduced lactate response to exercise and this response could be considered a metabolic advantage since the increase of lactic acid production and its conversion to lactate increases H^+ concentrations, which is a notable cause of exercise-related fatigue (Guyton & Hall, 2006). Lactate secretion into the blood can be a potent stimulator of GH secretion from the pituitary gland for muscle fibre regeneration and hypertrophy. Nevertheless, the decrease of lactate observed could also result from increased blood lactate clearance that cannot be ruled out, and the present study protocol does not allow for determining if the decreased lactate observed could result from less

production and/or higher clearance. In all cases, listening to music seems to have reduced the fatigue related signs, and that is in accordance with the findings of previous studies (Eliakim *et al*., 2012; Ghavam-Bakhtiar *et al*., 2012).

CONCLUSION

Despite the small size of the sample in this study, the statistical analysis showed significant results allowing for drawing preliminary conclusions with regard to the effects of listening to music on the hormonal responses to resistance training. In conclusion, listening to motivational music during CRE of moderate and high intensities, had no effect on the growth hormone, epinephrine and norepinephrine, but decreased the response of cortisol and lactate. Less secretion of cortisol by the adrenal glands and high clearance of this hormone from the blood may lead to less glucose degradation during glycolysis, resulting in less lactate production. The latter could be one of the underlying mechanisms of fatigue reduction related to listening to music during exercise. However, more studies are needed to comprehend clearly the exact mechanisms around hormonal responses to music listening during exercise. In the meantime, listening to rhythmic music when performing resistance-training exercises can be recommended.

REFERENCES

BOTTARO, M.; MARTINS, B.; GENTIL, P. & WAGNER, D. (2009). Effects of rest duration

between sets of resistance training on acute hormonal responses in trained women. *Journal of Science and Medicine in Sport*, 12(1): 73-78.

BROWNLEY, K.A.; MURRAY, R.G. & HACKNEY, A.C. (1995). Effect of music on physiological and affective responses to graded treadmill exercise in trained and untrained runners. *International Journal of Psychophysiology*, 19(3): 193-201.

BRZYCKI, M. (1993). Strength testing: Predicting a one-rep max from repetitions to fatigue. *Journal of Physical Education, Recreation and Dance*, 64(1): 88-90.

BUSH, J.A.; KRAEMER, W.J.; MASTRO, A.M.; TRIPLETT-MCBRIDE, N.T.; VOLEK, J.S.; PUTUKIAN, M.; SEBASTIANELLI, W.J. & KNUTTGEN, H.G. (1999). Exercise and recovery responses of adrenal medullary neurohormones to heavy resistance exercise. *Medicine and Science in Sports and Exercise*, 31(4): 554-559.

CHTOUROU, H. (2013). Benefits of music on health and athletic performance. In Peti Simon & Tamas Szabo (Eds.), *Music: Social impacts, health benefits and perspectives* (pp.245-260). New York, NY: Nova Publishers.

CHTOUROU, H.; CHAOUACHI, A.; HAMMOUDA, O.; CHAMARI, K. & SOUISSI, N. (2012a). Listening to music affects diurnal variation in muscle power output. *International Journal of Sports Medicine*, 33(1): 43-47.

CHTOUROU, H.; HAMMOUDA, O.; ALOUI, A.; CHAABOUNI, K.; MAKNI-AYEDI, F.; WAHL, M.; CHAOUACHI, A.; CHAMARI, K. & SOUISSI, N. (2014). The effect of time of day on hormonal responses to resistance exercise. *Biological Rhythm Research*, 45(2): 247-256.

CHTOUROU, H.; JARRAYA, M.; ALOUI, A.; HAMMOUDA, O. & SOUISSI, N. (2012b). The effects of music during warm-up on anaerobic performances of young sprinters. *Science and Sports*, 27(6): 85-88.

CHTOUROU, H. & SOUISSI, N. (2012). The effect of training at a specific time-of-day: A review. *Journal of Strength and Condition Research*, 26(7): 1984-2005.

COSTA, R.R.; LIMA-ALBERTON, C.; TAGLIARI, M. & MARTINS-KRUEL, L.F. (2011). Effects of resistance training on the lipid profile in obese women. *Journal of Sports Medicine and Physical Fitness*, 51(1): 169-77.

ELIAKIM, M.; BODNER, E.; ELIAKIM, A.; NEMET, D. & MECKEL, Y. (2012). Effect of motivational music on lactate levels during recovery from intense exercise. *Journal of Strength and Condition Research*, 26(1): 80-86.

GHADERI, M.; RAHIMI, R. & AZARBAYJANI, M.A. (2009). The effect of motivational and relaxation music on aerobic performance, rating of perceived exertion and salivary cortisol in male athletes. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 31(2): 29-38.

GHAVAM-BAKHTIAR, R.; NIKBAKHT, H.; ZIAEE, N. & MOHAMMADI, M. (2012). The effect of relaxing music on changes in blood lactate level during recovery following a maximal exercise session in young female athletes. *International Journal of Sports Medicine*, 2(9): 432-435.

GUYTON, A.C. & HALL, J.E. (2006). *Textbook of medical physiology* (11th ed.). Philadelphia, PA: Saunders Elsevier.

HOFFMAN, J.R.; IM, J.; RUNDELL, K.W.; KANG, J.; NIOKA, S.; SPEIRING, B.A.; KIME, R. & CHANCE, B. (2003). Effect of muscle oxygenation during resistance exercise on anabolic hormone response. *Medicine and Science in Sports and Exercise*, 35(11): 1929-1934.

HYMER, W.C.; KRAEMER, W.J.; NINDL, B.C.; MARX, J.O.; BENSON, D.E.; WELSCH, J.R.; MAZZETTI, S.A.; VOLLEK, J.S. & DEAVER, D.R. (2001). Characteristics of circulating growth hormone in women after acute heavy resistance exercise. *American Journal of Physiology, Endocrinology and Metabolism*, 281(4): 878-887.

JARRAYA, M.; CHTOUROU, H.; ALOUI, A.; HAMMOUDA, O.; CHAMARI, K.; CHAOUACHI, A. & SOUISSI, N. (2012). The effects of music on high-intensity short-term exercise in well trained athletes. *Asian Journal of Sports Medicine*, 3(4): 233-238.

JURCAU, R. & JURCAU, I. (2012). Influence of music therapy on anxiety and salivary cortisol, in stress induced by short-term intense physical exercise. *Palestrica of the third millennium – Civilization and Sport*, 13(4): 321-325.

KARAGEORGHIS, C.I.; MOUZOURIDES, D.A.; PRIEST, D.L.; SASSO, T.A.; MORRISH, D.J. & WALKING, C.L. (2009). Psychophysical and ergogenic effects of synchronous music during treadmill. *Journal of Sport and Exercise Psychology*, 31(1): 18-36.

KARAGEORGHIS, C.I.; PRIEST, D.L.; TERRY, P.C.; CHATZISARANTI, N.L.D. & LANE, A.M. (2006). Redesign and initial validation of an instrument to assess the motivational qualities of music in exercise: The Brunel Music Rating Inventory-2. *Journal of Sport Science*, 24(8): 899-909.

KOELSCH, S.; FUERMETZ, J.; SACK, U.; BAUER, K.; HOHENADEL, M.; WIEGEL, M.; KAISERS, U.X. & HEINKE, W. (2011). Effects of music listening on cortisol levels and propofol consumption during spinal anesthesia. *Frontiers in Psychology*, 58(2): 1-9.

KRAEMER, W.J. & RATAMESS, N.A. (2005). Hormonal responses and adaptations to resistance exercise and training. *Sports Medicine*, 35(4): 339-361.

KRAEMER, W.J.; VOLEK, J.S.; FRENCH, D.N.; RUBIN, M.R.; SHARMAN, M.J.; GOMEZ, A.L.; RATAMESS, N.A.; NEWTON, R.U.; JEMIOLO, B.; CRAIG, B.W. & HAKKINEN, K. (2003).
The effects of L-carnitine L-tartrate supplementation on hormonal responses to resistance exercise and recovery. *Journal of Strength and Condition Research*, 17(3): 455-462.

MOTTAHEDIAN-TABRIZI, E.; SAHRAEI, H.; MOVAHHEDI-RAD, S.; HAJIZADEH, E. & LAK, M. (2012). The effects of music on the level of cortisol, blood glucose and physiological variables in patients undergoing spinal anesthesia. *EXCLI Journal (Experimental and Clinical Sciences International Journal)*, 11(1): 556-565.

OKADA, K.; KURITA, A.; TAKASE, B.; OTSUKA, T.; KODANI, E.; KUSAMA, Y.; ATARASHI, H. & MIZUNO, K. (2009). Effects of music therapy on autonomic nervous system activity, incidence of heart failure events, and plasma cytokine and catecholamine levels in elderly patients with cerebrovascular disease and dementia. *International Heart Journal*, 50(1): 95-110.

RAHIMI, R.; GHADERI, M. & FARAJI, H. (2010a). Effects of very short rest periods on hormonal responses to resistance exercise in men. *Journal of Strength and Conditioning Research*, 24(7): 1851-1859.

RAHIMI, R.; GHADERI, M.; MIRZAEI, B.; GHAENI, S.; FARAJI, H. & SHEIKHOLESLAMI, D. (2010b). Effects of very short rest periods on immunoglobulin A and cortisol responses to resistance exercise in men. *Journal of Human Sport Exercise*, 5(2): 146-157.

SADEGI-BOROUJERDI, S. & RAHIMI, R. (2008). Acute GH and IGF-I responses to short vs. long rest period between sets during forced repetitions resistance training system. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 30(2): 31-38.

YAMASAKI, A.; BOOKER, A.; KAPUR, V.; TILT, A.; NIESS, H.; LILLEMOE, K.D.; WARSHAW, A.L. & CONRAD, C. (2012). The impact of music on metabolism. *Nutrition*, 28(11): 1075-1080.

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EFFECT OF FUNCTIONAL REHABILITATION EXERCISE ON CHRONIC ANKLE INSTABILITY IN ELITE ATHLETES

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ABSTRACT

A functional evaluation (FE) of the effect of a 6-week functional rehabilitation (FR) in elite athletes with chronic ankle instability (CAI) was conducted. Forty-seven athletes (26 male, 21 female) were recruited who trained at Taereung National Training Centre, Seoul in various sport and who had been diagnosed with CAI by means of a medical examination, radiography, ultrasonography, computerised tomography and magnetic resonance imaging. FR consisting of a 4-

week neuromuscular training protocol and 6-week dynamic neuromuscular training protocol and was performed 3 to 5 times per week. FE included the Cumberland ankle instability tool (CAIT), stability (static and dynamic), gait (single limb support time; %SLST), isokinetic ankle strength, and kinematic rear foot inversion (RFI) as measured at baseline and at weeks 2, 4, and 6. Descriptive statistics and one-way ANOVA was applied to identify differences across measurement times. CAIT score increased significantly ($p<0.001$). Both overall stability index (static stability) and test completion time (dynamic stability) decreased significantly ($p<0.001$). Peak torque/body weight (PT/BW) of dorsiflexion and eversion with eccentric contraction at 60°/s, as well as 120°/s increased significantly ($p<0.001$). The gait analysis (%SLST) increased significantly ($p<0.001$), while the RFI angle decreased significantly ($p<0.001$) during fast walking and running. The 6-week FR was effective.

Key words: Ankle sprain; Elite athletes; Chronic ankle instability; Functional rehabilitation; Functional evaluation.

INTRODUCTION

The ankle is the most frequently injured body part in elite sportspersons, accounting for 40% of injuries in sport including basketball, soccer and track and field (Chan *et al*., 2011). Lateral ankle ligament sprain accounts for 85% of ankle injuries (Frigg *et al*., 2007) and is a major cause of dysfunction, pain, oedema, muscle weakness and instability (Williams *et al*., 2007). Only 8% of sportspersons, who experience ankle ligament sprain, fully recover with conservative management (Chan *et al*., 2011), and 70 to 80% of them proceed to chronic ankle instability (CAI), from re-injury due to muscle weakness, postural control deficits and limited range of motion. These sportspersons also suffer from residual symptoms for 6 to 18 months (Coughlan & Caulfield, 2007; Erik *et al*., 2007; Webster & Gribble, 2010).

In recent years, rehabilitation protocols for injury have focused on functional movement and closed kinetic chain rather than static and open kinetic chain exercise (Webster & Gribble, 2010). Functional rehabilitation (FR) should be carried out to prevent CAI by repetitive ankle re-injury. Coughlan and Caulfield (2007) also stressed that FR should focus on dynamic and closed kinetic chain exercise to prevent re-injury and promote a return to field activity. This type of FR has been reported to better alleviate pain and oedema, as well as reduce the reoccurrence of injury compared to surgery and cast-wearing (Tropp *et al*., 1985; Wester *et al*., 1996; Michael & Thomas, 2003; Scott, 2007).

Previous studies have reported that ankle function, including postural control, improved when FR was performed three to five times/week for four to six weeks (Coughlan & Caulfield, 2007). Measurements of the effect of FR should include functional evaluation (FE) through dynamic tests of weight bearing, such as walking, running or competitive sport (Willems *et al.*, 2005; Coughlan & Caulfield, 2007).

To measure the effect of rehabilitation exercise on CAI, past studies assessed isokinetic strength using open kinetic chain, low velocity exercise without considering weight bearing or muscle contractile type, and evaluated static balance and inversion stress (Coughlan & Caulfield, 2007). Recently, Mckeon *et al*. (2009) evaluated the effect of FR consisting of

four weeks of balance training by examining shank rotation and RFA during walking and running. O'Driscoll and Delahunt (2011) assessed six weeks of neuromuscular training using the Cumberland ankle instability tool (CAIT), star excursion balance test, ankle joint angle at jump and landing, and ground reaction forces. However, studies that quantify the effectiveness of FR in elite sportspersons are still lacking.

PURPOSE OF THE STUDY

Few studies have been conducted to evaluate the dynamic movement at initial contact (IC) and single limb support time (%SLST) of the rear foot, which causes instability and dysfunction in sport and walking. Thus, this study aimed to assess the effect of 6 weeks of FR in elite sportspersons with CAI by means of FE.

METHODOLOGY

Participants

The participants (N=47) consisted of 26 elite sportsmen and 21 elite sportswomen who were diagnosed with CAI and suffered from chronic ankle pain (Table 1). These sportspersons trained at Taereung National Training Centre, Seoul, Korea (national sports village).

Diagnosis was based on medical examination, radiography, ultrasonography, computerised tomography and magnetic resonance imaging. These sportspersons competed in 7 sports (judo, fencing, hockey, handball, gymnastics, weight lifting and badminton). All participants signed a written informed consent form to participate in the study. Participants who had undergone ankle joint surgery within a 1-year period prior to the study were excluded. FE was conducted before FR (baseline, n=47), 2 weeks after (n=45), 4 weeks after (n=42) and 6 weeks after (n=37) FR.

TABLE 1. **CHARACTERISTICS OF FUNCTIONAL REHABILITATION GROUP**

Gender	n	Age (years)	Height (cm)	Weight (kg)	BMI
Male	26	25.7±3.5	175.2±8.5	77.1±18.0	24.9±4.2
Female	21	24.3±3.8	165.9±5.6	61.3± 8.4	22.3±2.8
Total	47	25.0±3.6	171.0±8.7	70.0±16.4	23.7±3.8

Values: mean±standard deviation

Functional rehabilitation programme

The 6-week FR programme for elite sportspersons with CAI was performed 3 to 5 times per week and this frequency was decided on in accordance with O'Driscoll and Delahunt (2011), who indicated the use of a chronic ankle intervention programme at 3 to 5 times per week. Also, this programme included the 4-week neuromuscular training protocol described by Coughlan and Caulfield (2007), and a 6-week dynamic neuromuscular training protocol

described by O'Driscoll and Delahunt (2011), which was based on the rehabilitation exercise protocol of Mattacola and Dwyer (2002) (Table 2).

Range of motion (ROM) without ankle pain was performed for 6 weeks with a graded load of frequency and repetition using Achilles tendon stretching and alphabet exercise. *Static balance*, an exercise for static postural stability, was performed for 6 weeks with a graded load of frequency and repetition using single leg squats and ball catching in a single leg squat posture. *Dynamic balance*, an exercise for dynamic postural stability, was performed for 6 weeks with a graded load of frequency and repetition using anterior and lateral single-leg lunges on a balance pad and box.

Strength training was performed for 6 weeks with a graded load of frequency and repetition as well as intensity, according to band colour using single leg heel raises, single leg bridge and dorsiflexion and eversion of the ankle with an elastic band. *Plyometric exercise* was performed for 6 weeks with a graded load of frequency and repetition, as well as level of difficulty of the equipment by jumping on the spot and hurdle jump. *Speed and agility* exercises were performed for 6 weeks with a graded load of frequency and repetition using forward and lateral running on a ladder.

Functional evaluation

Cumberland Ankle Instability Tool (CAIT)

The Cumberland Ankle Instability Tool, which evaluates the instability of the ankle joint, was used by translating the instrument described in the study by Hiller *et al*. (2006) into Korean. Cronbach's α for the translated CAIT to determine internal consistency was 0.85, indicating high reliability. The CAIT score consists of nine items assessed by 41 questions: pain, activity, turning, stairs, one leg, hopping, uneven ground, rolling and response to rolling. The CAIT scores range from 0 to 30 points and lower scores are associated with greater instability of the ankle joint (Hiller *et al*., 2006).

TABLE 2. **FUNCTIONAL REHABILITATION PROGRAMME**

Variables	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6

Range of motion (ROM)	(Pf) *Achilles tendon stretch* 30sX3reps *Alphabet Ex.* 3reps	(Pf) *Achilles tendon stretch* 30sX3reps *Alphabet Ex.* 3reps	(Pf) *Achilles tendon stretch* 30sX5reps *Alphabet Ex.* 5reps	(Pf) *Achilles tendon stretch* 30sX5reps *Alphabet Ex.* 5reps	(Pf) *Achilles tendon stretch* 30sX7reps *Alphabet Ex.* 7reps	(Pf) *Achilles tendon stretch* 30sX3reps *Alphabet Ex.* 7reps
Static postural stability	*Single-leg squats* (Airex ® cushion) 3 min.	*Single-leg squats* (Tilt board) 3 min.	*Single-leg squats* (Bosu ® ball) 3 min.	*Single-leg squats* (Bosu ball) rebounding catches 5 min.	*Anterior jump* land from Reebok ® step 10sX10r X3 sets Stabilisation	*Lateral jump* land from Reebok step 10sX10r X3 sets Stabilisation
Dynamic postural stability	*Double-leg squats* (Bosu) 10rX2 sets *Single leg lunges* forward (Togu ® cushion) 10rX2 sets	*Double-leg compressions* (Bosu) 10rX2 sets *Single leg lunges* side-to-side (Kybun ®) 10rX2 sets	*Double-leg box jumps* (Reebok step) 10rX2 sets *Lunge* from Reebok step onto Bosu 10rX2 sets	*Single leg step-up/-down* (Reebok step) 10rX2 sets *Lunges* side-to-side from Reebok step onto Bosu 10rX2 sets	*Single leg hops* (Bosu) 10rX2 sets Increase distance of jump onto Bosu	*Lateral Single leg hops* (Bosu) 10rX2 sets Increase distance of jump onto Bosu
Strength	*Double leg heel raises* 12rX3 sets *Double leg bridge* 10rX2 sets *Clam-shell* (for GM, each side) 10rX2 sets *Thera-band ® Ex.* (dorsiflexion, eversion) 10rX2 sets (green)	*Double leg heel raises* 12rX3 sets *Double leg bridge* 10rX2 sets *Clam-shell* (for GM, each side) 10rX2 sets *Thera-band Ex.* (dorsiflexion, eversion) 10rX2 sets (green)	*Single leg heel raises* 10rX2 sets (each side) *Single leg bridge* 12rX3 sets (each side) *Figure-4* (for GM) 10rX2 sets *Thera-band Ex.* (dorsiflexion, eversion) 12rX3 sets (blue)	*Single leg heel raises* 10rX2 sets (each side) *Single leg bridge* 12rX3 sets (each side) *Figure-4* (for GM) 10rX2 sets *Thera-band Ex.* (dorsiflexion, eversion) 12rX3 sets (blue)	*Single leg heel raises* (weight 15kg) 12rX3 sets (each side) *Double leg squats* 12rX3 sets *Resisted lateral side-steps* 12rX3 sets (each side) *Thera-band Ex.* (dorsiflexion, eversion) 12rX3 sets (black)	*Single leg heel raises* (weight 20kg) 12rX3 sets (each side) *Single leg squats* 10rX3 sets *Resisted lateral side-steps* 12rX3 sets (each side) *Thera-band Ex.* (dorsiflexion, eversion) 12rX3 sets (black)
Plyometrics	*Tuck jumps* 10r (Kybun cushion)	*Broad jumps* 10rX2 sets (Kybun cushion)	*180º Tuck jumps* 15rX3 sets (each direction)	*90º Hop turns* Clockwise & anticlockwise 10r	*Double leg lateral Jumps* (mini hurdle) 10rX3 sets	*Single leg lateral Jumps* (mini hurdle) 10rX3 sets
Speed-agility	*Figure-8 runs* (10m each direction) 5r	*Forward run* (ladder) 10r	*Lateral run* (ladder) 10r (each way)	*Lateral hop* (ladder) 10r (each way)	*Hopping slalom drill* (ladder) 10r	*Lateral shuttle runs* (10m) 10rX2 sets

Pf= Pain free Bosu= Both sides up balance trainer GM= Gluteus medius

Past instruments for FE of CAI include the Functional Ankle Instability Questionnaire (FAIQ) and the Ankle Joint Functional Assessment Tool (AJFAT) (Hiller *et al*., 2006). In the FAIQ, 9 of 11 items consist of a 2-point scale, which lacks sensitivity, and although 12

items on the AJFAT use a 5-point scale, the AJFAT is designed to compare the affected and non-affected ankle, and thus is useful only for unilateral ankle injury, not bilateral injury or instability (Hiller *et al*., 2006). By contrast, the CAIT consists of 9 items that evaluate functional movement, as well as pain in the affected ankle and sums the various scores to evaluate ankle joint instability. Therefore, the CAIT is a very useful instrument to evaluate the severity level of ankle joint instability (Hiller *et al*., 2006). Additionally, the CAIT demonstrated a high correlation (r=0.84) with the visual analogue scale (VAS), which has been widely used to identify changes to subjective pain in previous studies (Hiller *et al*., 2006). Cronbach's α, which represents internal consistency, was 0.85, which guarantees reliability of the instrument, since Numally and Bernstein (1994) reported that a value more than 0.60 is satisfactory.

A CAIT score of 0 to 21 points is considered to reflect severe instability, 21.5 to 24 moderate instability, 24.5 to 27 mild instability, and 27.5 to 30 to be normal (Hiller *et al.*, 2006). In this study, the mean CAIT scores at baseline and 2 weeks were 14.39±2.62 and 18.03±3.93 respectively, which indicated moderate instability, but they improved to 21.60±4.00 at 4 weeks and 25.51±2.36 at 6 weeks, indicating mild instability. Since rehabilitation exercise as an intervention for CAI has been reported to require 6 to 8 weeks (Coughlan & Caulfield, 2007; Slimmon & Brukner, 2010), analysis of the CAIT score at 8 weeks would be of interest in future studies.

Stability (static and dynamic)

Balance was measured using the Biodex Balance System (Biodex Medical Systems Inc., Shirley, USA). *Static balance*, to determine the overall stability index (OSI), was measured in 3 stages of single-leg standing on a moving platform for 20s, with an intraclass correlation coefficient of r=0.60 (Cachupe *et al*., 2001). Participants had no prior practice and individual foot position was measured and applied identically to reduce error due to foot position and posture (Julia *et al*., 2007). A higher OSI score indicates lower balance ability because of the greater shifts required to maintain postural balance during measurement. The inability to maintain a quiet stance during single-leg standing has consistently been shown to be associated with ankle instability (Hertel *et al*., 2006).

Dynamic balance was used to examine test completion time (TCT) in 8 stages, completing 9 tasks using a single leg on a moving platform. Each stage lasted for 3 continuous seconds (Perron *et al*., 2007). Higher TCT scores were associated with lower dynamic balance ability, as they indicate more time to complete a stage. Participants had no prior practice, and individual foot position was measured and applied identically to reduce error due to foot position and posture (Julia *et al*., 2007).

Gait analysis (% SLST)

Gait analysis was conducted using a gait analysis system (GAITRite; CIR Systems Inc., Peekskill, USA), which measures the proportion of single limb support time (%SLST) over the total gait cycle. SLST below the normal range (38 to 40%), indicates abnormal gait time (Mckeon *et al*., 2009). Participants had no prior practice and measurement was conducted in triplicate and the median of 3 measurements was recorded (Van Uden & Besser, 2004). To

reduce error in measurement time, the gait began 2m behind the measurement mat on the

leg with CAI and participants were then asked to walk 2m beyond the measurement mat (length: 366 cm, width: 61 cm) (Kim *et al.*, 2010). Gait speed was restricted from 1.25 to 1.35m/s using a speedometer (Seed Tech Inc., Incheon, Korea), to maintain a regular speed.

Isokinetic ankle measurements

Peak torque/body weight (PT/BW) of dorsiflexor, evertor for eccentric contraction at 60°/s and 120°/s was measured to identify isokinetic strength of the ankle using an isokinetic strength measurement system (Biodex System III; Biodex Medical Systems Inc., Shirley, USA). PT/BW of dorsiflexor for eccentric contraction in the ankle was determined from 5 repetitive measurements at 60°/s and 120°/s after three prior practise motions and description of the measurement procedure.

At knee flexion of 10° and neutral position of the talocrural joint, a range of 40° from 20° of dorsiflexion to 20° of plantar flexion was measured (Costantino *et al*., 2006; Fox *et al*., 2008). The PT/BW of evertor for eccentric contraction in the ankle was determined from five repetitive measurements at 60°/s and 120°/s after 3 prior practices and a description of the measurement procedure (Willems *et al*., 2002; Costantino *et al*., 2006; Fox *et al*., 2008). With a neutral position (0°) of the subtalar joint and 10° to 15° of plantar flexion in the talocrural joint (Sekir *et al*., 2008), a range of 40° from eversion of 15° to inversion of 25° was measured (Kaminski *et al*., 2003).

Kinematic measures of rear foot inversion (RFI)

Infrared cameras (N=12) (Eagle Motion Analysis, Santa Rosa, USA), capturing 120 frames per second, were used to analyse the motion of the participant. Participants were asked to perform fast walking (1.9m/s) and running (2.7m/s), and the mean rear foot angle (RFA) was calculated during 10% of the cycle from heel strike to toe take-off (Figure 1).

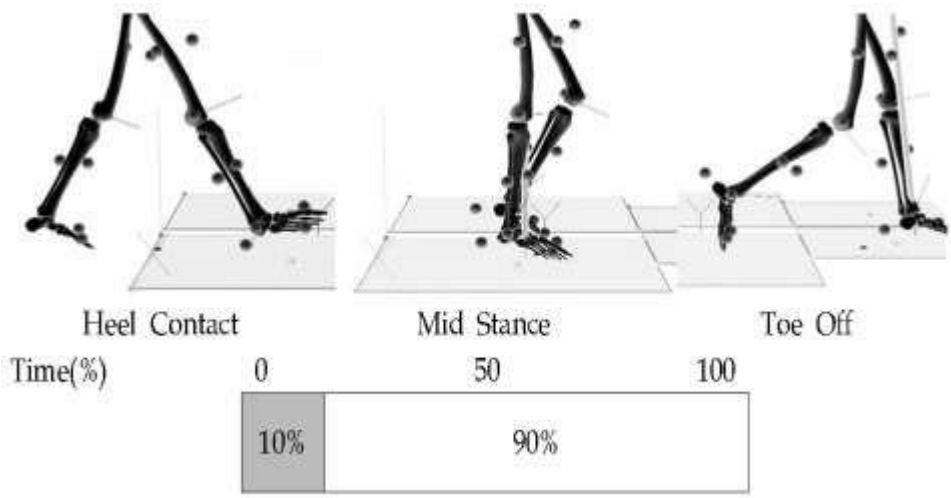

FIGURE 1. **INITIAL CONTACT (IC) PERIOD**

Markers (N=30), separated by 12.7mm, were attached to the lower limb using the 2001 Oxford Foot Model (Carson *et al*., 2001). Cut-off frequency was set at 6Hz using a

Butterworth fourth-order low pass filter method. RFA was defined as the angle between the vector component from the heel to the second metatarsal bone and the z-axis.

Statistical analysis

To evaluate the effect of 6 weeks of FR exercise, CAIT, stability (static and dynamic), gait analysis (%SLST), isokinetic strength of the ankle and kinematic analysis of RFI were measured at baseline and after 2, 4 and 6 weeks of FR. All data from functional tests were expressed as descriptive statistics, and data from 4 time measurements were analysed by one- way ANOVA using SPSS for Windows ver. 19.0 (IBM, Armonk, NY, USA). Post-hoc tests were conducted to examine the significance of differences between time points. All thresholds for statistical significance were set at $p<0.05$.

RESULTS

The result of FE at baseline and following 2, 4 and 6 weeks of FR exercise for elite sportspersons with chronic ankle joint instability is shown in Table 3.

CAIT score significantly increased following the 6-week intervention ($p<0.001$, $F=261.911$), and all differences between other times points were also significant. OSI significantly decreased after the 6-week intervention ($p<0.001$, $F=19.643$), and all differences between other times points were also significant.

TCT significantly decreased ($p<0.001$, $F=31.119$), reflecting improved dynamic stability. Significant differences between all other time points were also observed.

In measurements of isokinetic ankle strength following the 6-week intervention, PT/BW of dorsiflexor with eccentric contraction at 60°/s, as well as at 120°/s significantly increased (both $p<0.001$, $F=153.394$ and $F=49.144$ respectively), and all differences between other times points were also significant. PT/BW of eversion with eccentric contraction at 60°/s, as well as at 120°/s significantly increased (both $p<0.001$, $F=201.428$ and $F=90.731$ respectively), and all differences between other times points were also significant.

In gait analysis %SLST, following the 6-week intervention significantly increased ($p<0.001$, $F=31.362$), and all differences between other times points were also significant.

In motion analysis of RFI following 6-week intervention, the RFI angle during fast walking significantly decreased ($p<0.001$, $F=19.098$) and all differences between other times points were also significant.

The angle of RFI during running also significantly decreased ($p<0.001$, $F=14.773$), however, although the difference between baseline and 2 weeks was significant, no significant difference was observed between 2 and 4 weeks or between 4 and 6 weeks.

TABLE 3. **EFFECTS OF FUNCTIONAL REHABILITATION ON MEASURES**

Measures	Baseline[a]	2 week[b]	4 week[c]	6 week[d]	F	p	Post-hoc

CAIT (score)	14.4±2.6	18.0±3.9	21.6±4.0	25.5±2.4	261.911	<0.001	d>c c>b b>a
OSI (index)	5.6±2.7	4.0±1.7	3.6±1.5	3.3±1.2	19.643	<0.001	a>b b>c c>d
TCT (s)	165.8±43.6	134.5 ± 30.2	126.1±28.8	118.9±23.9	31.119	<0.001	a>b b>c c>d
IK 60° DF (ecc, N/kg)	31.9±8.7	40.7±11.8	54.7±13.5	66.9±10.2	153.394	<0.001	d>c c>b b>a
IK 120° DF (ecc, N/kg)	26.1±6.4	30.2±9.0	43.9±12.2	54.1±12.9	49.144	<0.001	d>c c>b b>a
IK 60° EV (ecc, N/kg)	30.5 ± 5.7	40.3±6.7	55.7±7.1	67.3±7.8	201.428	<0.001	d>c c>b b>a
IK 120° EV (ecc, N/kg)	25.2±5.2	32.8±7.4	45.3±9.5	55.2±9.9	90.731	<0.001	d>c c>b b>a
GC (%SLST)	34.0±3.0	36.2±2.8	38.1±1.5	38.6±1.9	31.362	<0.001	d>c c>b b>a
FW (RFI, °)	9.7±2.9	8.5±2.7	7.7±2.6	6.9±1.8	19.098	<0.001	a>b b>c c>d
RN (RFI, °)	7.3±2.1	6.5±2.1	6.2±1.8	5.8±1.5	14.773	<0.001	a>b

CAIT: Cumberland Ankle Instability Tool OSI: Overall Stability Index TCT: Test Completion Time IK: Isokinetic DF: Dorsiflexor EV: Evertor Ecc: Eccentric GC: Gait Cycle RN: Running FW: Fast Walking SLST: Single Limb Support Time RFI: Rear Foot Inversion

DISCUSSION

After musculoskeletal injury, evaluating the lack of postural stability and providing rehabilitation are essential (Mattacola & Dwyer, 2002). The Biodex Balance System has been used to evaluate quantitatively the ability to maintain stability and control balance after ligament injury (Kim *et al*., 2010). Rozzi *et al*. (1999) reported that the Biodex Balance System is reliable for the evaluation of postural stability. Other studies (Kim *et al*., 2010) have also supported the reliability of the Biodex Balance System.

The Biodex Balance System uses a circular platform with simultaneous movement of the anterior-posterior and medial-lateral axes, allowing the evaluation of multidirectional stability

at various levels of resistance (Arnold & Schmitz, 1998). The OSI simultaneously evaluates

the medial-lateral stability index and anterior-posterior stability index, as it very sensitively responds to bi-directional change. Therefore, this index is ideal for assessing static stability (Arnold & Schmitz, 1998). One prior study reported that OSI for the dominant and non-dominant lower limb demonstrated high reliability. In this study, OSI at baseline was 5.59±2.73 and it gradually decreased to 3.99±1.70, 3.59±1.49 and 3.30±1.17 at 2, 4 and 6 weeks respectively.

In a study by Kim *et al.* (2010) comparing underwater exercise and terrestrial exercise in elite sportspersons with acute injury to the ankle or knee ligament, the terrestrial exercise group demonstrated OSI values of 5.70±1.05 at baseline (third stage), 4.05±0.54 at 2 weeks, and 3.26±0.41 at 4 weeks of exercise, which is a greater reduction than that observed in the present study. This difference is assumed to reflect the fact that the participants of the present study were elite sportspersons with CAI involving multiple factors, such as nerve (proprioception, reflex, muscle reaction time), muscle (strength, power, endurance), and mechanics (extension of ligament) (Konradsen *et al*., 1998), whereas the participants of the previous study were elite sportspersons with first- and second-stage acute ligament injury to the ankle or knee. It would be of interest to observe the change in OSI in sportspersons with acute ligament injury upon completion of the FR programme suggested in this study and compare those findings with the results of the present study.

Many studies of stability evaluate static stability. However, assessment of static stability alone is difficult to apply to activities that require dynamic stability; therefore, static stability measurement does not reflect the aims of rehabilitation (Cachupe *et al*., 2001). Use of the Biodex Balance System in Dynamic Limit of Stability mode to evaluate dynamic stability does not coincide with all daily motion and sport activities, but it does include angular perturbation of the ankle joint, which frequently occurs in sport events, such as landing on another player's foot after jumping (Cachupe *et al*., 2001). Thus, this method is more applicable for use in sportspersons (Kim *et al*., 2010).

Dynamic Limit of Stability mode evaluates TCT (in seconds), of nine stages that require balance control with one leg on a moving platform. In the present study, initial TCT was 165.84±43.63s, and it gradually decreased to 134.51±30.18s, 126.06±28.81s, and 118.90±23.85s at 2, 4 and 6 weeks, respectively. In the study by Kim *et al*. (2010) comparing underwater and terrestrial exercise in elite sportspersons with acute ligament injury to the ankle or knee, initial TCT was 178.69±15.12s and decreased to 166.36±11.80s and 150.92±9.33s at 2 and 4 weeks respectively. Thus, a greater reduction in TCT was observed in the present study. After acute ankle injury, postural control is impaired from the first day up to 2 weeks, and it begins to recover for the subsequent 4 weeks (Hertel *et al*., 2001). But chronic instability of the ankle joint derives from complex factors including nerve, muscle, and mechanics (Konradsen *et al*., 1998), and rehabilitation exercise interventions from 6 to 8 weeks have generally been reported (Coughlan & Caulfield, 2007; Slimmon & Brukner, 2010). Therefore, TCT would be assumed to be higher in the present study than in the previous study by Kim *et al*. (2010), but the participation of elite sportspersons appears to be reflected in the lower TCT results observed.

Davies and Manske (1999) reported the importance of isokinetic exercise and stressed that

evaluation of isokinetic performance in rehabilitation programmes is more important than

simple muscle functions, such as strength. Peak torque acquired from an isokinetic dynamometer is regarded as the most important index for strength (Kannus, 1994), and has been used to identify impaired muscle performance (Basyches *et al*., 2009).

To prevent ankle joint sprain from sudden inversion, evertors should be contracted eccentrically to respond to the moment of initial inversion and disrupt inversion motion (Ashton-Miller *et al*., 1996). Loss of concentric eversion strength was not observed in a previous study that investigated eversion strength in participants with ankle joint instability using an isokinetic dynamometer, but loss of eccentric strength was detected (Munn *et al*., 2003). Therefore, measurement of eccentric strength is more appropriate than concentric strength in ankle joint instability (Munn *et al*., 2003). Additionally, dynamic stability of the ankle joint can be achieved by the coordinated effort of all muscles around the ankle joint (Kaminski & Hartsell, 2002). Thus, evaluation of other muscles around the ankle joint should be performed (Fox *et al*., 2008). For this reason, the strength of the evertors, as well as the dorsiflexors was measured, and PT/BW of eccentric contraction in the dorsiflexor and evertor at 60°/s and 120°/s was significantly increased over time. This improvement is assumed to reduce the risk of re-injury of the ankle joint by restricting sudden inversion.

Gait analysis is a useful method to measure mobility status objectively and a particularly effective instrument to assess prognosis in patients with lower limb injury (Gardner *et al*., 2007). Normal progression of gait recovery after lower limb injury was not determined, but it is widely used to evaluate the effect of therapy (Kroll *et al*., 1989). This study used the GAITRite system for gait analysis. Many studies have reported that this system has high inter-rater reliability (Bilney *et al*., 2003; Van Uden & Besser, 2004; Webster *et al*., 2005), as well as high test-retest reliability (Kim *et al*., 2010).

Symmetrical walking between the impaired and normal lower limbs reflects successful recovery (Kim *et al.*, 2010). Therefore, the present study assessed single-limb support time. The increase in the proportion of single-limb support time indicates that the normal gait pattern has recovered (Kim *et al*., 2010). In the present study, the initial proportion of single limb support time was 33.99±2.99 and it significantly increased to 36.19±2.77, 38.10±1.45, and 38.56±1.85 after 2, 4, and 6 weeks respectively, indicating that the gait of elite sportspersons with ankle joint instability recovered to a normal gait pattern.

Biomechanical abnormalities of the ankle joint reflected in the gait are a major reason for inversion sprain (Willems *et al*., 2005). Previous studies have reported that increased inversion upon initial terrestrial contact of the foot to the terrestrial surface causes ankle joint sprain (Robbins *et al*., 1995; Wright *et al*., 2000). Thus, the precise position of the foot upon initial contact with the terrestrial surface during walking and sport activities is very important (Willems *et al*., 2005).

Many models have been proposed to analyse the kinematics of the foot in detail, but the Oxford Foot Model has good repeatability (Curtis *et al*., 2009). The RFA during fast walking was significantly reduced from 9.72±2.85 at baseline to 6.94±1.81 at 6 weeks, indicating that the risk of re-injury was reduced in elite sportspersons with CAI, as the angle of inversion of the foot was reduced upon the initial touching of the rear foot to the terrestrial surface. The

initial angle of the rear foot during running was 7.27±2.12 and it gradually decreased to 6.54±2.08, 6.16±1.81 and 5.79±1.50 at 2, 4 and 6 weeks respectively. However, a significant reduction was observed only from baseline to 2 weeks in the post-hoc analysis. This result is assumed to derive from the fact that running involves a shorter duration of the rear foot touching the terrestrial surface compared to walking.

The participants of this study were national sportspersons. For this specific group, an approach that can result in fast recovery from lowered function due to injury, as well as prevention of re-injury is essential. Furthermore, the fact that previous studies did not apply a FR programme of proven effectiveness for ankle joint instability to a control group in a clinical research setting, infringes on participant's rights in terms of research ethnics. Therefore, this study was composed of a single group. However, the application of FE to elite sportspersons who did not experience CAI may be valuable to establish standard ranges for FE that can help guide the decision to return to a sport after injury.

A major limitation of this study is the exclusion of a control group. This exclusion detracts from the scientific nature of the research and places doubt on whether the achieved improvements in the ankle joint functional ability can be directly attributed to the exercise programme intervention alone.

CONCLUSION

The functional rehabilitation (FR) that was applied to elite sportspersons with chronic ankle instability (CAI) for six weeks appears to be effective based on functional evaluation (FE) using Cumberland ankle instability tool (CAIT), stability, gait analysis, isokinetic strength, and motion analysis measures.

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REFERENCES

ARNOLD, B.L. & SCHMITZ, R.J. (1998). Examination of balance measures produced by the Biodex stability system. *Journal of Athletic Training*, 33(4): 323-327.

ASHTON-MILLER, J.; OTTAVIANI, R.; HUTCHINSON, C. & WOJTYS, E. (1996). What best protects the inverted weight-bearing ankle against further inversion? *American Journal of Sports Medicine*, 24(6): 800-809.

BASYCHES, M.; WOLOSKER, N.; RITTI-DIAS, R.M.; CAMARA, L.C.; PUECH-LEAO, P. & BATTISTELLA, L.R. (2009). Eccentric strength and endurance in patients with unilateral intermittent claudication. *Clinics*, 64(4): 319-322.

BILNEY, B.; MORRIS, M. & WEBSTER, K. (2003). Concurrent related validity of the GAITRite walkway system for quantification of the spatial and temporal parameters of gait. *Gait and Posture*, 17(1): 68-74.

CACHUPE, W.J.C.; SHIFFLETT, B.; KAHANOV, L. & WUGHALTER, E.H. (2001). Reliability of Biodex Balance System measures. *Measurement in Physical Education and Exercise Science*, 5(2): 97-108.

(2001). Kinematic analysis of a multi-segment foot model for research and clinical applications: A repeatability analysis. *Journal of Biomechanics*, 34(10): 1299-1307.

CHAN, K.W.; DING, B.C. & MROCZEK, K.J. (2011). Acute and chronic lateral ankle instability in the athlete. *Bulletin of the NYU Hospital for Joint Diseases*, 69(1): 17-26.

COSTANTINO, C.; POGLIACOMI, F. & SONCINI, G. (2006). Effect of the vibration board on the strength of ankle dorsal and plantar flexor muscles. *Acta Biomedica*, 77(1): 10-16.

COUGHLAN, G. & CAULFIELD, B. (2007). A 4-week neuromuscular training program and gait patterns at the ankle joint. *Journal of Athletic Training*, 42(1): 51-59.

CURTIS, D.J.; BENCKE, J.; STEBBINS, J.A. & STANSFIELD, B. (2009). Intra-rater repeatability of the Oxford foot model in healthy children in different stages of the foot roll over process during gait. *Gait and Posture*, 30(1): 118-121.

DAVIES, G.J. & MANSKE, R.C. (1999). The importance of evaluating muscular power (torque acceleration energy) in patients with shoulder dysfunctions. *Physical Therapy*, 79: S81.

ERIK, A.; MARK, D.; TERESE, L. & JAMES, H. (2007). Dynamic postural stability deficits in subjects with self-reported ankle instability. *Medicine and Science in Sports and Exercise*, 39(3): 397-402.

FOX, J.; DOCHERTY, C.L.; SCHRADER, J. & APPLEGATE, T. (2008). Eccentric plantar-flexor torque deficits in participants with functional ankle instability. *Journal of Athletic Training*, 43(1): 51-54.

FRIGG, A.; MAGERKURTH, O.; VALDERRABANO, V.; LEDERMANN, H-P. & HINTERMANN, B. (2007). The effect of osseous ankle configuration on chronic ankle instability. *British Journal of Sports Medicine*, 41(7): 420-424.

GARDNER, M.J.; BARKER, J.U.; BRIGGS, S.M.; BACKUS, S.I.; HELFET, D.L.; LANE, J.M. & LORICH, D.G. (2007). An evaluation of accuracy and repeatability of a novel gait analysis device. *Archives of Orthopaedic and Trauma Surgery*, 127(3): 223-227.

HERTEL, J.; BRAHAM, R.A.; HALE, S.A. & OLMSTED-KRAMER, L.C. (2006). Simplifying the Star Excursion Balance Test: Analyses of subjects with and without chronic ankle instability. *Journal of Orthopaedic & Sports Physical Therapy*, 36(12): 131-138.

HERTEL, J.; BUCKLEY, W.E. & DENEGAR, C.R. (2001). Serial testing of postural control after acute lateral ankle sprain. *Journal of Athletic Training*, 36(4): 363-368.

HILLER, C.E.; REFSHAUGE, K.M.; BUNDY, A.C.; HERBERT, R.D. & KILBREATH, S.L. (2006). The Cumberland Ankle Instability Tool: A report of validity and reliability testing. *Archives of Physical Medicine and Rehabilitation*, 87(9): 1235-1241.

JULIA, G.; ANGELICA, A.; ANA, C. & GILBERTO, L. (2007). Correlation between body mass index and postural balance. *Clinics*, 62(6): 717-720.

KAMINSKI, T.W.; BUCKLEY, B.D.; POWERS, M.E.; HUBBARD, T.J. & ORTIZ, C. (2003). Effect of strength and proprioception training on eversion to inversion strength ratios in subjects with unilateral functional ankle instability. *British Journal of Sports Medicine*, 37(4): 410-415.

KAMINSKI, T.W. & HARTSELL, H.D. (2002). Factors contributing to chronic ankle instability: A strength perspective. *Journal of Athletic Training*, 37(4): 394-405.

KANNUS, P. (1994). Isokinetic evaluation of muscular performance: Implications for muscle testing and rehabilitation. *International Journal of Sports Medicine*, 15 (Supplement 1): S11-18.

KIM, E.K.; KIM, T.G.; KANG, H.Y.; LEE, J.H. & CHILDERS, M.K. (2010). Aquatic versus land-based exercises as early functional rehabilitation for elite athletes with acute lower extremity ligament injury: A pilot study. *American Academy of Physical Medicine and Rehabilitation*, 2(8): 703-712.

KONRADSEN, L.; OLESEN, S. & HANSEN, H.M. (1998). Ankle sensorimotor control and eversion

strength after acute ankle inversion injuries. *American Journal of Sports Medicine*, 26(1): 72-77.

KROLL, M.A.; OTIS, J.C.; SCULCO, T.P.; LEE, A.C.; PAGET, S.A.; BRUCKENSTEIN, R. & JENSEN, D.A. (1989). The relationship of stride characteristics to pain before and after total knee arthroplasty. *Clinical Orthopaedics and Related Research*, 239: 191-195, February.

MATTACOLA, C.G. & DWYER, M.K. (2002). Rehabilitation of the ankle after acute sprain or chronic instability. *Journal of Athletic Training*, 37(4): 413-429.

MCKEON, P.O.; PAOLINI, G.; INGERSOLL, C.D.; KERRIGAN, D.C.; SALIBA, E.N.; BENNETT, B.C. & HERTEL, J. (2009). Effects of balance training on gait parameters in patients with chronic ankle instability: A randomized controlled trial. *Clinical Rehabilitation*, 23(7): 609-621.

MICHAEL, D. & THOMAS, D. (2003). Prevention and treatment of ankle sprain in athletes. *Sports Medicine*, 33(15): 1145-1150.

MUNN, J.; BEARD, D.J.; REFSHAUGE, K.M. & LEE, R.Y.W. (2003). Eccentric muscle strength in functional ankle instability. *Medicine and Science in Sports and Exercise*, 35(2): 245-250.

NUMALLY, J.C. & BERNSTEIN, I.H. (1994). *Psychometric theory* (3rd ed.). New York, NY: McGraw- Hill.

O'DRISCOLL, J. & DELAHUNT, E. (2011). Neuromuscular training to enhance sensorimotor and functional deficits in subjects with chronic ankle instability: A systematic review and best evidence synthesis. *Sports Medicine Arthroscopy, Rehabilitation, Therapy and Technology*, 3: 19, September.

PERRON, M.; HÉBERT, L.J.; MCFADYEN, B.J.; BELZILE, S. & REGNIÉRE, M. (2007). The ability of the Biodex Stability System to distinguish level of function in subjects with a second-degree ankle sprain. *Clinical Rehabilitation*, 21(1): 73-81.

ROBBINS, S.; WAKED, E. & RAPPEL, R. (1995). Ankle taping improves proprioception before and after exercise in young men. *British Journal of Sports Medicine*, 29(4): 242-247.

ROZZI, S.L.; LEPHART, S.M.; STERNER, R. & KULIGOWSKI L. (1999). Balance training for persons with functionally unstable ankles. *Journal of Orthopaedic and Sports Physical Therapy*, 29 (8): 478-486.

SCOTT, E.R. (2007). Noise-enhanced postural stability in subjects with functional ankle instability. *British Journal of Sports Medicine*, 41(10): 656-659.

SEKIR, U.; YILDIZ, Y.; HAZNECI, B.; ORS, F.; SAKA, T. & AYDIN, T. (2008). Reliability of a functional test battery evaluating functionality, proprioception, and strength in recreational athletes with functional ankle instability. *European Journal of Physical and Rehabilitation Medicine*, 44(4): 407-415.

SLIMMON, D. & BRUKNER, P. (2010). Sports ankle injuries: Assessment and management. *Australian Family Physician*, 39(1): 18-22.

TROPP, H.; ASKLING, C. & GILLQUIST, J. (1985). Prevention of ankle sprains. *American Journal of Sports Medicine*, 13: 259-262.

VAN UDEN, C.J.U. & BESSER, M.P.B. (2004). Test-retest reliability of temporal and gait characteristics measured with an instrumented walkway system (GAITRite). *BMC (BioMed Central) Musculoskeletal Disorders*, 5: 13.

WEBSTER, K.A. & GRIBBLE, P.A. (2010). Functional rehabilitation interventions for chronic ankle instability: A systemic review. *Journal of Sport Rehabilitation*, 19: 98-114.

WEBSTER, K.E.; WITTWER, J.E. & FELLER, J.A. (2005). Validity of the GAITRite walkway system for the measurement of averaged and individual step parameters of gait. *Gait and Posture*, 22(4): 317-321.

WESTER, J.U.; JESPERSEN, S.M.; NIELSEN, K.D. & NEUMANN, L. (1996). Wobble board training after partial sprains of the lateral ligament of the ankle: A prospective randomized study.

Journal of Orthopaedic and Sports Physical Therapy, 23(5): 332-336.

WILLIAMS, G.N.; JONES, M.H. & AMENDOLA, A. (2007). Syndesmotic ankle sprains in athletes. *American Journal of Sports Medicine*, 35(7): 1197-1207.

WILLEMS, T.; WITVROUW, E.; DELBAERE, K.; DE COCK, A. & DE CLERCQ, D. (2005). Relationship between gait biomechanics and inversion sprains: A prospective study of risk factors. *Gait & Posture*, 21(4): 379-387.

WILLEMS, T.; WITVROUW, E.; VERSTUYFT, J. & CLERCQ, D.D. (2002). Proprioception and muscle strength in subjects with a history of ankle sprains and chronic instability. *Journal of Athletic Training*, 37(4): 487-493.

WRIGHT, I.C.; NEPTUNE, R.R.; VAN DEN BOGERT, A.J. & NIGG, B.M. (2000). The influence of foot positioning on ankle sprains. *Journal of Biomechanics*, 33(5): 513-519.

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DIFFERENT VENUES, DIFFERENT MARKETS, DIFFERENT EXPERIENCES: EVIDENCE FROM LIVE MUSIC PERFORMANCES IN SOUTH AFRICA

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ABSTRACT

The purpose of this research was to determine whether visitors who attend the same live music performance at four different destinations/locations vary and whether their needs were the same for a memorable visitor experience. Two-way frequency tables and Chi-square tests, as well as ANOVA and Tukey's multiple comparisons were used to investigate any significant differences between the four locations of the shows. The results indicate significant statistical differences between the various locations based on visitor profile, economic impact and what factors visitors regarded as important for a memorable visitor experience. Determining these differences not only equips major music event managers with the improved knowledge to develop and manage future concerts at various destinations (cities) and locations (venues), but this research also helps management to ensure the creation of a memorable visitor experience.

Key words: Neil Diamond concert; Critical success factors; Location; Destination; Event management; Memorable visitor experience.

INTRODUCTION

Hosting major music events has become a significant motivator of tourism and features highly in the development and marketing plans in the majority of destinations (Getz, 2008). South Africa is no exception. The event management sector in South Africa has shown a market expansion since 1994 (Tassiopoulos, 2000). This resulted in a growth in demand for music events in South Africa, as the popularity of international pop, rock and jazz artists, among others, has escalated (Manners, 2012). The sight of international artists performing in South Africa is, however, still a fairly new phenomenon and individuals are willing to pay and travel various distances to see international artists perform live and enjoy the unique experience with relatives and friends.

According to Uysel *et al*. (1993) and Brown *et al*. (2002), there are many reasons to host major music events. These events have the potential to generate a positive image of a destination and they can minimise negative impacts, contribute to sustainable development and foster better host-guest relations. Consequently, it is clear that even single events have the potential of making a significant impact on the host communities where the events are held (Gibson & Connell, 2005). One of the most anticipated live music concerts held in South Africa was that of Neil Diamond. Neil Diamond performed for the first time in South Africa during April 2011 when he headlined four shows at the new stadiums built for the 2010 FIFA

Soccer World Cup. His tour began at the FNB Stadium (Johannesburg), then went to Moses Mabhida Stadium (Durban). This was followed by a performance at Nelson Mandela Bay Stadium (Port Elizabeth) and ended at Green Point Stadium (Cape Town) (Big Concerts, 2010). This was the first live major music event in South Africa to be held at the newly built stadiums in the four different locations.

Considering the music industry, it is evident that this is an enormous industry (Pidgeon, 1991), and according to Silvers (2012), managing an event, such as a live music performance, is an intense and difficult task that requires common sense, imagination and experience. According to Packer *et al*. (2008), the focus of event organisers often remains on the setting of the location and on the management of the factors, also referred to as critical success factors, rather than catering to the needs of the visitors attending the event and giving them a memorable experience. With the four Neil Diamond performances in mind, two aspects are therefore important to consider, namely visitors‟ evaluation of the experience at the concerts and the location where the concerts are held.

With regard to the first aspect, experience has always been an important aspect of the entertainment industry (Pine & Gilmore, 1998). According to Andereck *et al*. (2006), the experience of visitors at an event, such as a live music performance, is affected by the setting and by the expectations created by the visitor. Therefore, when referring to a memorable visitor experience, it can be defined as the apprehension of the „wow factor‟ at an event, which is worth remembering once the event is over (Manners *et al*., 2013). Getz (2007) states that events have the ability to attract paying visitors, who will expect delivery of the guaranteed product or experience at a high standard and who are eligible to complain if individuals do not get the perceived money‟s worth. Apart from this, when individuals attend concerts/events, their expectation is to be entertained and to have fun with like-minded fans in a dynamic social setting (Getz, 2007). However, it is important to keep in mind that different visitors will expect, want and/or need different things from essentially similar offerings (Yeoman *et al*., 2004). Therefore, visitors to events cannot be regarded as identical in terms of what they view as important factors for a memorable experience.

Regarding the second aspect, Reisinger (2009) explains that the various geographic areas are furthermore characterised by different climates, economies, politics, religious affiliations and customs and, therefore, offer distinct lifestyles, values and cultures. Reisinger (2009) and Walker and Walker (2011), add that the location/area has an effect on the price and that major geographic variables can also affect the buying behaviour of the visitors. These aspects influence the target market and need to be considered when organising events at different locations. In addition, for locations to have a potential tourism impact, Saayman and Slabbert (2002) and Van der Wagen (2005) mention that it is important for a destination to know where the visitors to an event originate from.

According to Getz (2007) and Berridge (2007), the expectations, moods and attitudes of visitors will always be innovative and, therefore, the experiences of visitors will fluctuate, regardless of the line-up and setting. According to Saayman (2007), the variety or attractiveness of national artists only has an effect within a small radius, usually within the town/area surrounding the event venue. However, the impact of renowned international artists, such as Neil Diamond, would be much larger and could extend to neighbouring towns

and regions, which suggests that more visitors will be prepared to travel further to attend the event. Therefore, it is important to determine the various profiles of visitors to each Neil Diamond concert, as well as to determine what the visitors at each location regard as important for the critical success factors making it a memorable visitor experience.

PURPOSE OF THE STUDY

The purpose of this research was to determine whether the visitors, who attend the same live music performance (that of Neil Diamond), at four different destinations/locations, vary and whether their needs are the same for a memorable visitor experience.

LITERATURE REVIEW

Page and Connell (2009:642) define event management as "the practical aspects of preparing for and staging an event". According to Tassiopoulos (2000:40), "event management is designed to manage or control event resources on a given activity, within time, cost and performance requirements". Therefore, event management is used to signify the production of an event (Singh, 2009). According to Allen *et al*. (2005), event management is made up of numerous management areas, which include planning, leading, marketing, designing, budgeting and control, risk management, logistics, staging and evaluation. However, judging by the definition, event management is a complex phenomenon and the complexity of managing live music events is clear.

Kruger and Saayman (2012:183) define a major music event or live music performance, such as the Neil Diamond concerts, as

> A performance event comprising one live performance (or an additional live performance, usually in the form a supporting artist of band) of a specific music genre (such as rock, pop and classical, to name but a few), usually over a few hours (3-5 hours) on one day in a specific venue/city that attracts over 20 000 attendees, which is packaged as a coherent whole.

There are, therefore, various significant aspects that event managers need to take into account when staging an event.

Music events create visitor expectations regarding the experience those visitors will have in the event. These expectations should also be managed. Expectations are often influenced by two key aspects, namely (1) the performing band/performer/artist and (2) management aspects regarding the organisation of the event. These aspects are also referred to as critical success factors. Silvers (2004), Bowdin *et al*. (2006) and Matthews (2008), all indicate that management aspects include entertainment, technical aspects, food and beverages, marketing, stalls, entrance, visitors, transport, information, layout, accommodation, financial services, parking, community, staff, emergency and medical services, children, safety and security, ticket sales, directions, infrastructure, and the venues themselves to name the most obvious factors.

Certain management aspects can be controlled, as different individuals in the organisation team are held responsible for certain aspects of the event. As such, it is clear that these aspects can be, and are directly controlled by management. These key aspects form part of the fundamental experience by visitors of their expectations and influences their perception of the general success of the event.

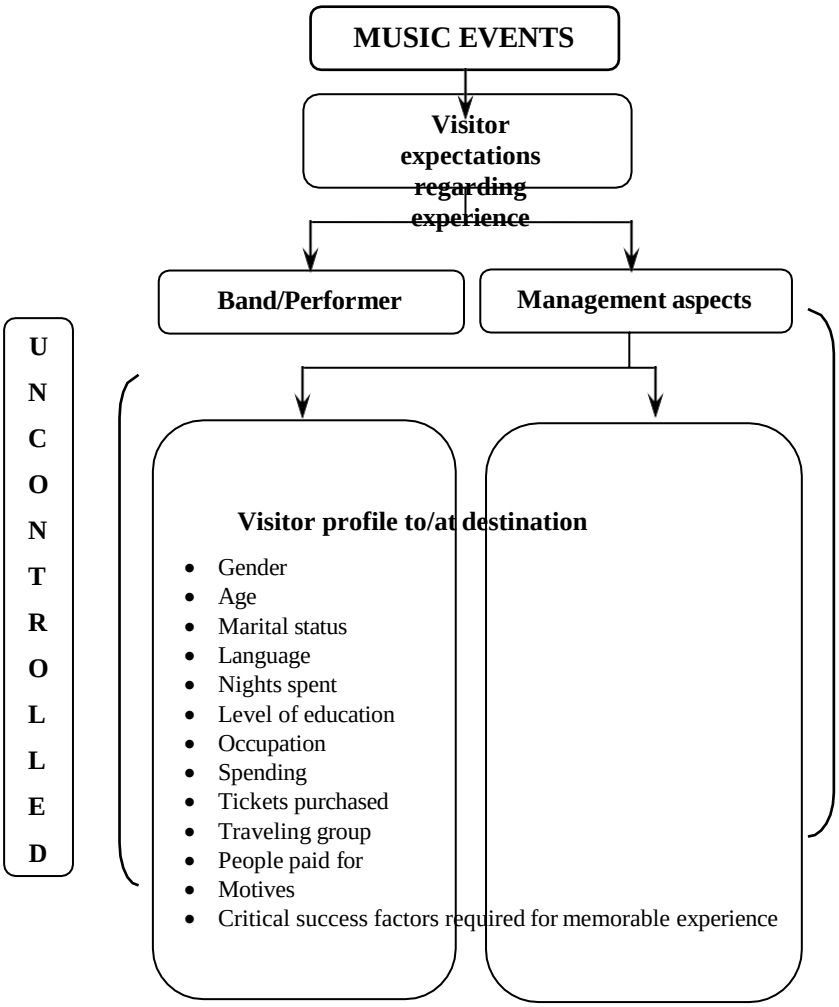
According to Packer *et al*. (2008), the focus of event organisers often remains on the setting of the location and on the management of the critical success factors, rather than catering to the needs of the visitors attending the event. However, in the case of major music events, the setting of the location along with knowledge regarding the needs of the visitors play a significant role in the overall experience of visitors (Walker & Walker, 2011). Page and Connell (2009) indicate that there is a distinct difference between a destination and location. They offer the definition that a destination is the combination of different tourism components (that is, attractions, accommodation, transport, resources and infrastructure), in a geographical location, promoted by a tourism organisation, whereas they believe that location is the site or specific place at which a business or, in this case, an event takes place.

In the case of the present study, the various cities where the Neil Diamond concerts were held are referred to as the destination and the stadiums at the various destinations are referred to as the location of the event. The location chosen for an event should offer the potential to deliver specific production and technical needs within budgetary expectations (Booth, 2010). Therefore, the location of an event (global, local and venue choices), places the event within the public context. Events take into account the site that is chosen to meet the event requirements, including the purpose, stakeholders and event design elements. However, the choice of venue is often a compromise between organisational needs and that of attracting an audience (Booth, 2010). Nevertheless, within a geographic location, there may be a variety of factors that influence visitors‟ experiences at each venue, as indicated in Figure 1.

Figure 1 illustrates that certain management aspects concerning the location/venue are under the direct control of the event management. These aspects include adequate parking, information boards, practical layout of the venue, emergency and medical facilities and services, safety and security aspects, adequate seating on the stands, vendors to supply snacks and refreshments to visitors, ATM facilities, sufficient and clean ablution facilities, sound and lighting, accessibility and an effective/practical stage plan, to name but a few. In addition to influencing certain managerial aspects (critical success factors), the location also influences the profile and needs of the visitors attending the event. For event managers, it is essential to meet the needs of the visitor and, therefore, it is vital to understand what the visitor wants to achieve from the anticipated experience (Van der Wagen, 2005).

Event visitors are attracted to particular events that offer something in addition to the fundamental services provided and to the universal benefits derived from all events (Tassiopoulos, 2000), something that makes the event different and unique. According to Minor *et al*. (2004), the physical setting (in this case, the location), represents the milieu for the musical performance and the interaction connecting the musicians and the audience with one another. Therefore, it is evident that location may have an influence, not only on the economic impact and travel behaviour of visitors, but also on what visitors consider as important for a memorable experience. Van der Wagen (2005) believes that it is, therefore,

important to research and understand the characteristics of different client populations at different locations.



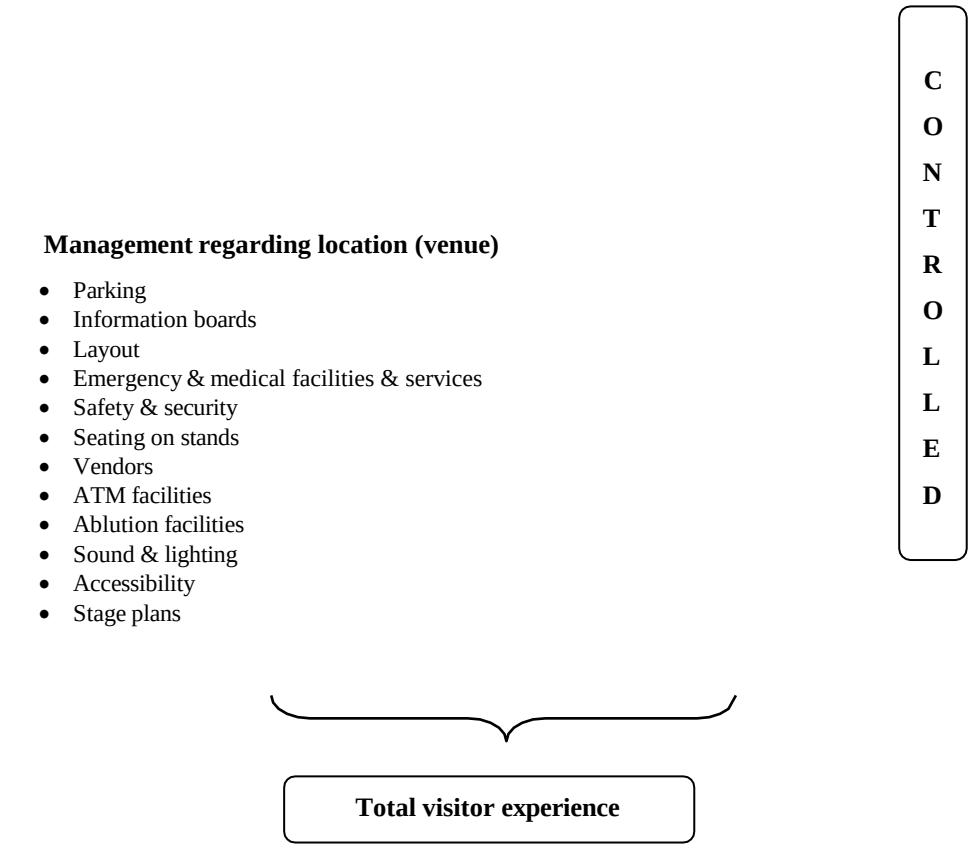


FIGURE 1. **VISITOR EXPECTATIONS BASED ON LITERATURE REVIEW**

The place where the event occurs has an influence on visitors profile and behaviour, which has been determined by various authors within the tourism literature. However, only limited research has focused on this aspect specifically at events. Saayman and Saayman (2006)

conducted a study on the influence of location on the magnitude of the economic impacts of arts festivals in South Africa. They found firstly, that the location of an arts festival determines the origin of visitors to the festival; secondly, that visitors from different provinces spend different amounts and influence the magnitude of the economic impact in the festival area; thirdly, the better the infrastructure and suprastructure of the location, the easier it is to host events; and finally, that the location is just one of a number of aspects that influence the magnitude of the economic impact.

Other studies relating to location have also focused mainly on its influence on visitors‟ spending patterns at various tourism operations, including arts festivals and nature-based destinations. However, the influence of location on spending is inconsistent. Kruger (2010) found that the province of origin had no influence on higher spending in South Africa. This contradicts the findings by Saayman *et al*. (2007b), Saayman and Saayman (2008), Kruger (2009), Saayman *et al*. (2009), as well as those of Slabbert *et al*. (2009), who all found that visitors who travel from Gauteng in South Africa spend more. Cannon and Ford (2002) established that spending patterns also relate to visitors‟ place of residence, as expenditure levels increase for international visitors. Saayman *et al*. (2007a), Saayman and Saayman (2008) and Kruger (2009), also found that the province of origin (location) plays a significant role in the spending of visitors at arts festivals and national parks in South

Africa. These results each indicated that visitors originating from more affluent provinces, particularly Gauteng and the Western Cape, tend to be higher spenders. Research by Long and Perdue (1990), Lee (2001) and Saayman *et al*. (2007a, b), showed that the distance travelled to visit tourist attractions affects expenditures positively.

In addition, Deighton (1992) states that the evaluation of live music performances is uncommon and research mainly focuses on issues such as tempo, rhythm, timbre or other variables more suitable for evaluating a particular piece than an entire performance. Consequently, minimal research has focused on music events, or specifically, on live music events. Therefore, research fails to address issues of one artist performing at different venues in one country, as well as the interactions between the consumers who attend a live music performance (Deighton, 1992). The only study found that focused on the critical success factors at an event was that of Lade and Jackson (2004). These authors determined the critical success factors of regional festivals in Australia and found that the creative and unique programme development each year, as well as appropriate response to the feedback from patrons, are considered important. No studies have previously focused on major music events in South Africa. The critical success factors determined for the management of the visitor experience in previous research conducted in South Africa largely focused on other types of tourism operations and festivals. These critical success factors that have been determined for other tourism operations in South Africa include those of a wine festival (Marais, 2009), a guesthouse (Van der Westhuizen, 2003), a conference centre (Kruger, 2006), wedding events (De Witt, 2006), an arts festival (Erasmus, 2011) and hotels (Appel, 2011). The results from these studies showed that each tourism operation requires different and unique critical success factors to be managed successfully.

The results from previous research concerning critical success factors and location collectively show that location has a significant influence on visitor behaviour, especially their spending patterns and that critical success factors differ from one tourism operation to

the next. In the case of Neil Diamond who presented four shows, each in one of the major metropolitan cities in South Africa, it can be assumed that the critical success factors (that is, the needs, wants, preferences and particularly what visitors consider as important for a satisfactory experience), will differ and that location will, therefore, influence the expectations of visitors, as well as their experiences. Determining these differences will not just enable management to develop and manage future concerts, but will also improve and enable superior management decisions at the various destinations (cities) and venues, specifically to satisfy the needs of the various visitors and thereby exceeding their expectations. This will ensure a memorable visitor experience and aid management in promoting future events more accurately to various target audiences and sponsorships. This knowledge will also contribute to improving the bid processes when an organisation wishes to host major music events in different locations.

METHODOLOGY

Sampling method and survey

Surveys were conducted at the Neil Diamond concerts in Johannesburg (1 April, 2011),

Durban (5 April, 2011), Port Elizabeth (8 April, 2011) and Cape Town (11 April, 2011). The various stadiums had been divided into blocks determined by the value of the different tickets purchased. For example, the seats on the field and close to the stage were more expensive than the seating further away. Each block had its own entrance. A stratified sampling method was, therefore, used where trained fieldworkers distributed questionnaires to a range of Neil Diamond concert visitors at each of the four occasions. To limit bias, a simple random sampling method was used within the stratified method where the trained fieldworkers followed specific guidelines as questionnaires were distributed to different, non- homogeneous age groups, gender groups and ticket holders.

Visitors at the various stadiums were also asked to complete questionnaires at the gates as they waited to enter the venue. Willing participants completed the questionnaire prior to the event as fieldworkers explained the purpose of the survey before any questionnaires were completed. The willing participants had to evaluate what they consider vital at the specific event in order to ensure a memorable visitor experience that is they rate their expectations regarding the aspects and not evaluate the items. Israel (2009) indicates that, in a population of 100 000 (N), 398 respondents (n) are seen as representative.

According to the event organisers, Big Concerts, approximately 52 000 visitors attended Neil Diamond at the FNB stadium (613 questionnaires were completed), 21 000 attended the Nelson Mandela Bay stadium in Port Elizabeth (443 questionnaires were completed) and 37 000 attended the Green Point stadium in Cape Town (522 questionnaires were completed). However, in the case of Durban, a total of 288 questionnaires were completed with 25 000 visitors attending the concert at the Moses Mabhida stadium. In this case, a sampling error of 7% was permitted due to adverse weather conditions that hindered the survey at the event. The total number of completed questionnaires at each show was, therefore, more than adequate. A total of 2 000 questionnaires were administered and 1 866 questionnaires were received back. This resulted in a 93% return rate. Of the 1 866 questionnaires received back, 1 820 completed questionnaires were included in the analysis.

Questionnaire

A structured questionnaire that was divided into 3 sections served as the instrument for collecting the data for this research. Section A determined the socio-demographic information of the respondents (gender, age, home language, marital status and province of residence). Section B determined the critical success factors for a memorable visitor experience at each destination, where the statements measured were based on questions used in the studies of Marais (2009) and Erasmus (2011). Various aspects relating to general management, human resource management, layout, parking, security, accessibility, ticket sales and food and beverages were adapted from the art-and-wine-festival‟s questionnaire to relate to a major music event. This resulted in the inclusion of 50 management aspects pertaining to the creation of a memorable visitor experience. A 5-point Likert scale of importance was used to measure a major music event, where 1 indicated not at all important, 3 neither important nor unimportant and 5 extremely important. Section C determined the visitors‟ behaviour and musical interests, where 22 questions concerning the reasons that visitors attended concerts, such as those of Neil Diamond, and were also evaluated on a 5-point Likert scale of importance.

Statistical analysis

Microsoft© Excel© was used for data capturing, while SPSS (SPSS Inc, 2010) was used for the analysis of data. The data from the 4 shows were pooled in order to compare the results. This study comprised 2 stages. Firstly, 2 principal axis factor analyses, using an Oblimin rotation with Kaiser normalisation, were performed on 22 motivation items and the 50 critical management factors for a memorable experience, to explain the variance-covariance structure of a set of variables through a few linear combinations of these variables.

The Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett‟s test of sphericity were used to determine whether the covariance matrix was suitable for factor analysis. Kaiser‟s criteria for the extraction of all factors with eigenvalues larger than one were used; these criteria were considered to explain a significant amount of variation in the data. In addition, all items with a factor loading above 0.3 were considered as contributing to a factor, whereas all items with factor loadings less than 0.3 were considered as not correlating significantly with this factor (Steyn, 2000). Any item that cross-loaded onto 2 factors with factor loadings greater than 0.3 was categorised in the factor where interpretability was best.

A reliability coefficient (Cronbach‟s alpha), was computed for each factor to estimate the internal consistency of each factor. All factors with a reliability coefficient above 0.6 were considered as acceptable in this study. The average inter-item correlations were computed as another measure of reliability. The average inter-item correlation should lie between 0.15 and
0.55 (Clark & Watson, 1995).

Secondly, the 4 locations where the Neil Diamond concerts were held were analysed based on the differences regarding the motives of visitors to attend the specific concert in that area and on the management aspects (critical success factors), visitors regard as important for a memorable visitor experience. An ANOVA and Tukey‟s multiple comparisons were used to investigate any significant differences between the 4 locations. The study employed demographic variables (gender, home language, age, occupation and province of origin),

behavioural variables (length of stay, expenditure per person, people paying for, amount of tickets purchased and size of the travelling group), as well as motivational factors (heard about the concert, type of music preferred and attend music festivals), to examine whether statistically significant differences existed between the locations.

RESULTS

Factor analysis: Travel motives of visitors to the Neil Diamond concerts

The pattern matrix of the principal axis factor analysis, using an Oblimin rotation with Kaiser normalisation, identified 4 motivational factors that were labelled according to similar characteristics (Table 1).

TABLE 1. **MOTIVATIONAL ASPECTS FOR VISITORS ATTENDING THE NEIL DIAMOND CONCERT**

Motivation factors and items	Factor loading	Mean value	Reliability coefficient	Ave.inter-item corr.
Factor 1: Excitement and group affiliation		3.81	0.83	0.49
To experience new things	0.68			
For a chance to be with people who are enjoying themselves	0.64			
To have fun	0.61			
To share the event with someone special	0.52			
It is an exciting thing to do	0.41			
Factor 2: Socialisation		2.78	0.81	0.41
To meet new people	0.88			
It is a social event	0.63			
Because I got tickets for free or as a present	0.57			
Out of curiosity	0.49			
To spend time with family and friends	0.47			
I try to attend as many of these music events as possible	0.41			
Factor 3: Artist affiliation & unique experience		4.36	0.82	0.39
It is a once-in-a-lifetime experience	0.84			
Neil Diamond is a well-known international artist	0.75			
I always wanted to see Neil Diamond perform live	0.75			
The concert is a unique experience	0.60			
To see my favourite artist	0.52			
To be part of this unique and exciting event	0.44			
The concert is value for money	0.32			
For nostalgic reasons/memories	0.32			
Factor 4: Entertainment		4.20	0.79	0.57
Because I enjoy these types of special events	0.80			
These concerts are entertainment at its best	0.66			
To enjoy the music	0.35			
Total variance explained	**59%**			

These factors accounted for 59% of the total variance. All factors had relatively high reliability coefficients, ranging from 0.79 (the lowest) to 0.83 (the highest). The average

inter-item correlation coefficients with values between 0.39 and 0.57 also imply internal consistency for all factors. Moreover, all items loaded onto a factor with a loading greater than 0.3, and the relatively high factor loadings indicate a reasonably high correlation between the factors and their component items. The Kaiser-Meyer-Olkin measure of sampling adequacy of 0.92 also indicates 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).

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. As Table 1 shows, the following travel motives for visitors attending the various Neil Diamond concerts were identified: *Excitement and group affiliation* (Factor 1), *Socialisation* (Factor

2), *Artist affiliation and unique experience* (Factor 3), and *Entertainment* (Factor 4). With a mean value of 4.36, *Artist affiliation and unique experience* was considered the most important motive to attend the Neil Diamond concerts, followed by *Entertainment* (4.20), *Excitement and group affiliation* (3.81) and *Socialisation* (2.78).

Factor analysis: Critical success factors for a memorable visitor experience

Regarding the critical success factors in creating a memorable visitor experience, the pattern matrix of the principal axis factor analysis using an Oblimin rotation with Kaiser normalisation identified 6 management factors (critical success factors). These factors accounted for 59% of the total variance. All factors had relatively high reliability coefficients, ranging from 0.84 (the lowest) to 0.94 (the highest).

The average inter-item correlation coefficient, with values between 0.35 and 0.84, implies internal consistency for all factors. Moreover, all items loaded onto a factor with a loading greater than 0.3 and the relatively high factor loadings indicate a reasonably high correlation between the factors and their component items. The Kaiser-Meyer-Olkin measures of sampling adequacy of 0.97 indicate that the patterns of the 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 following management factors for visitors attending the various Neil Diamond concerts were identified: *General management* (Factor 1); *Souvenirs* (Factor 2); *Marketing* (Factor 3); *Venue and technical aspects* (Factor 4); *Accessibility and parking* (Factor 5); and *Amenities and catering* (Factor 6). *General management (4.44)* was considered the most important management factor to enhance the visitor experience at the Neil Diamond concerts, followed by *Venue and technical aspects* (4.43), *Marketing* (4.36), *Accessibility and parking* (4.30), as well as *Amenities and catering* (3.94). *Souvenirs* (3.27) obtained the lowest mean value and was regarded as a less important critical success factor (Table 2).

TABLE 2. **FACTOR ANALYSIS OF CRITICAL SUCCESS FACTORS TO MANAGE VISITOR EXPERIENCE AT A MAJOR MUSIC EVENT**

CSFs and items	Factor loading	Mean value	Reliability coefficient	Ave. inter-item corr.
Factor 1: General management		4.44	0.93	0.51
Clean and hygienic ablution facilities	0.45			
Effective traffic control to and from the event	0.45			
Visibility of security on stadium terrain	0.42			
Friendly and professional personnel in and around the stadium	0.40			
Appropriate gate opening time prior to event	0.39			
Personnel that are trained to handle any concert/event enquiries	0.39			
Adequate ablution facilities inside/outside the stadium	0.38			
Correct information on the tickets (seat numbering, date, time)	0.37			
Visibility of emergency personnel	0.37			
Concert/Event personnel that are easily noticeable	0.33			

Adequate safety measures/precautions in place during the concert	0.32			
High quality service at ticket sales	0.27			
Adequate control over alcohol use	0.26			
Factor 2: Souvenirs		3.27	0.94	0.84
Availability of a variety of souvenirs	0.99			
Affordable souvenirs (caps, t-shirts, posters)	0.90			
Adequate stalls available for the purchasing of souvenirs	0.85			
Factor 3: Marketing		4.36	0.91	0.63
User friendly and accessible website	0.92			
User friendly website with adequate information on Big Concert‟s website	0.84			
Effective ticket sales prior to the concert via the internet	0.77			
Adequate information regarding the concert/event	0.76			
Effective marketing prior to the concert regarding date, time, venue, transport etc.	0.56			
Correct information given through marketing (date, time, venue, transport options)	0.53			
Factor 4: Venue and technical aspects		4.43	0.93	0.46
Good quality acoustics in the stadium	0.62			
Good visibility of the stage from all viewpoints in the stadium	0.60			
Good layout of the stadium	0.43			
Accessibility of the stadium entry points	0.41			
Effective technical aspects during shows (lights/sound)	0.40			
Comfortable seating	0.37			
Effective and fast service at the entrance gates of the stadium	0.33			

TABLE 2. **FACTOR ANALYSIS OF CRITICAL SUCCESS FACTORS TO MANAGE VISITOR EXPERIENCE AT A MAJOR MUSIC EVENT (cont.)**

CSFs and items	**Factor loading**	**Mean value**	**Reliability coefficient**	**Ave. inter-item corr.**
Factor 4: Venue and technical aspects (cont.)		4.43	0.93	0.46
Adequate seats in the stadium	0.30			
Adequate information boards on the stadium‟s terrain and effective signage and directions to the stadium	0.29			
Punctuality of the concert programme	0.27			
Factor 5: Accessibility and parking		4.30	0.88	0.35
Effective communication on parking options	0.83			
Effective signage and directions to the stadium	0.76			
Effective communication on the day of the event with regard to road closures	0.62			
Adequate security at parking areas	0.57			
Adequate parking arrangements (e.g. park‟n‟ride,	0.53			

park‟n‟walk)				
Adequate information kiosks at the stadium	0.39			
Fast and effective services at the token exchange outlets	0.30			
Factor 6: Amenities and catering		3.94	0.84	0.35
Concert programme that caters for all ages	0.59			
Variety of food and beverage availably (Halaal, vegetarian)	0.56			
Affordable food and beverages at the stadium	0.48			
Adequate ATM facilities at the stadium	0.46			
Well-known pre-concert artists prior to the main event	0.45			
Affordable prices of transport services	0.39			
Affordable tickets	0.37			
Adequate variety of national and international artists performing	0.32			
Accessibility for the disabled	0.29			
Total variance explained	**59%**			

Differences between visitors at the four different stadiums

ANOVAs and Tukey‟s post hoc multiple comparisons were employed to determine the differences between visitors at the 4 different stadiums where the Neil Diamond concerts were held (Johannesburg [1 April, 2011[, Durban [5 April, 2011], Port Elizabeth [8 April, 2011] and Cape Town [11 April, 2011]). As shown in Table 3, there are statistically significant differences between the 4 different locations, based on age (p=0.001), accommodation (*p*=0.001), food (p=0.001), beverages (p=0.041), transport (p=0.001), souvenirs (p=0.001), tickets (p=0.001) and parking (p=0.001) as spending categories, expenditure per person (p=0.001), tickets purchased (p=0.010), nights spent (p=0.001), people paying for (p=0.004), travelling group (p=0.005), *Excitement* and *groupaffiliation* (p=0.039), *Socialisation* (p=0.001) and *Entertainment* (p=0.006) as travel motives, and *General management* (p=0.010), *Marketing* (p=0.001), *Accessibility and parking* (p=0.007)

and *Amenities* (p=0.032) as critical success factors. The significant differences are discussed below.

Age

Johannesburg had the youngest visitors (an average age of 44 years), whereas Durban had the oldest visitors (an average of 51 years). Visitors at each of the Cape Town and Port Elizabeth shows were an average age of 48 years.

Spending per person

Visitors attending the concert in Johannesburg had the lowest average spending (R786.76), while visitors at the Durban concert had the highest average spending (R1 327.70), followed by visitors at Cape Town (R1 159.90) and then at Port Elizabeth (R1 058.70).

Spending categories

Accommodation: Johannesburg differs statistically from the other 3 cities because visitors at

this concert spent the least on accommodation (an average of R132.14). Visitors at the Durban concert spent the most on accommodation with an average of R710.14, while visitors to Cape Town spent an average of R492.42 on accommodation. This was followed by visitors at the Port Elizabeth concert (an average of R473.55).

Food: Similar to the accommodation results, Johannesburg differs from Cape Town, Durban and Port Elizabeth. Visitors at the Johannesburg concert spent the least on food during the concert (an average of R200.88). It is clear that visitors at the Durban concert spent the most on food with an average of R464.17, followed by visitors at the Cape Town concert (R395.66) and by the visitors at the Port Elizabeth concert (R337.98).

Transport: Visitors to the Durban concert spent the highest average on transport (R537.71), followed by visitors at the Port Elizabeth (R464.90) and Cape Town (R318.30) concerts. Visitors at the Johannesburg concert spent the least on transport (an average of R190.48).

Souvenirs: Visitors at the Durban concert spent the most on souvenirs, with an average of R101.53, whereas visitors to Johannesburg spent the least (an average of R33.39). Visitors at the Cape Town concert spent an average of R69.85 on souvenirs, while visitors at the Port Elizabeth concert spent an average of R55.41 on souvenirs.

Tickets: Visitors at the Johannesburg and Cape Town concerts spent the most for tickets (an average of R 1 132.90 and R1 130.50, respectively), followed by visitors at the Durban concert (an average of R826.17) and Port Elizabeth (an average of 808.69) concert.

Parking: Visitors to the Johannesburg concert spent the most on parking (an average of R45.76), whereas visitors to the Port Elizabeth concert only spent R11.40 on parking. Visitors at the Cape Town concert spent an average of R42.19 and visitors at the Durban concert spent an average of R35.43 on parking fees.

Beverages: There are statistically significant differences between the 4 cities regarding beverages; however, Tukey‟s post hoc test indicates no significant differences. Nevertheless,

it is clear that visitors at the Durban concert spent the most on beverages (an average of R229.84), whereas visitors to the Port Elizabeth concert spent the least (an average of R141.12). Visitors at the Johannesburg concert spent an average of R186.12, followed by visitors at the Cape Town concert who spent an average of R141.12 on beverages.

Number of tickets purchased

Corresponding with their higher spending on tickets, visitors at the Johannesburg concert purchased the most tickets (an average of 2.92 tickets), while visitors at the Cape Town concert purchased an average of 2.60 tickets. Visitors at the Durban and Port Elizabeth concerts do not differ significantly from Cape Town, Johannesburg or each other and visitors to these concerts purchased an average of 2.58 tickets.

Length of stay

Visitors to the Durban concert spent the longest time in the area (an average of 4 nights), whereas visitors to the Johannesburg‟s Neil Diamond concert spent only an average of 1

night (the least amount of nights). This explains the low average spending of visitors to the Johannesburg concerts, particularly on accommodation and transport. Visitors to Cape Town spent an average of 3 nights, and Port Elizabeth visitors spent an average of 2 nights in the area.

Number of people paying

Visitors to the Johannesburg concert were financially responsible for more people (an average of 2.5 persons) compared to visitors to the Cape Town concert, who were financially responsible for an average of 2.1 persons. Visitors at the Durban and Port Elizabeth concerts were financially responsible for an average of 2.3 persons.

Travelling group

The size of the travelling group to Johannesburg, Cape Town and Port Elizabeth contained 4 visitors, whereas visitors to Durban had a group size of 3 attendees travelling together.

Travel motives

Socialisation and *Entertainment* as motives differ statistically between the 4 locations. Based on the mean values, visitors to both the Johannesburg and Port Elizabeth concerts regarded *Socialisation* as an important motive to attend the event (2.87) compared to visitors at the Durban and Cape Town concerts who regarded this motive as only slightly important (2.76 and 2.60 respectively). With regard to *Entertainment*, although visitors at all 4 concerts consider this motive as important; visitors at the Durban concerts regarded it as less important when compared to the other 3 locations, and especially when compared to visitors at the Port Elizabeth concert who considered it a very important motive.

There were also statistically significant differences based on *Excitement* and *group affiliation:* once again, however, Tukey"s post hoc test indicated no significant differences. It is clear that Port Elizabeth (3.87) regarded *Excitement* and *group affiliation* as a slightly more important motive when compared to visitors at the Johannesburg (3.84), Durban (3.83) and Cape Town (3.70) concerts. Concerning *Artist affiliation* and *unique experience*, visitors to both the Durban and Port Elizabeth (4.40) concerts regarded this motive as extremely important, while the visitors at the Johannesburg (4.35) and Cape Town (4.32) concerts regarded it as only important.

Critical success factors

Visitors to the 4 concerts regarded all 6 critical success factors as important for a memorable visitor experience. Corresponding with the findings of the factor analysis, *General management* was considered the most important critical success factor, whereas *Souvenirs* was regarded as the least important aspect. The differences between the 4 locations with regard to the critical success factors are discussed below (Table 3).

General management

Visitors to the Durban concert obtained the highest mean value (4.52) and considered *General management* as extremely important, whereas visitors at the Port Elizabeth concert had the lowest mean value for this critical success factor (4.39), between the 4 cities but, still considered it as very important.

Souvenirs

According to the results in Table 3, of the 4 locations, visitors at the Johannesburg concert regarded *Souvenirs* as important with the highest mean value of 3.32, whereas visitors at the Durban concert had the lowest mean value of 3.18.

Marketing

Visitors at the Durban concert had the highest mean value of 4.44; visitors to this concert regarding this factor as very important when compared to visitors at the Cape Town and Port Elizabeth concerts, who recorded the lowest mean values (4.30), respectively.

Venue and technical aspects

Visitors at all 4 destinations regarded *Venue* and *technical aspects* as important; however, it was not regarded as statistically significant. Visitors to the Durban concert regarded this aspect as very important because here it had the highest mean value of 4.49, followed closely by visitors to the Johannesburg and Port Elizabeth concerts; whereas visitors to the Cape Town concert had the lowest mean value of 4.40.

Accessibility and parking

Visitors at the Johannesburg concert regarded this management aspect as very important with the highest mean value of 4.37, whereas visitors to the Cape Town concert had the lowest mean value of 3.24.

Amenities

The mean values between the 4 locations were all high for *Amenities*; however, visitors to the Johannesburg concert had the highest mean value of 4.00 concerning *Amenities*, while visitors to the Cape Town concert had the lowest mean value of 3.88.

TABLE 3. **ANOVA RESULTS: DESTINATION VARIABLES AT VARIOUS LOCATIONS**

	Neil Diamond concert destinations					
Characteristics	**Johannes-burg** (N=613)	**Cape Town** (N=522)	**Durban** (N=288)	**Port Elizabeth** (N=443)	**F-Ratio**	**Sign. level**
Age	44[a]	48[cb]	51[b]	48[c]	18.110	0.001*
Spending per person	R786.76[a]	R1159.90[b]	R1327.70[b]	R1058.40[b]	11.264	0.001*
Spending categories						
Accommodation	R132.14[a]	R492.42[b]	R710.14[b]	R473.55[b]	36.512	0.001*
Food	R200.88[a]	R395.66[b]	R464.17[b]	R337.98[b]	33.347	0.001*
Beverages	R186.12	R141.12	R229.84	R169.01	2.763	0.041*
Transport	R190.48[a]	R318.30[ab]	R537.71[c]	R464.90[b]	25.979	0.001*
Souvenirs	R33.39[a]	R69.85[ab]	R101.53[b]	R55.41[ab]	10.986	0.001*
Tickets	R1132.90[a]	R1130.50[a]	R826.17[b]	R808.69[b]	17.753	0.001*
Parking	R45.76[a]	R42.19[a]	R35.43[a]	R11.40[b]	25.453	0.001*
Tickets purchased	2.92[a]	2.60[b]	2.58[ab]	2.58[ab]	3.810	0.010*
Nights spent	0.5[a]	2.7[b]	3.50[b]	1.90[c]	46.900	0.001*

People paying for	2.5[a]	2.1[b]	2.30[ab]	2.30[ab]	4.500	0.004*
Travelling group	4[a]	4[b]	3[b]	4[ab]	4.340	0.005*
Motivations						
Excitement and group affiliation	3.84	3.70	3.83	3.87	2.793	0.039*
Socialisation	2.87[a]	2.60[b]	2.76[ab]	2.87[ab]	7.609	0.001*
Artist affiliation and unique experience	4.35	4.32	4.40	4.40	1.475	0.219
Entertainment	4.17[ab]	4.11[a]	4.29[ab]	4.28[b]	4.166	0.006*
CSFs[†]						
General management	4.46[ab]	4.40[a]	4.52[b]	4.39[c]	3.810	0.010*
Souvenirs	3.32	3.26	3.18	3.25	0.932	0.424
Marketing	4.42[a]	4.30[b]	4.44[ab]	4.30[b]	5.200	0.001*
Venue and technical aspects	4.42	4.40	4.49	4.42	1.480	0.218
Accessibility and parking	4.37[a]	4.24[b]	4.34[ab]	4.26[ab]	4.091	0.007*
Amenities	4.00[a]	3.88[b]	3.93[ab]	3.91[ab]	2.940	0.032*

[†] Respondents were asked to indicate how they evaluate each motivation item on the scale (1 = not at all important; 2 = slightly important; 3 = important; 4 = very important; 5 = extremely important).

*Statistically significant difference: $p<0.05$

[a] Group differs significantly from type (in row) where [b] is indicated.
For example, in terms of age, Johannesburg[a] differs statistically from Cape Town[cb], Durban[b] and Port Elizabeth[c] while Port Elizabeth[c] differs significantly from Durban[b] and Johannesburg[a].

FINDINGS AND IMPLICATIONS

Based on the results, this research leads to the following findings and implications. Firstly, this research set out to determine whether the profile and behaviour of visitors to the same concert at different destinations/locations play a role in determining what the visitors at the same concert held at different destinations/locations regarded as important for a memorable visitor experience. As the destinations offer different tourism aspects and the locations differ concerning the setting, appearance and accessibility, the same critical success factors cannot be used for the same event taking place at different locations. This research specifically focused on the Neil Diamond concerts held at four different locations (the FNB Stadium in Johannesburg, Moses Mabhida Stadium in Durban, Nelson Mandela Bay Stadium in Port Elizabeth and the Green Point stadium in Cape Town).

As the four top event regions in South Africa, each destination is developed to host certain events (Tassiopoulos, 2000), where certain tourism attributes attract tourists to the area. Agreeing with Saayman and Slabbert (2002), Ritchie and Crouch (2003), Reisinger (2009) and Walker and Walker (2011), these locations have a significant influence on the visitors with regard to their socio-demographic profiles, behaviours and what the visitors consider as important aspects (critical success factors), for a memorable visitor experience. This again emphasises the fact that event visitors cannot be regarded as homogeneous and, therefore, each destination‟s visitors have to be regarded as individual target audiences. Neil Diamond is a well-known international artist who has the ability to attract visitors from across the country, and not merely from the surrounding areas where the various events were held (Saayman, 2007). Even so, the implication is that event organisers should

be aware of visitors‟ specific needs and preferences, and should organise and market the event and performing artist(s) accordingly.

Secondly, with regard to the critical success factors, it is clear that all four locations consider the six critical success factors identified (*General management, Souvenirs, Marketing, Venue* and *technical aspects, Accessibility and parking* and *Amenities*), as important. However, even though the four Neil Diamond concerts were held at similar venues (stadia designed primarily as sporting venues), significant differences are evident at the various locations. Since these aspects influence the visitor experience and can be directly controlled by management (as shown in Figure 1), information regarding these differences is crucial. This also implies that event managers need to take not only the destination (city), but also the location (venue) into consideration when planning and organising live music performances.

Management should also understand that critical success factors vary from location to location and, therefore, it is important that the same event in different locations should not be considered as having identical management aspects, as visitors to different destinations consider some aspects more important than others for a memorable visitor experience. As mentioned, although the events and the various locations (stadia) seem similar, there are significant aspects that management need to take into consideration when organising such major events. For instance, the size of the stadiums differ for the FNB Stadium in Johannesburg and can accommodate more visitors than, for example, the Moses Mabhida stadium in Durban and, therefore, more visitors will attend the concert than at the other stadiums. Therefore, traffic, parking, food, seating, crowd control, accessibility and security

have all to be controlled according to the stadium‟s capacity and the surroundings of each stadium as the surroundings or each stadium are quite different.

Thirdly, location has a significant influence on visitors‟ spending behaviour. Johannesburg (Gauteng) had the lowest spenders when compared to the other destinations. This finding corresponds with that of Kruger (2010), who found that Gauteng Province had no influence on high spending in South Africa. However, this also contradicts the findings by Saayman *et al*. (2007a, b); Saayman and Saayman (2008); Saayman *et al.* (2009); Slabbert *et al.* (2009); as well as Kruger (2009), who all found that visitors who travel from Gauteng spend more. Visitors at the Cape Town concert were the second highest spenders. This supports the findings by Saayman *et al.* (2007a, b), Kruger (2009) and Saayman and Saayman (2008), that visitors from the Western Cape are prone to be higher spenders. The Cape Town concert also had the highest number of international visitors who attended the Neil Diamond concert. This corresponds with Cannon and Ford (2002), who established that the expenditure levels increase for international visitors.

These results also indicate that location has an effect on the price of certain aspects, such as accommodation, beverages, parking, and transport and other factors. This supports the beliefs published by Reisinger (2009) and Walker and Walker (2011). The implication is that the different locations must consider ways to enhance tourists‟ length of stay and thereby increase spending, perhaps by offering special packages that include accommodation and transport, marketing of attractions in the area and affordable transport for visitors from other provinces. This is an opportunity for local authorities to work in

collaboration with airlines, bus and railway services. These opportunities could encourage visitors to spend more in the area, resulting in a still-greater economic impact of the event.

Fourthly, from the results, it is evident that Durban and Port Elizabeth attracted the most tourists from other destinations/regions in South Africa. By hosting major music events, opportunities are created to generate a positive destination image, add to the sustainable development of the destination, minimise negative impacts, support a better host-guest relationship, help protect the natural and cultural environments and generate capital for local community (Uysel *et al*., 1993; Brown *et al*., 2002). Therefore, major events such as the Neil Diamond concerts create opportunities that the local community is able to benefit from. Therefore, the local authorities need to work in collaboration with event organisers to compile packages (as mentioned previously), applicable for the duration of the event, which should include accommodation, concert tickets, transport to and from the event and local tours at the destination. These aspects also create great opportunities for the tourism industry. Major music events such as the Neil Diamond concerts can be used to encourage and promote tourism within a city or region. Cities (locations) should, therefore, include major music events in their overall marketing campaigns to attract visitors to the area. Major music events can also be used to create a wider geographical dispersion of events in South Africa.

CONCLUSION

The purpose of this research was to determine whether the visitors who attend the same performance at four different destinations/locations vary and whether their needs are the same for a memorable visitor experience. This was the first time that this type of research was

applied to the same major music event held at four different locations. Limitations did occur and determining the aspects for visitors at a live music performance prior to experiencing the actual event can differ from results where visitors have experienced the actual event. However, apart from this aspect, this research contributes greatly to the literature regarding managing the same event at four different locations to create a memorable visitor experience with regard to each location‟s unique requirements.

Significant differences were found among the four locations where the Neil Diamond concerts were held. These findings contribute to a deeper knowledge that the visitors to each location have different expectations and needs that have to be considered and it is, therefore, important that individual events at various locations should not be regarded as being the same as the performances held in other locations. This will ensure that each individual event is able to tailor the event to the various needs of the visitors at each destination, ensuring a memorable visitor experience.

RECOMMENDATIONS

Since the event industry is growing rapidly in South Africa, it is important to consider that visitors to various concert genres (e.g. pop, rock, jazz and others) will regard different aspects as important for a memorable visitor experience. It is therefore recommended that further research is done to identify what these different music concert visitors regard as

important for a memorable visitor experience in order to compare results. Future research should also focus on the differences between locations (venues), since this research showed that location has a significant influence on the organisation of live music performances. This will ensure that specific management strategies can be developed to enhance the experience that visitors will gain at different music concerts held at different locations and venues.

REFERENCES

ALLEN, J.; O"TOOLE, W.; MCDONNELL, I. & HARRIS, R. (2005). *Festival and special event management* (3rd ed.). Milton, Canada: Wiley.

ANDERECK, K.; BRICKER, K.S.; KERSTETTER, D. & NICKERSON, N.P. (2006). Connecting experiences to quality: Understanding the meanings behind visitor"s experiences. In G. Jennings & N.P. Nickerson (Eds.), *Quality tourism experiences* (pp.81-111). Oxford, UK: Elsevier.

APPEL C. (2011). Critical success factors in managing hotels in South Africa. Unpublished Honours mini-thesis. Potchefstroom: North-West University, Potchefstroom Campus.

BERRIDGE, G. (2007). *Event design and experience*. Oxford, UK: Elsevier.

BIG CONCERTS (2010). "Neil Diamond live for the first time ever in South Africa." Hyperlink [http://www.bigconcerts.co.za/media_centre/press_release/2010/october/Neil%Diamond%20Official%Press%20Release.pdf]. Retrieved on 30 March 2011.

BOOTH, A. (2010). Developing the event concept. In P. Robinson, D. Wale & G. Dickson (Eds.), *Events management* (pp.19-31). Wallingford, Oxfordshire, UK: Cabi.

BOWDIN, G.; ALLEN, J.; O"TOOLE, W.; HARRIS, R. & MCDONNELL, I. (2006). *Event management* (2nd ed.). Oxford, UK: Elsevier.

BROWN, M.D.; VAR, T. & LEE, S. (2002). Messina Hof Wine and jazz festival: An economic impact analysis. *Tourism Economics*, 8(3): 273-279.

CANNON, T.F. & FORD, J. (2002). Relationship of demographic and trip characteristics to visitor spending: An analysis of sports travel visitors across time. *Tourism Economics*, 8(3): 263-271.

CLARK, L.A. & WATSON, D. (1995). Constructing validity: Basic issues in objective scale development. *Psychological Assessment*, 7(3): 309-319.

DEIGHTON, J. (1992). The consumption of performance. *Journal of Consumer Research*, 19(1): 362- 372.

DE WITT, L. (2006). Key success factors for managing special events: The case of wedding tourism. Unpublished Master"s thesis. Potchefstroom: North-West University, Potchefstroom Campus.

ERASMUS, L.J. (2011). Key success factors in managing the visitors" experience at the Klein Karoo National Arts Festival. Unpublished Master"s thesis. Potchefstroom: North-West University, Potchefstroom Campus.

FIELD, A.(2005). *Discovering statistics using SPSS* (2nd ed.). Thousand Oaks, CA: SAGE.

GETZ, D. (2007). *Event studies: Theory, research and policy for planned events*. Oxford, UK:

Elsevier. GETZ, D. (2008). Event tourism: Definition, evolution and research. *Tourism Management*,

29(1): 403-
428.

GIBSON, C. & CONNELL, J. (2005). *Aspects of tourism: Music and tourism, on the road again.* Clevedon, UK: Channel View Publications.

ISRAEL, G.D. (2009). "University of Florida IFAS Extension. Determining the sample size". Online: [http://edis.ifas.ufl.edu/pd00600pdf]. Retrieved on 17 May 2011.

KRUGER, M. (2009). Spending behaviour of visitors to the Klein Karoo National Arts Festival. Unpublished Master‟s thesis. Potchefstroom: North-West University, Potchefstroom Campus.

KRUGER, M. (2010). A critical evaluation of market segmentation at national arts festivals in South Africa. Unpublished PhD dissertation. Potchefstroom: North-West University, Potchefstroom Campus.

KRUGER, M.E. (2006). Key success factors in managing a conference centre in South Africa. Unpublished Master‟s thesis. Potchefstroom: North-West University, Potchefstroom Campus.

KRUGER, M. & SAAYMAN, M. (2012). Listen to your heart: Motives for attending Roxette live. *Journal of Convention and Event Management,* 13(3): 181-202.

LADE, C. & JACKSON, J. (2004). Key success factors in regional festivals: Some Australian experiences. *Event Management*, 9(1): 1-11.

LEE, H. (2001). Determinants of recreational boater expenditures on trips. *Tourism Management*, 22(6): 659-667.

LONG, P.T. & PERDUE, R.R. (1990). The economic impact of rural festivals and special events: Assessing the spatial distribution of expenditures. *Journal of Travel Research*, 39(4): 10-14.

MANNERS, B. (2012). The critical succes factors for managing the visitor experience at a major musical event. Unpublished Master‟s thesis. Potchefstroom: North-West University. Potchefstroom Campus.

MANNERS, B., SAAYMAN, M. & KRUGER, M. (2013). The "Wow Factor" at live music performances in South Africa: A demand side analysis. *African Journal of Hospitality, Tourism and Leisure*, 3(2): 1-19.

MARAIS, M. (2009). Key success factors in managing the Wacky Wine Festival. Unpublished Master‟s thesis. Potchefstroom: North-West University, Potchefstroom Campus.

MATTHEWS, D. (2008). *Special event production: The process*. Oxford, UK: Butterworth-

Heinemann. MINOR, M.S.; WAGNER, T.; BREWERTON, F.J. & HAUSMAN, A. (2004).

Rock on! An

elementory model of customer satisfaction with musical performances. *Journal of Service Marketing*, 18(1):7-18.

PACKER, T.; SMALL, J. & DARCY, S. (2008). "Tourist experiences of individuals with vision impairment". Cold Coast, Qld., Australia: Sustainable Tourism. Hyperlink [**Error! Hyperlink reference not valid.**]. Retrieved on 17 May 2011.

PAGE, J.P. & CONNELL, C. (2009). *Tourism a modern synthesis* (3rd ed.). Hampshire, UK: Cengage Learning EMEA.

PALLANT, J. (2007). *SPSS survival manual: A step-by-step guide to data analysis using SPSS Version15.*(3rd ed.). New York, NY: McGraw-Hill.

PIDGEON, J. (1991). *Making it in music*. London, UK: Hodder and Stoughton.

PINE, J. & GILMORE, J.H. (1998). Welcome to the experience economy. *Harvard Business Review*, 76: 97-105.

REISINGER, Y. (2009). *International tourism cultures and behaviour*. Oxford, UK: Elsevier.

RITCHIE, J.R. & CROUCH, G.I. (2003). *The competitive destination: A sustainable tourism perspective*. Cambridge, MA: CABI Publishing.

SAAYMAN, M. (2007). *En route with tourism: An introductory text* (3rd ed.). Potchefstroom: Institute for Tourism and Leisure Studies.

SAAYMAN, M.; KRUGELL, W. & VAN DER MERWE, P. (2007a). The determinants of spending

by biltong hunters. *South African Journal of Economics and Management Science*, 10(2): 184-194.

SAAYMAN, M. & SAAYMAN, A. (2006). Does the location of arts festivals matter for the economic impact? *Regional science*, 85(4): 569-584.

SAAYMAN, M. & SAAYMAN, A. (2008). Why travel motivations and socio-demographics matter in managing a national park. *Koedoe*, 51(1): 381-388.

SAAYMAN, M. & SLABBERT, E. (2002). *An introduction to conference tourism*. Potchefstroom: Institute for Tourism and Leisure Studies.

SAAYMAN, M., SAAYMAN, A., SLABBERT, E. & VIVIERS, P. (2007b). Die sosio-ekonomiese impak van besoekers aan die KKNK. Ongepubliseerde navorsingsverslag. Potchefstroom: Instituut vir Toerisme en Vryetyd Studies.

SAAYMAN, M.; VAN DER MERWE, P. & PIENAAR, J. (2009). Expenditure based segmentation of tourists to the Kruger National Park. *Acta Academica*, 41(3): 107-127

SILVERS, J. (2004). *Professional event co-ordination*. Hoboken, NJ: Wiley.

SILVERS, J. (2012). The role of management in events management. In D. Tassiopoulos (Ed.), *Events management: A developmental and managerial approach* (3rd ed.) (pp.49-63). Lansdowne, RSA: Juta Academic.

SINGH, S.R. (2009). *Event Management*. New Delhi, India: A.P.H Publishing.

SLABBERT, E.; KRUGER, M.; VIVIERS, P.; SAAYMAN, M. & SAAYMAN, A. (2009). The socio-economic impact of visitors to the ABSA KKNK in Oudtshoorn 2009. Unpublished manuscript. Potchefstroom: Institute for Tourism and Leisure Studies.

SPSS INC. (2010)."SPSS® 16.0 for Windows, Release 16.0.0, Copyright© by SPSS Inc., Chicago, Illinois." Hyperlink [http://www.spss.com]. Retrieved on 17 September 2011.

STEYN H.S. (2000). Practical significance of the difference in means. *South African Journal of Industrial Psychology*, 26(3): 1-3.

TASSIOPOULOS, D. (2000). Events: An introduction. In D. Tassiopoulos (Ed.), *Event management*. *A proferssional and developmental approach* (pp.2-36). Lansdowne, RSA: Juta Academic.

UYSEL, M.; GAHAN, L. & MARTIN, B. (1993). An examination of event motivations: A case study. *Festival Management and Event Tourism*, 1(1): 5-10.

VAN DER WAGEN, L. (2005). *Event management for tourism, cultural, business and sporting events.* Frenchs Forest, Australia: Pearson Education.

VAN DER WESTHUIZEN, T. (2003). Key success factors for developing and managing a guesthouse. Unpublished Master‟s thesis. Potchefsroom: North-West University, Potchefstroom Campus.

WALKER, J.R. & WALKER, J.T. (2011). *Tourism concepts and practices*. Engelwood Cliffs, NJ: Prentice-Hall.

YEOMAN, I.; ROBERTSON, M.; ALI-KNIGHT, J.; DRUMMOND, S. & MCMAHON-BEATTIE, U. (2004). *Festival and events management: An international arts and culture perspective*. Oxford, UK: Elsevier.

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STUDENT PRECISION AND RELIABILITY OF THE TEAM SPORT ASSESSMENT IN BASKETBALL: A PRIMARY EDUCATION CASE STUDY

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ABSTRACT

The main aim of this study was to apply the Team Sport Assessment Procedure (TSAP) and formative assessment of invasion sport. The specific objectives were to

determine the degree of agreement among expert observers, inter-observer reliability (internal consistency), and intra-observer reliability (temporal reliability). Elementary sixth grade pupils (N=52; age 11.35±0.77), from a state school in Seville (Spain) participated. The pupils followed a training process using the Team Sport Assessment Procedure, which features six variables distributed between the game phases, attack and defence. Training consisted of five sessions of 45 minutes each. After the training process, the pupils observed and assessed the edited sequences for subsequent analysis. In four of the five variables chosen, 80% of the 52 pupils obtained intraclass correlation scores of ≥0.80. For 'volume of play', 82.46% of the observers obtained a precision coefficient of ≥0.80. In contrast, the 'efficiency index', recorded a moderate precision coefficient. What is new in this study is the presentation of situations of superiority and the monitoring of participation of primary school children. The positive results obtained from observer precision reliability, reinforce the possibility of using this tool as a method of assessment in primary education.

Key words: TSAP; Pupils; Primary school; Invasion games; Formative assessment.

INTRODUCTION

Invasion sport (basketball, football, handball, hockey, rugby, waterpolo), are the most popular forms of physical activity among the general population (Otero-Saborido *et al*., 2014a). In the educational sphere, both physical education teachers and learners from different countries concur that they are the most frequently taught by teachers and the favourite sport for learners (Shropshire & Carroll, 1998; Hill & Cleven, 2006; Gutiérrez *et al*., 2007).

Traditionally, teachers have taught these games with a focus on mastering technical skills (Martin *et al*., 2005; Arias & Castejón, 2012; Otero-Saborido *et al*., 2014a). However, this teaching model has been criticised by the approach of Teaching Games for Understanding (TGfU) (Bunker & Thorpe, 1982). TGfU suggests a technical skills approach to developing game knowledge and understanding (knowing what to do, and when and how to do it). Tactical models, as opposed to a technical approach, develop a better understanding of the game according to Bunker and Thorpe (1982). Tactical models have been referred to as, „Play

Practice" by Launder (2001), as the „Tactical Games Model" by Mitchell *et al*. (2006) and as the „Tactical-Decision Learning Model" by Gréhaigne *et al*. (2005). From the perspective of teaching for understanding, different studies claim that little declared knowledge leads to a low quality of game decision-making (French & Thomas, 1987; Figueiredo *et al*., 2008; Moreno *et al*., 2010). Therefore, assessment tools are needed to promote tactical understanding of the game and not only for assessing the pupils" technical skills.

However, opinions of teachers about the assessment of invasion sport were that tactical complexity was one of the aspects, which makes assessment difficult (Otero-Saborido *et al*., 2014a). Traditional assessment in invasion sport has two characteristics (López, 1999). Firstly, with regard to pupil participation, hetero-evaluation was used, where the teacher

alone evaluated the pupil and there was no cognitive involvement on the part of the pupil in the assessment process. In the traditional assessment model, pupils do not participate in the assessment (Vera *et al.*, 2009; Lorente-Catalán & Kirk, 2014). Therefore, assessment was synonymous with assigning a grade or mark. Secondly, the instruments used, in the case of team sport, were standardised tests, which focused on the motor dimension and technical performance, omitting such vital elements as decision-making (Figueiredo *et al*., 2008; Memmert & Harvey, 2008).

In recent years, however, there have been concerns voiced by different researchers towards changing these two aspects: firstly, by involving pupils cognitively in their assessment through participation in the assessment, either through self-evaluation methods or through peer or co-evaluation; and secondly, traditional tests, which only evaluated isolated technical aspects of the game. This evolved to a point where they can assess decision-making and tactical aspects in all the game situations, which can arise from a game/match.

Research studies published in recent years confirm that both these characteristics should be involved in the assessment of invasion sport (Oslin *et al*., 1995; Gréhaigne *et al*., 1997; Méndez, 2005; López *et al*., 2007; Figueiredo *et al*., 2008; Memmert & Harvey, 2008; Nadeau *et al*., 2008a; Pérez *et al*., 2008; Santos, 2010; Arias & Castejón, 2012; Arias-Estero & Castejón, 2014; Lorente-Catalán & Kirk, 2014; Otero-Saborido *et al*., 2014a; Otero *et al*., 2014b; Morillo & Hernández-Mendo, 2015). These studies are all unanimous that pupils should participate in assessment and be more than just a recipient of a grade. Moreover, all the authors use whole-game situations to evaluate decision-making, casting aside traditional technical tests isolated from real play, which do not reflect the idiosyncrasies of invasion sport. Within this tendency towards a more comprehensive assessment of invasion sport regarding pupil participation, the foundation was established by Oslin *et al*. (1995), with the Game Performance Assessment Instrument (GPAI), and by Gréhaigne *et al*. (1997 with the Team Sport Assessment Procedure (TSAP). The latter was applied in this present study.

The GPAI is a tool, which contains different variables (base, adjusting, decision-making, skill execution, covering, supporting and saving/scoring), and quantifies the appropriateness of the decisions made by the pupil. However, the TSAP is a tool, which quantifies the player‟s total offensive performance based on two actions, namely what the player does with the ball when in possession and how he/she obtains the ball. The TSAP is an assessment procedure developed by Gréhaigne *et al*. (1997) and for which evidence of validity (content, concurrent, ecological), and reliability (inter-observer reliability >0.82, performance stability >0.86), is

provided. The GPAI and TSAP are instruments, which are useful for helping pupils to understand the game better. The TSAP encodes objective decisions, while the GPAI encodes subjective decisions (an observer judges the performance of the player to ascertain whether a decision is, or is not, appropriate). This subjective coding, however, does not contribute to accurate calculations of reliability.

With the TSAP at the centre of this study, a review of the literature shows that only five research papers have been published on the TSAP (Richard *et al*., 1998, 1999, 2000; Nadeau *et al*., 2008a; Nadeau *et al*., 2008b). A recent review of the TSAP by Arias and

Castejón (2012), highlights some interesting data concerning the use of this tool. First, the TSAP was used more in invasion games (88.9%) and to a lesser extent in net/wall games (11.1%). Secondly, the five studies using the TSAP included each of the components of the original instrument. One of the contributions of the current study is that it modifies the original and adds a neutral player. Finally, the TSAP was used in Physical Education classes (60%) and in extra-curricular sports (40%), and the age group used (60%), was between 10 and 14 years (Arias-Estero & Castejón, 2014). The data confirm that the strength of this tool is its adaptability to different educational contexts, such as primary education, and that pupils can observe their teammates from the age of 10 years old (Méndez, 2005).

AIM OF THE RESEARCH

The aim of the present study was to implement the TSAP with pupils from Year Six in Primary School (6^{th} Grade in Elementary School). The different reliability and concordance indicators were investigated after applying the experiment with the specific objective to assess the possible implementation of this tool in the school curriculum. In this context, past research on the use of the TSAP (Gréhaigne *et al*., 1997; Richard *et al*., 1998, 1999, 2000; Nadeau *et al*., 2008a; Nadeau *et al*., 2008b), were very helpful in enabling the researchers to make comparisons with the results of the current study.

METHODOLOGY

Research design

This research typifies an observational design. The research is quantitative because the TSAP is a very structured instrument, which codes the number of events. According to the classification of observational studies in sport (Anguera & Hernández, 2013), this study can be classified as ideographic, multi-dimensional and an individual components research.

Sample

The observations of 52 pupils (6^{th} Grade) at a state school in Seville (Spain) were recorded and analysed in this study. The average age of the group was 11.35±0.77 years, with 53.84% (n=28) girls and 46.15% (n=24) boys. The pupils observed and analysed themselves. All of the 6^{th} Grade pupils in the school took part in the research, but the results of pupils with extreme learning difficulties were not taken into account, following the control protocol of extraneous variables found in similar studies (Cuéllar *et al.*, 2004; Otero-Saborido *et al.*,

2012a; Otero-Saborido *et al*., 2012b). The Research Ethics Committee of the University approved the study.

Instruments

The 3 university lecturers, who participated in the study, were all specialists in team sport. These experts designed game situations, recorded sequences and conducted the pupils‟ training programmes. The pupils were video recorded during 4 sessions of Physical Education. Sequences of game play were filmed using 2 Sony cameras DSC-HXU. The

different video sequences of play were edited using Dartfish Team Pro 5.5 – the version adapted for team sport. Finally, the researchers used a Promethean 2011 digital whiteboard to project game situations to the pupils for their subsequent assessment.

Observation instrument

The initial proposal of the TSAP by Gréhaigne *et al.* (1997) features 6 variables distributed between the 2 phases of the game, attack and defence. One of the advantages of the TSAP is its adaptability to educational contexts and the motor skills of pupils. Table 1 shows the TSAP variables adapted for this study. For this study, basketball was used as the invasion sport, following Méndez‟s (2005) recommendation that the 6 variables be reduced to 5 (Table 1), enabling assessment of the pupils. In this case, the neutral ball category was eliminated, since it is difficult for pupils to discern when a pass is dangerous for an opponent and when it is not. In the same way, the application of the TSAP by Richard *et al*. (2000), in a similar educational context to this study, also omitted computation of the results of the neutral ball category given its complexity.

TABLE 1. **VARIABLES OF TEAM SPORT ASSESSMENT PROCEDURE: ADAPTATION OF ORIGINAL TSAP** (Gréhaigne *et al.,* 1997:507)

Phases	**Actions observed**	**Code**	**Description**
How I get the ball	Received Ball	RB	I received it from a teammate and was not immediately lost.
	Conquered Ball	CB	I take it from an opponent; I intercept a pass; I pick up a rebound from the opposing team‟s shot.
How I play the ball	Lost Ball	LB	I lose it to an opponent I throw it off court
	Offensive Ball	OB	I pass ball to a teammate
	Basket Shot	BS	Shot at basket which scores points Shot which misses the basket but rebound goes to a teammate

Volume of Play index (VP)= RB+CB Efficiency Index (IE)= $\frac{CB+OB+BS}{10 + LB}$

Procedure

Selection of the participating groups

One of the characteristics of sport at primary school level is the heterogeneity of the pupils (Otero-Saborido, 2005). In the setting of extracurricular sport, the level of learners is more homogeneous, which has made different specialist authors on the subject to point out 2 different education modalities in the initiation of a sport: Physical Education and extracurricular sport (Hernández *et al*., 2000; Fradua & Moreno, 2001). Based on this, the pass and bounce tests, proposed by Strand and Wilson (1993) for basketball, were used, as was the case in a similar study by Yáñez and Castejón (2011). The current study had 2 objectives. Firstly, to determine 3 levels of skill to divide the pupils into groups where participation in the game would be as homogenous as possible, thereby avoiding situations

where the more skilful players dominate play to the detriment of the less skilful ones. Secondly, tests were administered to ascertain whether the technical level of the pupils would determine the whole-game situation as the researchers had proposed.

Game situation

Situations of numerical superiority take on a very important role following the logical scheme for education of firstly, situations of numerical superiority, then situations of equality, and finally inferiority (Sans & Frattarola, 1993), as they facilitate the teaching of team sport to adapt to the abilities of the pupils. With this pedagogical criterion, situations of superiority with the presence of neutral players prevail over situations of equality, above all in the primary school context.

Various specialist researchers in sport initiation have commented in similar terms concerning the use of wildcards and adapted game situations (Antón, 1990; Sans & Frattarola, 1993; Fradua & Moreno, 2001; Pintor & Cárdenas, 2001; Ardá & Casal, 2003; Bengué, 2005). The game situation in the current study was „3 versus 3" plus a neutral player, who played with the team that had possession of the ball (Lisbona & Mingorance, 2010), which is unlike previous studies where game situations in a primary school context involved only an equal number of players.

Observer training

Before applying the instrument of observation, the pupils went through a training process as recommended by various authors (Medina & Delgado, 1999; García *et al.*, 2002). The number of training sessions proposed by Richard *et al*. (2000), in a similar study was increased to consist of 5 sessions of 45 minutes per session. The first session explained the theory of the TSAP and its variables. In the following 2 sessions, the pupils analysed and assessed game situations by observing live matches of „3 vs. 3 + 1" of fellow pupils. To finalise the procedure, the last 2 sessions were centred on the analysis of video sequences of players of different levels by the pupils and clarifying observation queries in the various categories. Once the training process was completed, 6 video sequences were produced and presented to 6 pupils from the 3 different levels of play. Each sequence lasted between 3 and 4 minutes (periods where play had stopped were deleted). From this point, all the pupils who participated in the present study (N=52), observed and assessed the edited sequences for subsequent analysis.

Data analysis

There were 3 aims for the data analysis: (1) to determine the degree of agreement with the expert observers; (2) to determine inter-observer reliability by means of internal consistency; and (3) to determine intra-observer reliability for temporal reliability.

To determine the above aims, the researchers used an intraclass correlation coefficient, as has been used by researchers of similar studies (Gréhaigne *et al.*, 1997; Richard *et al.*, 2000; Nadeau *et al.*, 2008a), utilising the Two-way random absolute agreement model. In the case of agreement with expert observer and inter-observer reliability, two performance indices were used („volume of play" and „efficiency index"), and the 5 categories selected for the present study. For temporal reliability, performance scores were used. With regard to acceptable levels of reliability, a scale of 3 levels was determined. Firstly, scores less

than
0.60 were considered unacceptable. The second level between 0.60 and 0.79 were proposed as having moderate reliability, and finally, a score of 0.80 and above represented a high level of reliability. Microsoft Office Excel 2007 was used to process the data recorded, and the SPSS V.15 for Windows statistics programme was used to analyse the data.

RESULTS

Agreement in observation

The results for the 5 variables chosen from the TSAP and of the 2 performance indices can be found in Tables 2 and 3.

Table 2 shows the levels of intraclass correlation. In general terms, and in the case of the variables, in 4 of the 5 variables chosen, approximately 80% of the pupils obtained intraclass correlation scores equal to or higher than 0.80. Within these high levels of precision in observation in the „Basket Shot" and „Received Ball" categories, 98.09% and 88.46% (respectively) of the pupils scored a precision level above 0.80 with regard to the observations of the experts.

TABLE 2. **LEVEL OF INTRACLASS CORRELATION BETWEEN 52 PUPILS AND EXPERTS FOR FIVE VARIABLES**

Levels of reliability	Conquered ball (CB)	Received ball (RB)	Lost ball (LB)	Offensive ball (OB)	Basket shot (BS)
Range of reliability	0.75–0.97*	0.80–0.98	0.34–0.86	0.94–0.97	0.94–1
≥0.80	43/52 (82.69%)	46/52 (88.46%)	24/52 (46.15%)	41/52 (78.80%)	51/52 (98.09%)
0.60 - 0.79	8/52 (15.34%)	4/52 (7.69%)	9/52 (17.30%)	4/52 (7.69%)	1/52 (1.29%)
> 0.60	1/52 (1.94%)	2/52 (3.85%)	19/52 (36.53%)	7/52 (13.46%)	0/52 (0%)

*Intraclass correlation coefficient (range)

„Lost Balls" is the variable which obtained the worst precision results among the experts. A descriptive analysis of the results shows that only 36.53% of the pupils computed the same number of „Lost Balls" like the experts. This data indicates that 46.15% of the pupils obtained the same or higher than 0.80 precision in their observations. Finally, in the „Conquered Ball" category, an accumulated frequency of 98.03% of observers provided precision coefficients above 0.60. More specifically, 82.69% of pupils scored a precision level equal to or higher than 0.80.

TABLE 3. **AGREEMENT IN OBSERVATION BETWEEN 52 PUPILS AND EXPERTS FOR TWO EXECUTION INDICES: VP/IE**

Levels of reliability	Volume of play	Efficiency index
Range	0.86–0.98	0.73–0.97
≥0.80	46/52 (88.46%)	22/52 (42.31%)
0.60 - 0.79	4/52 (7.69%)	25/52 (48.08%)
> 0.60	2/52 (3.85%)	5/52 (9.61%)

Volume of Play index (VP)= RB+CB Efficiency Index (IE)= $\frac{CB+OB+BS}{10 + LB}$

Table 3 shows agreement in observation between the pupils and the experts. In the case of the performance indices, „Volume of Play" and „Efficiency Index", high levels of precision were registered in the first category and moderate in the second category. For „Volume of Play", 88.46% of the observers obtained a precision coefficient equal to or greater than 0.80 because of the excellent coefficients of the two categories comprising this index („Received Ball" and
„Conquered Ball").

Inter-observer reliability

TABLE 4. **INTER-OBSERVER RELIABILITY FOR TWO INDICES (VP/IE) AND FIVE VARIABLES (CB/RB/LB/OB/BS) IN TSAP**

Indicator	Intraclass	Corrected intraclass
Volume of Play (VP)	0.93	0.94 (1 case omitted)
Efficiency Index (IE)	0.87	0.87 (5 cases omitted)
Received Ball (RB)	0.81	0.83 (2 cases omitted)
Conquered Ball (CB)	0.88	0.88 (1 case omitted)
Lost Ball (LB)	0.56	0.70 (19 cases omitted)
Offensive Ball (OB)	0.87	0.96 (7 cases omitted)
Offensive Ball (BS)	0.92	0.92 (0 cases omitted)

To establish the reliability of the observing pupils, the intraclass correlation coefficient with the Two-way random absolute agreement model was applied. Table 4 shows the inter-observer reliability for 2 indices (VP/IE). The results obtained show high levels of reliability among observers of all categories except for „lost balls". However, in the same terms as the study by Richard *et al*. (2000), they reported a corrected intraclass correlation coefficient, omitting cases with reliability levels below 0.60. The new coefficient indicates high reliability in all categories.

Temporal reliability

In the current study, temporal reliability was considered an indicator to assess the benefits of the procedure and the stability of the results. There was a period of 3 weeks between both readings. Pupils observed and analysed identical situations obtaining a coefficient of 0.72 for the performance scores, which suggests the results had moderate stability.

DISCUSSION

Regarding *observer precision*, differences were found in the results when compared with those obtained by Richard *et al*. (2000), for a group of pupils of the same age as in the current study. The results of Richard *et al*. (2000), contain higher precision scores in „conquered balls", „basket shots" and „received balls". High scores for the „basket shot" variable were surprising considering its complexity, given that the offensive rebound also had to be identified. For this reason, the researchers insisted on observer training. Results for „lost balls" were significantly lower. Such low results do not concur with a clear definition of the
„lost ball" category. Nevertheless, when play is in the area of the basket, situations occur, especially in the case of rebounds, which are far from clear for the accurate observation and scoring of this category. At the same time, the low frequency of „lost balls" for the six players observed by the pupils scored negatively for the precision indicators in cases where there was no congruence with the observers.

As for the *execution indicators*, there was a similar coefficient for „Volume of Play", while reliability of the „Efficiency Index" was lower in the current study due to the low reliability scores in the „lost balls" category. In contrast, the moderate precision coefficient of the
„Efficiency Index" (only 42.30% of observers scored high levels of validity), concurs with the low results obtained in the „lost balls" category, which is part of this same indicator. Other studies that applied the TSAP did not find reliability with regard to the group of experts (Gréhaigne *et al.*, 1997; Nadeau *et al.*, 2008a). García *et al*. (2002) obtained much lower coefficients in observer precision with experts in water polo game situations, although a comparison cannot be made with the present study since the context and subjects were different.

In the case of *inter-observer reliability*, there were hardly any differences with the results obtained by Gréhaigne *et al*. (1997) in „Volume of Play" (0.94 and 0.99), and „Efficiency Index" (0.82 and 0.90). Although the results were slightly higher than the current study, the pupils assessed by Gréhaigne *et al*. (1997) were from an older age range than in the current study. The opposite occurred in the work by Richard *et al*. (2000), where the pupils were the same age as in the current study. In indices, „volume of play" (0.89), and „Efficiency Index" (0.78), the results for inter-observer reliability were noticeably higher in the present study,

which may suggest the positive influence of the greater number of training hours of the observers. Nadeau *et al.* (2008a) obtained similar reliability results to the current study with adolescent hockey players.

Temporal reliability has already been used as a way to measure performance in education and assessment of team sports (Gréhaigne *et al.*, 1997; Nadeau *et al.*, 2008a; Moreno *et al.*,

2010; Otero-Saborido & Silva, 2015). The temporal stability obtained in this study is acceptable as psychometric evidence (0.72). However, Tritschler (2000) provides coefficients equal to or superior to 0.80 as the most desirable to be able to talk about permanence across time for the results. The temporal reliability result obtained by Nadeau *et al.* (2008a), was inferior to that in the present study (0.26, 0.59 and 0.16). For their part, Gréhaigne *et al.* (1997) obtained a greater stability of results (0.87), which could be because the subjects in their study were older than the subjects in the current study.

CONCLUSIONS

From the application of the TSAP in this study as an assessment tool for team sport, which involves the pupils cognitively, it can be deduced that there is a high level of concordance with the group of experts. Likewise, inter-observer reliability and stability obtained over time are more than acceptable. In conclusion, the psychometric indicators provide optimism with regard to the usefulness of such tools and their potential for implementation in schools. It is important to highlight two notable findings of the current study, which is similar to research previously initiated by a range of other researchers. Firstly, the use of game situations with numerical superiority and with neutral or wildcard players are situations that are the most appropriate for favouring the person in possession of the ball in a primary school context, where technical levels are more heterogeneous and less developed than in a sporting context. Secondly, the adaptation of the instrument to the abilities of 11-year-old pupils may require eliminating categories. Researchers should note that most studies applied the TSAP with adolescent pupils, whereas the 10 to 11 age groups have not been studied extensively to date.

Finally, from the perspective of the physical education teacher, the problem is that it is a very complex process involving multiple tasks (tool design, recording and editing of games, observer training, computing data via Excel, later to SPSS, reliability calculations, etc.), which makes it impractical as an assessment tool for the teacher or for assigning grades to pupils. This multitude of tasks means that an extraordinary scientific tool cannot be recommended for use in primary school. The computer automation of a large part of these processes could render its feasible integration into teaching processes.

REFERENCES

ANTÓN, J.L. (1990). *Fundamentos y etapas de aprendiza*je (*trans.*: Fundamentals and stages of learning). Madrid, España: Gymnos.

ANGUERA, M.T. & HERNÁNDEZ-MENDO, A. (2013). Observational methodology in the field of sport. *Revista de Ciencias del Deporte*, 9(3): 135-160.

ARDÁ, A. & CASAL, C.A. (2003). *Fútbol: Metodología de la enseñanza del fútbol* (*trans.*: Football: Teaching methodology for European football) (1st ed.). Barcelona, España: Paidotribo.

ARIAS-ESTERO, J. & CASTEJÓN, F. (2014). Using instruments for tactical assessment in Physical Education and extra-curricular sports. *European Physical Education Review*, 20(4): 525–535.

ARIAS, J.L. & CASTEJÓN, F.J. (2012). Review of the instruments most frequently employed to assess tactics in Physical Education and youth sports. *Journal of Teaching in Physical Education*, 31: 381-391.

BENGUÉ, L. (2005). *Fundamentos transversales para la enseñanza de los deportes de equipo* (*trans.*: Fundamentals for transversal teaching of team sports) (1st ed.). Barcelona, España: Paidotribo.

BUNKER, D. & THORPE, R. (1982). A model for the teaching of games in secondary schools. *Bulletin of Physical Education*, 18(1): 5-8.

CUÉLLAR, M.J.; DELGADO, M. & DELGADO, M.A. (2004). Construcción y validación de un instrumento para la evaluación de aspectos conceptuales en danza (*trans.*: Construction and validation of an instrument for assessing conceptual aspects in dance). *Tándem: Didáctica de la Educación Física*, 14: 93-105.

FIGUEIREDO, L.M.; LAGO, C. & FERNÁNDEZ, M.A. (2008). Análisis del efecto de un modelo de evaluación recíproca sobre el aprendizaje de los deportes de equipo en el contexto escolar (*trans.*: Analysis of the effect of a model of peer evaluation on the learning of team sports in the school context). *Motricidad: Revista de Ciencias de la Actividad Física y del Deporte*, 21: 99-117.

FRADUA, L. & MORENO, R. (2001). La iniciación al fútbol en el medio escolar (*trans.*: Initiation of football in schools). In F. Ruiz, A.J. García & C. Casimiro (Eds.), *La iniciación deportiva basada en los deportes colectivos: Nuevas tendencias metodológicas* (*trans.*: Initiation of sports based on team sports: New methodological trends) (pp.145-178). Madrid, España: Gymnos.

FRENCH, K.E. & THOMAS, J.R. (1987). The relation of knowledge development to children‟s basketball performance. *Journal of Sport Psychology*, 9(1): 15-32.

GARCÍA, P.; ARGUDO, F. & ALONSO, J.I. (2002). "Validación de un entrenamiento de observadores para el análisis de una microsituación de juego en waterpolo (*trans.*: Validation of training observers for analysing micro game situations in waterpolo)." *Lecturas: Educación Física y Deportes*, 109. Hyperlink [http://www.efdeportes.com/efd109/validacion-de-un-entrenamiento- de-observadores-en-waterpolo.htm]. Retrieved on 20 October 2012.

GRÉHAIGNE, J.F.; BOUTHIER, D. & GODBOUT, P. (1997). Performance assessment in team sports. *Journal of Teaching in Physical Education*, 16(4): 500-516.

GRÉHAIGNE, J.F.; WALLIAN, N. & GODBOUT, P. (2005). Tactical-decision learning model and students‟ practices. *Physical Education and Sport Pedagogy*, 10(3): 255–269.

GUTIÉRREZ, M.; PILSA, C. & TORRES, E. (2007). Perfil de la educación física y sus profesores desde el punto de vista de los alumnos (*trans.*: Profile of physical education and their teachers from the point of view of students). *Revista Internacional de Ciencias del Deporte*, 3(8): 39-52.

HERNÁNDEZ, J.; CASTRO, U.; CRUZ, H.; GIL, G.; GUERRA, G.; QUIROGA, M. & RODRIGUEZ, J.P. (2000). *La iniciación a los deportes desde su estructura y dinámica. Aplicación a la educación física escolar y al entrenamiento deportivo* (*trans.*: Initiation into sports from its structure and dynamics). Zaragoza, España: Inde.

HILL, G.M. & CLEVEN, B.A. (2006). Comparison of students' choices of 9th grade physical education activities by ethnicity. *High School Journal*, 89(2): 16-23.

IGLESIAS, D. (2006). Efecto de un protocolo de supervisión reflexiva sobre el conocimiento procedimental, la toma de decisiones y la ejecución en jugadores jóvenes de baloncesto (*trans.*: Effect of protocol for reflective supervision of procedural knowledge, decision-making and implementation in young basketball players). Unpublished PhD. dissertation. Extremadura, España: Universidad de Extremadura, Departamento de Didáctica Expresión Musical, Corporal y Plástica.

LAUNDER, A.G. (2001). *Play practice: The games approach to teaching and coaching sports.* Champaign, IL: Human Kinetics

LISBONA, M. & MINGORANCE, A.C. (2011). Unidad Didáctica sobre baloncesto desde un enfoque comprensivo en Educación Física (*trans.*: A teaching unit on basketball from a comprehensive approach in Physical Education). In A. Méndez (Ed.), *Modelos actuales de iniciación deportiva* (*trans.*: Current models of sport initiation) (pp.179-205). Sevilla, España: Wanceulen.

LÓPEZ, V.M. (1999). *Prácticas de evaluación en educación física: Estudio de casos en Primaria, Secundaria y formación del profesorado* (*trans.*: Assessment practices in physical education: Studies in teacher training for primary and secondary schools). Valladolid, España: Universidad de Valladolid.

LÓPEZ PASTOR, V.M.; BARBA MARTIN, J.J.; MONJAS AGUADO, R.; MANRIQUE ARRIBUS, J.C.; HERAS BERNARDINO, C.; GONZÁLEZ PASCUAL, M. & GÓMEZ GARCÍA, J.M.
(2007). Trece años de evaluación compartida en educación física (*trans*. Thirteen years of shared assessment in physical education). *International Journal of Medicine and Science of Physical Activity and Sport*, 7(26): 69-86.

LORENTE-CATALÁN, E. &. KIRK, D. (2014). Making the case for democratic assessment practices within a critical pedagogy of physical education teacher education. *European Physical Education Review*, 20(1): 104-119.

MARTIN, J.A.; BLANKSBY, B.A. & WHIPP, R.P. (2005). A retrospective evaluation of assessment in Physical Education. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 27(1): 17-26

MEDINA, J. & DELGADO, M.A. (1999). Metodología de entrenamiento de observadores para investigaciones sobre Educación Física y Deporte en las que se utilice como método la observación (*trans.*: Observer training methodology for research on Physical Education and Sport where observation is used). *Motricidad: Revista de ciencias de la actividad física y del deporte*, 5: 69-86.

MEMMERT, D. & HARVEY, S. (2008). The Game Performance Assessment Instrument (GPAI): Some concerns and solutions for further development. *Journal of Teaching in Physical Education*, 27: 220-240.

MÉNDEZ, A. (2005). Hacia una evaluación de los aprendizajes consecuente con los modelos alternativos de iniciación deportiva (*trans.*: Towards a consistent assessment of learning with alternative models of sport initiation). *Tándem: Didáctica de la Educación Física*, 7: 38-58.

MITCHELL, S.A.; OSLIN, J.L. & GRIFFIN, L.L. (2006). *Teaching sport concepts and skills: A tactical games approach* (2nd ed.). Champaign, IL: Human Kinetics.

MORENO, A.; MORENO, P.; GARCÍA-GONZÁLEZ, GIL A. & DEL VILLAR, F. (2010). Desarrollo y validación de un cuestionario para la evaluación del conocimiento declarativo en voleibol (*trans.*: Development and validation of a questionnaire for assessing declarative knowledge of volleyball). *Motricidad: Revista de Ciencias de la Actividad Física y del Deporte*, 25:183-195.

MORILLO, J.P. & HERNÁNDEZ-MENDO, A. (2015). Analysis of qualitative data: A tool for observing the attack in beach handball. *Revista Iberoamericana de Psicologia del Ejercicio y el Deporte*, 10(1): 15-22

NADEAU, L.; GODBOUT, P. & RICHARD, J. (2008a). Assessment of ice hockey performance in real-game conditions. *European Journal of Sport Science*, 8(6): 379-388.

NADEAU, L.; GODBOUT, P. & RICHARD, J. (2008b). The validity and reliability of a performance assessment procedure in ice hockey. *Physical Education and Sport Pedagogy*, 13(1): 65-83.

OSLIN, J.L.; MITCHELL, S.A. & GRIFFINS, L.L. (1995). The Game Performance Assessment Instrument, GPAI: Development and preliminary validation. *Journal of Teaching in Physical Education*, 17(2): 231-243.

OTERO-SABORIDO, F.M. (2005). Análisis de los elementos determinantes en la aplicación de una tarea evaluativa en educación física: Propuesta para un deporte de cooperación-oposición y participación simultánea (*trans.*: Analysis of the key factors in implementing an evaluation task in Physical Education: Proposal for sport opposition cooperation and simultaneous participation). *Tándem: Didáctica de la Educación Física*, 18: 59-69.

OTERO-SABORIDO, F.M.; CALVO, Á. &. GONZÁLEZ-JURADO, J.A. (2014a). Analysis of the assessment of invasion sports in elementary school. *Cultura, Ciencia y Deporte*, 9(26): 139-153.

OTERO-SABORIDO, F.M.; CARMONA, J.; ALBORNOZ, M.; CALVO, A. & DÍAZ, J.A. (2014b).
Teacher"s methodology of invasion games in primary school. *International Journal of Medicine and Science of Physical Activity and Sport*, 14(53): 69-87.

OTERO-SABORIDO, F.M.; GONZÁLEZ, J.A & CALVO, A. (2012a). Validation tools for measuring procedural and declarative knowledge and assessing decisions in school European

football. *Retos, Nuevas tendencias en Educación Física, Deporte y Recreación*, 21: 65-69

OTERO-SABORIDO, F.M.; GONZÁLEZ, J.A.; CALVO, A. & MOLINA, E. (2012b). Contenidos conceptuales en educación física: Efecto de un programa de intervención (*trans.*: Conceptual content in physical education: Effect of an intervention programme). *Revista digital de Educación Física Emás*, 22: 55-66.

OTERO-SABORIDO, F.M. & SILVA, J. (2015). Fiabilidad en la observación en fútbol sala a través de una herramienta de evaluación de los deportes de equipo (*trans.*: Reliability futsal observation through the Team Sport Assessment Procedure). *Revista Iberoamericana de Psicología del Ejercicio y el Deporte*, 10: 259-266.

PÉREZ, A.; HERAS, B. & HERRÁN, I. (2008). Evaluación formativa en la educación secundaria obligatoria: Su aplicación a una unidad didáctica de deportes colectivos en el marco de un estilo actitudinal (*trans.*: Formative assessment in compulsory secondary education: Application for a teaching unit of team sports as part of an attitudinal style). *Revista Española de Educación Física*, 9: 14-25.

PINTOR, D. & CÁRDENAS, D. (2001). La iniciación al baloncesto en el medio escolar (*trans.*: Introduction to basketball in schools). In F. Ruiz, A.J. García & C. Casimiro (Eds.), *La iniciación deportiva basada en los deportes colectivos: Nuevas tendencias metodológicas* (*trans.*: Introduction to sports initiation for team sports: New methodological trends) (pp.105-144). Madrid, España: Gymnos.

RICHARD, J.F.; GODBOUT, P. & GRÉHAIGNE, J.F. (1998). The establishment of team-sport performance norms for grade 5 to 8 students. *Avante*, 4(2): 1-19.

RICHARD, J.F.; GODBOUT, P.; TOUSIGNANT, M. & GRÉHAIGNE, J.F. (1999). The try-out of a team-sport assessment procedure in elementary and junior high school PE classes. *Journal of Teaching in Physical Education*, 18(3): 336-356.

RICHARD, J.F.; GODBOUT, P. & GRÉHAIGNE, J.F. (2000). Students´ precision and reliability of team sport performance. *Research Quarterly Exercise Sport*, 70(1): 85-91.

SANS, A. & FRATTAROLA, C. (1993). *Entrenamiento en el fútbol base: Programa de aplicación técnica, 1er nivel* (*trans.*: Youth football training: Program of technical application at first level) (1st ed.). Barcelona, España: Paidotribo.

SANTOS, S. (2010). La utilización de hojas de registro en la enseñanza de los deportes colectivos (*trans.*: The use of record sheets on teaching team sports). *Tándem: Didáctica de la Educación Física*, 34: 91-108.

SHROPSHIRE, J. & CARROLL, B. (1998). Final year primary school children's physical activity levels and choices. *European Journal of Physical Education*, 3(2): 156-166.

STRAND, B.N. & WILSON, R. (1993). *Assessing sport skills*. Champaign, IL: Human Kinetics.

TRITSCHLER, K. (2000). *Barrow and McGee's practical measurement and assessment* (5th ed.).
Baltimore, MD: Lippincott Williams & Wilkins.

VERA, J. A.; MORENO, R. & MORENO, J.A. (2009). Relationships between the transfer of responsibility in assessment and the perception of equality in Physical Education classes. *Cultura, Ciencia y Deporte*, 4(10): 25-31.

YÁÑEZ, J. & CASTEJÓN, F.J. (2011). La utilización de la transferencia para el aprendizaje de la táctica colectiva deportiva en educación secundaria (*trans.*: The use of learning for transfer in collective tactics in secondary education sports). *Infancia y Aprendizaje*, 34(1): 95-107.

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PHYSICAL AND MOTOR PERFORMANCE PREDICTORS OF LOWER BODY EXPLOSIVE POWER (LBEP) AMONG ADOLESCENTS IN THE NORTH-WEST PROVINCE: PAHL STUDY

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ABSTRACT

The aim of this study was to develop a lower body explosive power (LBEP) prediction model from various physical and motor performance components among a cohort of male and female adolescents living in the Tlokwe local municipality of the North-West Province. A cross-sectional experimental research design was employed with 214 15-year-old adolescents (88 males; 126 females; mean age: 15.8±0.68 years), from six schools, two from the Potchefstroom city area and four from the Ikageng area. They were measured over a 7-day period. Informed consent and demographic questionnaires were completed followed by seven physical and 14 motor performance tests. Regression analyses indicated that gender and 10m-speed formed a significant component-derived prediction model for LBEP values in 15- year-old adolescents, with gender contributing 39% (R^2=0.39) and 10m-speed contributing 7% (R^2=0.07). Results show that 46% (R^2=0.46) of the LBEP can be predicted by speed and gender components of adolescents. Variables other than physical and motor performance components contributed 54% to LBEP prediction in adolescents. The results could be used to identify adolescents who show potential to excel in LBEP performance driven sport.

Key words: Explosive power; Motor and physical performance; Prediction model; Adolescents; Gender.

INTRODUCTION

Lower body explosive power **(**LBEP) is dependent on the velocity of a movement and can be defined as the greatest rate of work achieved during a single, ballistic, resisted contraction (Saunders *et al*., 2008). Explosive power produced will, therefore, influence performance in activities that require high velocity at release or impact (Newton & Kraemer, 1994). Successful performance in sport such as basketball, volleyball and handball are all dependent on LBEP activities, such as jumping, sprinting, striking and agility (Karahan & Cecilia, 2011).

Several researchers (Witvrouw *et al*., 2004; Kinser *et al*., 2008; Nevill *et al*., 2009; Milanese, 2010; Milojević & Stanković, 2010), have identified various components as possible contributors to LBEP jumping in children and adolescents. The possible physical and motor performance variables include, arm hang time (Lennox *et al.*, 2008; Milojević & Stanković, 2010), grip strength (Girard & Millet, 2009), leg stiffness (Korff *et al*., 2009), agility T-test

(Jovanović *et al*., 2010; Hermassi *et al*., 2011), VO_2 (Dumke *et al*., 2010), arrowhead agility test and predicted VO_{2max} (Boyle, 2011). Contribution to higher LBEP production, as demonstrated by a higher counter movement jumping height is due to the result of greater elasticity of the muscle-tendon units of the lower limbs (higher flexibility) (Witvrouw *et al*., 2004). A decreased stiffness of the muscle component is described occasionally in conjunction with increased flexibility (Morse *et al*., 2008). Contradictory to some of the previously mentioned findings is that a decreased stiffness of the series elastic component (SEC), had led to a 7.4% decrease ($p<0.05$) in LBEP output in adults (Cornwell *et al*., 2002). Furthermore, Korff *et al*. (2009) found a significantly positive correlation ($r=0.70$, $p<0.001$) between leg stiffness and peak LBEP production jumping activities among adolescents. Similarly, Kinser *et al*. (2008) stated that flexibility-induced changes due to stretching might have no effect on the LBEP output production of children and adolescents. Additionally, low flexibility scores in adults have been associated with poor speed performances (Nicholas, 1997).

Various researchers found that LBEP for children and adolescents negatively correlates with speed over short distances between 5m and 40m (Nevill *et al*., 2009; Milanese, 2010; Milojević & Stanković, 2010). Moreover, it has been suggested that motor and physical performance components could influence LBEP performance, such as handgrip strength in 13- to 15-year-old male adolescents ($r=0.72–0.83$; $p=0.001–0.01$) (Girard & Millet, 2009); leg strength in 11- to 16-year-old male ($r=0.85$) and female adolescents ($r=0.78$) (Temfemo *et al*., 2009); and in 14- to 15-year-old adolescents ($r=0.36$; $p<0.00$) (Milojević & Stanković, 2010).

Anaerobic sprinting speed (40m-sprint) and LBEP (vertical jump performance), have also shown a strong correlation in adolescent populations (Foran, 2001; Du Plessis, 2007; Nevill *et al*., 2009). LBEP as measured by performance in the horizontal jump test, have demonstrated a higher correlation with sprinting speed than vertical jump test performances (Maulder & Cronin, 2005). With regard to maturation, it seems that in early mature adolescent populations an increase in LBEP (vertical jump performance), is also accompanied by a decrease in agility shuttle run times and sprint values when compared with late mature adolescent populations (Figueiredo *et al*., 2010). Maturity of male adolescents generally correlates positively with strength and motor performance abilities (Malina *et al*., 2004a), whereas, static strength and motor performance generally are not significantly related to the maturity status of female adolescents, since most correlations are low and negative (Malina *et al*., 2004a; Lennox *et al*., 2008). Maturation refers to the timing (specific maturation events occur, like appearance of pubic hair in girls and boys), and tempo (the rate at which maturation progresses, early or late), of progress toward the mature biological stage (Malina *et al*., 2004a). The above-mentioned could be underlined by the fact that male adolescents experience an increase in maximal power delivery of 375% with muscle mass doubling, while an increase in maximal power delivery of 295% and a fat mass multiplication of 1.5 with the onset of maturation occur in female adolescents (Ronan *et al*., 2003; Malina *et al*., 2004b).

Currently, the available literature on LBEP prediction models for adolescents are limited and mostly applied on adult populations. Regarding adolescents, only Travill (2011) investigated the extent various anthropometric characteristics influence LBEP production of 7- to 18-year-

old male adolescents in South Africa. A LBEP prediction model will be of great value to various sporting codes, such as soccer, tennis, basketball, handball and volleyball, which are all dependent on the ability to produce great LBEP (Karahan, 2011; Cherif *et al*., 2012). Prediction models have been successfully used in the prediction of aerobic performance in both adult and adolescent populations (Akalan *et al*., 2008; Roberts *et al*., 2009; Jacks *et al*., 2012; Pienaar *et al*., 2015). To the best of the authors' knowledge, no attempt has been made to develop a LBEP prediction model by making use of physical and motor performance variables in adolescents from South Africa. The only study that could be found is that of Carvalho *et al*. (2011) from Portugal in which an attempt at quantifying maximal short-term power production (a contribution model) in male adolescents was made. As such, findings from Carvalho *et al.* (2011) reported the percentage contribution of various indicators to maximal short-term power production, which in turn might indirectly influence the LBEP performances of adolescents. In addition, anaerobic peak power production contributed 52% to maximal short-term power production. The limited available literature, as well as the fact that no physical and motor performance LBEP model currently exists for 15-year-old South African adolescents has prompted this study. Results from this study will equip South African coaches and sport scientists who are interested in adolescents' performance with a tool to predict LBEP accurately in adolescents.

PURPOSE OF THE STUDY

The purpose of this study was to develop a valid LBEP prediction model from various physical and motor performance components among a cohort of male and female adolescents living in the Tlokwe local municipality of Dr the Kenneth Kaunda district in the North-West Province of South Africa.

RESEARCH METHOD

Research design

The research data for this study forms part of the Physical Activity and Health Longitudinal Study (PAHLS), which is an observational multidisciplinary study (2010–2014) (Monyeki *et al*., 2012). For the purpose of the current study, a cross-sectional experimental research design was employed in which the data of 2012 was used. The Ethics Committee of the North-West University (NWU-0058-01-A1), as well as the District Director of the Department of Basic Education in the Tlokwe Local Municipality approved the study.

Subjects

The 126 female and 88 male adolescents from Grade 10 (N=214; 15.8±0.68 years) were purposefully selected from pre-required class lists from 6 high schools in the Tlokwe Local Municipality (Potchefstroom area) of the Dr Kennith Kaunda District in the North West Province of South Africa. Four (4) of the selected schools were in the Ikageng Township area, which primarily consisted of subjects living in an semi-urban area (areas which are not part of a legally proclaimed urban area, but adjoin it; Statistics South Africa, 2007) and 2 of the schools were from the Potchefstroom urban area. At the time of measurement in 2012 only subjects in Grade 10 were eligible for participation. Prior to commencement, all

subjects

were informed concerning the nature of the study, including all potential risks and benefits. Informed consent for the research was requested from the school authorities, the parents and subjects of the participating schools in the weeks leading up to the research period. Only subjects who obtained full consent from all parties concerned took part in the study. Subjects were free to withdraw from the study at any time if they needed to do so.

Testing procedure

To determine the reliability of the tests used, a pilot study was conducted before commencement of the main study, during which one school's learners were subjected to the anthropometric protocol, as well as all the physical and motor performance tests. The average test-retest reliability coefficient for the physical and motor performance component tests of the pilot study was between 0.89 and 0.99. For the main part of the study, the subjects underwent 1 day of testing at the testing centre of the research institution. On arrival, the subjects completed the Demographic, General Information, Sport and Training Habits, Physical Activity and Maturity Determination Questionnaires after which the anthropometric measurements, physical, LBEP and motor performance tests were administered. Before the start of the physical, LBEP and motor performance tests, the subjects were subjected to a thorough warm-up of approximately 15 minutes consisting of aerobic running exercises for an estimated 8 minutes. Thereafter, a shorter warm-up period of specifically high-intensity movements and dynamic stretches followed.

Measurements and data were obtained with regard to stature, sitting height and body mass according to methods of the International Society for the Advancement of Kinanthropometry (ISAK) (Stewart *et al*., 2011), together with age, maturity age, and Peak Height Velocity (PHV) age. This was followed by the measurement of the physical and motor performance variables. *Physical performance* tests, each in accordance with their own method, included: sit-and-reach test (Maud & Kerr, 2006), shoulder external rotation (Harvey & Mansfield, 2000; Maud & Kerr, 2006), shoulder internal rotation (Harvey & Mansfield, 2000; Maud & Kerr, 2006), passive straight-leg raise (Maud & Kerr, 2006), active straight-leg raise (Harvey & Mansfield, 2000), Modified Thomas Iliopsoas test (MTIT) (Harvey & Mansfield, 2000; Maud & Kerr, 2006), and the Modified Thomas Quadriceps test (MTQT) (Harvey & Mansfield, 2000). The *motor performance* tests included, basketball throw (Ball, 1991), handgrip strength (Hoffman *et al*., 2009), abdominal strength (Eurofit, 1988), bent arm hang (Eurofit, 1988), sit-ups (Ellis *et al*., 2000), 40-metre acceleration and speed test (Ellis *et al*., 2000), and the 505-agility test (Ellis *et al*., 2000).

PHV age was calculated by using the birth date, measurement date and gender. For estimating maturity age, the anthropometric measurements of sitting height, body stature and body mass were used. For the final maturity age, chronological age was used from which PHV age at the date of measurement was subtracted (Thompson *et al*., 2002). If the PHV age was identical to chronological age, maturity age was categorised as zero (Thompson *et al*., 2002). Noting at which age male adolescents' voice broke and at which age menarche onset occurred for female adolescents was a verification of maturation age for each gender. The determination of maturation age for individual adolescents could not

be done utilising the Tanner stages (Faulkner, 1996) as cultural beliefs and practices prohibited the researchers from doing so.

For the LBEP measurements, the following test or measurements were taken: the Horizontal Jump Test (HJT), or as referred to as the standing broad jump (SBJ), the Vertical Jump Test (VJT), as well as peak velocity and peak power.

The VJT is regarded as a valid (r=0.93) and objective test (r=0.90) for determining the peak anaerobic power output of subjects (Safrit, 1990; Maud *et al*., 2006). The method of Harman *et al*. (2000) was used to execute the VJT. The subjects performed a minimum of 2 trials with a 10-second rest period between each trial with the better of the 2 trials being used in the final analysis. Power output during the VJT was measured for each jump with a Tendo Power Output Unit (Tendo Sports Machines, Trensin, Slovak Republic, 2009). The Tendo unit consisted of a transducer that was attached to the waist of each subject, which measured linear displacement and time. Subsequently, jump velocity was calculated and power would be determined. Both peak and mean power output were recorded for each jump and used for the subsequent analyses. According to Hoffman *et al*. (2009), the test-retest reliability of the Tendo unit is $r \leq 0.90$.

The HJT measured the explosive power in the legs and the ability to jump in a horizontal direction. To measure horizontal power output, the method of Maulder and Cronin (2005) was used. Each of the subjects was allowed 2 trials and the better of the 2 trials was used in the final analysis. The HJT is regarded as a reliable (r=0.89–0.90) (Maulder & Cronin, 2005:79) and valid test for determining peak anaerobic power output.

Data analysis

The Statistical Consultation Services of the North-West University (Potchefstroom Campus) determined the statistical methods and procedures for the analysis of the research data. SPSS for Windows (version 20) was applied for the analyses of the data. Firstly, descriptive statistics (minimum, maximum, mean and standard deviations), for each test predictor was analysed. T-tests (independent groups) were used to indicate statistically significant differences between the mean value of the male and female adolescents. Secondly, an exploratory principal component factor analysis with varimax rotation was performed for all the prediction variables. This was followed by a forward, stepwise multiple regression analysis in which the independent predictors identified from the factor analysis was included. The LBEP values, as measured by the vertical jump and the horizontal jump test were set as the dependant variables. The level of significance was set at $p \leq 0.05$.

The 4 measurements representing LBEP were the VJT, tendo peak power, tendo speed and the SBJ. Due to the high correlation between these 4 measurements, a Principal Component Factor Analysis (PCFA) was performed. The results of the PCFA indicated that the measurement of the adolescents' VJT had the highest loading as predictor of LBEP with a value of 0.86, while tendo peak power (0.73), tendo speed (0.83) and the SBJ (0.70) each yielded a lower loading as predictors. The prediction model for LBEP was, therefore, based on the VJT performance of the adolescents.

RESULTS

The descriptive statistics of the male and female adolescents are represented in Tables 1 to 3.

TABLE 1. **DESCRIPTIVE STATISTICS AND INDEPENDENT T-TEST FOR VARIABLES**

Variables	Total group (N=214)			Females (n=126)			Males (n=88)		
	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max
Age (yrs)	15.8±0.7	13.6	17.1	15.8±0.7	13.6	17.0	15.8±0.6	14.4	17.1
Stature (cm)	163.7±8.7	146.7	196.2	159.9±6.1	147.4	173.7	169.1±8.9**	146.7	196.2
Maturity age (yrs)	1.8±0.4	1.0	2.0	1.8±0.4	1.0	2.0	1.8±0.4	1.0	2.0
Sitting height (cm)	119.8±14.5	13.8	141.2	118.5±13.5	13.8	141.2	121.6±15.8	18.8	137.9
Body mass (kg)	57.2±14.2	32.9	120.8	55.4±12.9	32.9	118.5	59.3±15.0	34.8	120.8
PHV age (yrs)	14.2±0.7	12.4	16.0	14.2±0.7	12.4	16.0	14.2±0.7	12.5	16.0

* p<0.05 ** p<0.001 yrs= years cm= centimetre kg= kilogramme PHV= Peak Height Velocity

The results of Table 1 indicate significant differences only in the stature of the male and female adolescents.

TABLE 2. **DESCRIPTIVE STATISTICS AND INDEPENDENT T-TEST FOR FLEXIBILITY-RELATED PREDICTORS**

Measurements	Total group (N=214)			Females (F) (n=126)			Males (M) (n=88)		
	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max
Sit-and-reach end (cm)	30.6±9.2	0.0	53.5	32.3±7.4	10.7	49.0	28.3±11.0*	0.0	53.5
Shoulder external rotation best (º)	98.5±13.2	23.0	119.0	100.8±8.7	73.0	118.0	95.0±17.3*	23.0	119.0
Shoulder internal rotation best (º)	42.5±16.2	17.0	101.0	42.2±15.1	17.0	83.0	43.2±17.9	21.0	101.0
Passive straight-leg raise best (º)	99.4±16.5	57.0	153.0	101.4±14.9	61.0	135.0	96.7±18.1*	57.0	153.0
Active straight-leg raise best (º)	80.4±21.3	-1.0	230.0	84.2±20.0	50.0	230.0	75.2±22.1*	-1.0	121.0
MTIT best (º)	4.9±11.9	-30.0	83.0	3.0±9.4	-30.0	22.0	7.6±14.4*	-13.0	83.0
MTQT best (º)	66.1±11.5	40.0	97.0	67.8±11.4	40.0	97.0	63.5±11.2*	40.0	94.0

* p<0.05 ** p<0.001 cm= centimetre º= degrees
MTIT= Modified Thomas Iliopsoas Test MTQT= Modified Thomas Quadriceps Test

From Table 2 it is clear that the female adolescents showed statistically significantly better flexibility measurements (p<0.05) in the sit-and-reach test, shoulder external rotation,

passive straight-leg raise, active straight-leg raise, MTIT and the MTQT, than their male adolescent counterparts.

TABLE 3. **DESCRIPTIVE STATISTICS AND INDEPENDENT T-TEST FOR PHYSICAL- AND MOTOR PERFORMANCE-RELATED PREDICTORS**

	Total group (N=214)			Females (F) (n=126)			Males (M) (n=88)		
Measurement	**Mean±SD**	**Min**	**Max**	**Mean±SD**	**Min**	**Max**	**Mean±SD**	**Min**	**Max**
VJ (cm)	32.6±12.4	4.5	55.0	26.1±10.2	4.5	50.0	41.8±9.1 **	15.5	55.0
Tendo peak power (W)	1347.2±373.9	696.0	2870.0	1207.5±258.7	696.0	2264.0	1535.5±408.8 **	847.0	2870.0
Tendo speed (cm)	2.4±0.3	1.7	3.3	2.3±0.3	1.7	2.8	2.6±0.2 **	2.2	3.3
SBJ (cm)	165.5±34.5	98.0	325.0	150.8±30.9	108.0	325.0	186.7±28.1 **	98.0	280.0
Basketball throw (m)	4.6±2.8	1.2	7.4	4.1±0.56	1.2	5.4	5.0±0.9	3.6	7.4
Handgrip strength (kg)	30.8±8.4	9.3	58.2	26.2±4.7	9.3	40.6	37.4±8.0 **	18.4	58.2
Abd. strength (level)	2.3±1.9	0.0	7.0	1.9±1.7	0.0	6.0	2.9±1.9 **	0.0	7.0
Bent arm hang (sec)	10.1±12.5	0.0	55.4	3.2±4.2	0.0	21.4	20.2±13.6 **	0.0	55.4
Sit ups (reps)	27.0±10.4	2.0	52.0	22.5±9.8	2.0	46.0	33.2±7.6 **	13.0	52.0
5m-speed (sec)	1.3±0.2	0.9	1.8	1.3±0.1	0.9	1.8	1.1±0.1 **	0.9	1.5
10m-speed (sec)	2.2±0.2	1.6	2.9	2.3±0.2	1.7	2.9	2.0±0.1 **	1.6	2.3
40m-speed (sec)	7.2±3.4	5.3	54.3	7.5±0.8	5.9	10.4	6.7±5.2	5.3	54.3
505 left (sec)	3.0±0.3	2.3	3.8	3.1±0.2	2.3	3.8	2.8±0.2 **	2.4	3.3
505 right (sec)	3.0±0.3	2.4	4.0	3.1±0.2	2.7	4.0	2.8±0.2 **	2.4	3.4

* p<0.05 ** p<0.001 cm= centimetre sec= seconds VJ= Vertical Jump SBJ= Standing Broad Jump

Table 3 indicates significant differences (p<0.001) in the following tests: VJT, tendo peak power, tendo speed, SBJ, basketball throw, handgrip strength, abdominal strength, bent arm hang, sit ups, 5m-, 10m- and 40m-speed, 505 left and 505 right, with the results of the male adolescents being better than those of female adolescents.

In addition, an exploratory principal component factor analysis with varimax rotation was applied to all the physical and motor performance predictors and the predictors were reduced from 27 to 7. The remaining predictors used for further analyses were: gender,

10m-speed (sec), sit-and-reach end measurement (cm), the MTIT right (degrees), shoulder internal rotation test right (degrees), shoulder external rotation test right (degrees) and 40m-speed

(sec). These 7 predictors, together with the dichotomised value of gender (male=1, female=0) were entered into the forward stepwise regression analysis. The results are presented in Table 4.

TABLE 4. **RESULTS OF FORWARD STEPWISE REGRESSION ANALYSIS**

Predictors	***ß*eta**	**Regression coefficient**	**R-square change**	**p-value**
Gender	0.39	9.81	0.39	0.000**
10m-speed (sec)	-0.34	-18.33	0.07	0.000**

** $p<0.001$

The results in Table 4 indicate that only gender ($R^2=0.39$) and 10m-speed ($R^2=0.07$) acted as significant ($p\leq0.001$) predictors of LBEP in the adolescents with gender contributing 39% and 10m-speed contributing a further 7% to the total LBEP of the adolescents. The results further show that males achieved greater LBEP than female adolescents. The stepwise forward regression analysis coefficient of $R^2=0.458$ suggests that gender and 10m-speed contributed 46% to the variance of the LBEP values of the adolescents.

The prediction formula derived for LBEP from the predictors of gender and 10m-speed, equated to:

$$LBEP = 68.21 + 9.81\ (gender) - 18.33\ (10m\text{-}speed)$$

DISCUSSION

To the best of the authors' knowledge, this is the first study that attempted to develop a LBEP prediction model from various physical and motor performance components among a cohort of male and female adolescents living in the Tlokwe local municipality of the Dr Kenneth Kaunda district in the North-West Province of South Africa. The results revealed that a prediction model for the adolescents could be compiled by making use of gender and the 10m-speed results of the adolescents.

Accordingly, gender delivered a LBEP production contribution of 39% ($R^2=0.39$) to the total prediction model ($p<0.001$). Gender-specific differences during maturation resulting in increased body weight can be seen from the results (Table 1), and are in accordance with previous research by Rogol *et al*. (2000). Tomkinson (2007) demonstrated that an increase in fat mass impaired LBEP jumping values whereas an increase in muscle mass led to increased LBEP jumping values in children and adolescents form 6 to 19 years of age. For further clarification of the above-mentioned, Nevill *et al*. (2009) found 12-year-old male adolescents to have a LBEP of 9% higher compared to female adolescents due to males' marked increase in muscle mass. The increase in muscle mass and corresponding increase in LBEP is not experienced in female adolescents, mainly due to a lesser increase in testosterone production (Bratić *et al*., 2010). It is, therefore, suggested that an increase in

muscle mass contributes to an increase in the absolute anaerobic power output achieved from LBEP (Malina *et al*., 2004a; Tomkinson, 2007; Lazzer *et al*., 2009). The higher LBEP production seen in males is

also emphasised by the fact that female adolescents experience a 1.5 times increase in their fat mass during maturation (Malina *et al*., 2004a).

The results of the current study further indicate that 10m-speed contributed 7% (R^2=0.07; p<0.001) to the LBEP of the cohort of adolescents. In similar findings, the Counter Movement Jump test (CMJ), a variation of the VJT which is also used to evaluate LBEP, significantly correlated (r= -0.89; p<0.001), with the 10m-speed values of 12- to 15-year-old male and female tennis players (Girard & Millet; 2009). The ability to cover the longest possible distance in the shortest time span is vital for performance in some sporting events and this ability is directly related to maximum speed during the sprinting phases to propel the body horizontally (Boyle, 2011).

Therefore, the application of vertical jumping force and the ability to transfer the power generated into horizontal force, is key to the propulsion of the body during each stride in sprinting (Boyle, 2011; Paja, 2011). More specifically, Boyle (2011) found that LBEP, as measured by the SBJ, has a correlation of r= -0.54 to an adolescent's 10m-sprinting time. This take-off speed of a LBEP jump may influence the performance of adolescents in the vertical jump as the forward propulsion of the jump is also applied as vertical power (Boyle, 2011), and thus it will be assumed that a high take-off speed improves jumping performance (Papadopoulos *et al*., 2011). Sprinting distances, specifically of 10m, showed a weak significant correlation with the VJT (r= -0.36; p≤0.05) (Boyle, 2011).

For LBEP jumps, a stronger positive relationship is found between horizontal jumps than between vertical jumps (Maulder & Cronin, 2005). In this regard, Boyle (2011) reported that LBEP, as measured in the SBJ, explained 29% of the variance in 10m-sprinting time and 10 to 20% in 5m-sprinting time. No explanatory variable depicting VJT forces, such as the above-mentioned proposed by Boyle (2011), could be found for adolescent populations. Boyle (2011) further indicate that for elite under-15 to under-17 male soccer players, the 5m- sprinting time equation would be 20% less accurate if the LBEP (horizontal and vertical) production was not accounted for. The initiation of the sprinting action requires LBEP (Boyle, 2011), and thus, emphasises the use of LBEP during the initial phases and also the first 10m of a sprint in order to accelerate. The results of the current study concur with these above-mentioned results.

It is acknowledged that very little is currently known regarding the maturity effects on anaerobic power necessary for LBEP (Malina *et al*., 2004a). To further emphasise the complicated effects between gender, motor performance variables (LBEP and speed) and maturity (as with increased muscle mass), Figueiredo *et al*. (2010) found that early mature adolescents showed a higher vertical jump performance in conjunction with an increase in sprint and agility shuttle run values than late mature adolescents.

The significant contribution of 46% (R^2=0.458) made only by gender (39%), and 10m-speed (7%) to the LBEP prediction model of the cohort of adolescents, leads to the conclusion that LBEP is also influenced by various other factors. Anthropometrical (Malina

et al., 2004b; Girard & Millet, 2009), psychological (Escarti & Guzman, 1999), and external factors, such as available sporting facilities and environment (Chillón *et al*., 2011), as well as technique and training experience (Vanezis & Lees, 2005; Moresi *et al*., 2011; Paja, 2011), may be

some of the other factors that could account for the remaining variables in the LBEP prediction model.

CONCLUSIONS

The results from the present study led to the development of a LBEP prediction from two physical and motor performance components among a cohort of male and female adolescents living in the Tlokwe local municipality of the Dr Kenneth Kaunda district in the North West Province of South Africa. It is believed that this is the first study to investigate the possibility of predicting LBEP in adolescents. It seems conclusive that an adolescent's gender (r=0.390), as well as the power generated by an adolescent for propulsion of his/her own body weight in a 10m-sprint (r= -0.349), correlates significantly with his/her VJ height achieved during LBEP production. Limitations of this study are extended to non-demographic representation of the South African adolescent population, as female adolescents were represented by 48% more than male adolescents in the study population. Furthermore, Caucasian adolescents were also measured, but not necessarily in relation to their South African representation in general.

RECOMMENDATIONS

Recommendations for future research of this kind would be to compile LBEP prediction models for adolescents of all ages, as well as to conduct the study on a broader population representative of South Africa thereby allowing a better demographic representation of all races, as well as a more balanced gender representation. In spite of some limitations, the LBEP model developed may be valuable tool for sport scientists, coaches or teachers where no other measurement options are available or if expensive and time-consuming test batteries cannot be applied to obtain VJT measurements. Additionally, the LBEP prediction model developed may be used by making use of a gender notation entry and a 10m-sprint time result and will allow for accurate prediction of LBEP of adolescents with specific reference to the North-West Province of South Africa.

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REFERENCES

AKALAN, C.; ROBERGS, R.A. & KRAVITZ, L. (2008). Prediction of VO_2-max from an individualized submaximal cycle ergometer protocol. *Journal of Exercise Physiology*, 11(2): 1-17.

BALL, T.E. (1991). Medicine ball put (sitting on the floor) test. In R.F. Kirby (Ed.), *Kirby's guide to fitness and motor performance tests* (pp.331-332). Cape Girardeau, MO: Ben Oak Publishing.

BOYLE, M.A. (2011). Association and cross transfer of anthropometric data and vertical and broad jump forces with speed, agility and aerobic fitness in elite male u15-u17 soccer. Unpublished MSc thesis. Houston, TX: University of Houston-Clear Lake.

BRATIĆ, M.; NURKIĆ, M.; IGNJATOVIĆ, A.; STANKOVIĆ, N. & RADOVANOVIĆ, D. (2010). "Anaerobic power in male subjects of different chronological and biological age." Hyperlink [http://www.fsp.uni-lj.si/COBISS/Monografije/Proceedings1.pdf]. Retrieved on 7 March 2012.

CARVALHO, H.M.; COELHO E. SILVA, M.J.; FIGUEIREDO, A.J.; GONÇALVES, C.E.; PHILIPPAERTS, R.M.; CASTAGNA, C. & MALINA, R.M. (2011). Predictors of maximal
short-term power outputs in basketball players 14–16 years. *European Journal of Applied Physiology*, 111(5): 789-796.

CHERIF, M.; SAID, M.; NEJLAOUI, O.; GOMRI, D. & ABDALLAH, A. (2012). The effect of a combined high-intensity plyometric and speed-training program on the running and jumping ability of male handball players. *Asian Journal of Sports Medicine*, 3(1): 27-34.

CHILLÓN, P.; ORTEGA, F.B.; FERRANDO, J.A. & CASAJUS, J.A. (2011). Physical fitness in rural and urban children and adolescents from Spain. *Journal of Science and Medicine in Sport*, 14(5): 417-423.

CORNWELL, A.; NELSON, A.G. & SIDAWAY, B. (2002). Acute effects of stretching on the neuromechanical properties of the triceps surae muscle complex. *European Journal of Applied Physiology*, 86(5): 428-434.

DUMKE, C.L.; PFAFFENROTH, C.M.; MCBRIDE, J.M. & MCCAULEY, G.O. (2010.) Relationship between muscle strength, power and stiffness and running economy in trained male runners. *International Journal of Sports Physiology and Performance*, 5(2): 249-261.

DU PLESSIS, D.J. (2007). Comparative characteristics of New Zealand and South African u/16 rugby players with reference to game-specific skills, physical abilities and anthropometric data. Unpublished Master's thesis. Pretoria: University of Pretoria.

ELLIS, L.; GASTIN, P.; LAWRENCE, S.; SAVAGE, B.; BUCKERIDGE, A.; STAPFF, A.; TUMILTY, D.; QUINN, A.; WOOLFORD, S. & YOUNG, W. (2000). Protocols for the
physiological assessment of team sport players. In C.J. Gore (Ed.), *Physiological tests for elite athletes* (pp.128-144). Champaign, IL: Human Kinetics.

ESCARTI, A. & GUZMAN, J.F. (1999). Effects of feedback on self-efficacy, performance, and choice in an athletic task. *Journal of Applied Sport Psychology*, 11(1): 83-96.

EUROFIT (1988). *Handbook for the EUROFIT test of physical fitness*. Strasbourg (France): Council of Europe Committee for the Development of Sport, Committee of Experts on Sport Research.

FAULKNER R.A. (1996). Maturation. In D. Docherty (Ed.), *Measurement in pediatric exercise science* (pp.129-158). Champaign, IL: Human Kinetics.

FIGUEIREDO, A.J.; COELHO E SILVA, M.J. & MALINA, R.M. (2010). Size and maturity mismatch in youth soccer players 11- to 14-years-old. *Paediatric Exercise Science*, 22(4): 596-612.

FORAN, B. (2001). *High performance sports conditioning* (1st ed.). Champaign, IL: Human Kinetics.

GIRARD, O. & MILLET, G.P. (2009). Physical determinants of tennis performance in competitive teenage players. *Journal of Strength and Conditioning Research*, 23(6): 1867-1872.

HARMAN, E.; GARHAMMER, J. & PANDORF, C. (2000). Administration, scoring and

interpretation of selected tests (2nd ed.). In T.R. Beachle (Ed.), *Essentials of strength training and conditioning* (pp.218-317). Champaign, IL: Human Kinetics.

HARVEY, D. & MANSFIELD, C. (2000). Measuring flexibility for performance and injury prevention. In J.C. Gore (Ed.), *Physiological tests for elite athletes* (pp.98-113). Champaign, IL: Human Kinetics.

HERMASSI, S.; FADHLOUN, M.; SOUHAIL CHELLY, M. & BENSBAA, A. (2011). Relationship between agility T-test and physical fitness measures as indicators of performance in elite adolescent handball players. *Проблеми фізичного виховання і спорту* (*trans*.: Problems of Physical Education and Sport), 5: 125.

HOFFMAN, J.R.; RATAMESS, N.A.; KANG, J.; RASHTI, S.L.; FAIGENBAUM, A.D. & TRANCHINA, C.P. (2009). Effect of protein-supplement timing on strength, power and body-composition changes in resistance-trained men. *Journal of Sports Nutrition and Exercise Metabolism*, 19(2): 172-185.

JACKS, D.E.; TOPP, R. & MOORE, J.B. (2012). Prediction of VO_2 peak using a sub-maximal bench step test in children. *Clinical Kinesiology*, 65(4): 68-75.

JOVANOVIĆ, S.; TEŠANOVIĆ, G. & BOŠNJAK, G. (2010). "Speed, agility and explosive strength as components of jazz ballet dancers' training process". Hyperlink [http://www.fsp.uni-lj.si/COBISS/Monografije/Proceedings1.pdf]. Retrieved on 7 March 2012.

KARAHAN, M. (2011). The comparison of aerobic and anaerobic characteristics of young female team sports players. *World Journal of Sport Sciences*, 4(3): 234-238.

KARAHAN, M. & CECILIA, G. (2011). A comparative study: Differences between early adolescent male indoor team sports players' power, agility and sprint characteristics. *Science, Movement and Health*, 11(2): 185-189.

KINSER, A.M.; RAMSEY, M.W.; O'BRYANT, H.S.; AYRES, C.A.; SANDS, W.A. & STONE, M.H. (2008). Vibration and stretching effects on flexibility and explosive strength in young gymnasts. *Medicine and Science in Sport and Exercise*, 40(1): 133-140.

KORFF, T.; HORNE, S.L.; CULLEN, S.J. & BLAZEVICH, A.J. (2009). Development of lower limb stiffness and its contribution to maximum vertical jumping power during adolescence. *Journal of Experimental Biology*, 212(22): 3737-3742.

LAZZER, S.; POZO, R.; REJC, E.; ANTONUTTO, G. & FRANCESCATO, M.P. (2009). Maximal explosive muscle power in obese and non-obese prepubertal children. *Scandinavian Society of Clinical Physiology and Nuclear Medicine*, 29(3): 224-228.

LENNOX, A.; PIENAAR, A.E. & WILDERS, C. (2008). Physical fitness and the physical activity status of 15-year-old adolescents in a semi-urban community. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 30(1): 59-73.

MALINA, R.M.; BOUCHARD, C. & BAR-OR, O. (2004a). *Growth, maturation, and physical activity* (2nd ed.). Champaign, IL: Human Kinetics.

MALINA, R.M.; EISENMANN, J.C.; CUMMING, S.P.; RIBEIRO, B. & AROSO, J. (2004b). Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13-15 years. *European Journal of Applied Physiology*, 91(5-6): 555-562.

MAUD, P.J. & KERR, K.M. (2006). Static technique for the evaluation of joint range of motion and muscle length (2nd ed). In P.J. Maud & C. Foster (Eds.), *Physiological assessment of human fitness* (pp.227-251). Champaign, IL: Human Kinetics.

MAULDER, P. & CRONIN, J. (2005). Horizontal and vertical jump assessment: Reliability, symmetry, discriminative and predictive ability. *Physical Therapy in Sport*, 6(2): 74-82.

MILANESE, C.; BORTOLAMI, O.; BERTUCCO, M.; VERLATO, G. & ZANCANARO, C. (2010). Anthropometry and motor fitness in children aged 6-12 years. *Journal of Human Sport and Exercise*, 5(2): 265-279.

MILOJEVIĆ, A. & STANKOVIĆ, V. (2010). The development of motor abilities of younger adolescents. *Physical Education and Sport*, 8(2): 107-113.

MONYEKI, M.A.; NEETENS, R.; MOSS, S.J. & TWISK, J. (2012). The relationship between body composition and physical fitness in 14-year-old adolescents residing within the Tlokwe local

municipality, South Africa: The PAHL study. *BMC (Bio Medical Central) Public Health*, 12:374- 382.

MORESI, M.P.; BRADSHAW, E.J.; GREENE, D. & NAUGHTON, G. (2011). The assessment of adolescent female athletes using standing and reactive long jumps. *Sports Biomechanics*, 10(2): s73-s84.

MORSE, C.I.; DEGENS, H.; SEYNNES, O.R.; MAGANARIS, C.N. & JONES, D.A. (2008). The acute effect of stretching on the passive stiffness of the human gastrocnemius muscle tendon unit. *Journal of Physiology*, 586(1): 97-106.

NEVILL, A.; TSIOTRA, G.; TSIMEAS, P. & KOUTEDAKIS, Y. (2009). Allometric associations between body size, shape, and physical performance of Greek children. *Paediatric Exercise Science*, 21(2): 220-232.

NEWTON, R.U. & KRAEMER, W.J. (1994). Developing explosive muscle power: Implications for a mixed methods training strategy. *Strength and Conditioning Journal*, 16(5): 20-31.

NICHOLAS, C.W. (1997). Anthropometric and physiological characteristics of rugby football players. *Sports Medicine*, 23(6): 375-389.

PAJA, M.P. (2011). Correlation of the hang clean and back squat on vertical jump and lower body explosive strength. Unpublished MSc thesis. Marshall, MN: Southwest Minnesota State University.

PAPADOPOULOS, C.; NOUSSIOS, G.; MANOLOPOULOS, E.; KIRITSI, O.; NTONES, G.; GANTIRAGA, E. & GISSIS, I. (2011). Standing long jump and handheld halters: Is jumping performance improved? *Journal of Human Sport and Exercise*, 6(2): 436-443.

PIENAAR, C.; COETZEE, B. & MONYEKI, A.M. (2015). The use of anthropometric measurements and the influence of demographic factors on the prediction of VO_{2max} in a cohort of adolescents: The PAHL study. *Annals of Human Biology*, 42(2): 134-142.

ROBERTS, M.D.; DRINKARD, B.; RANZENHOFER, L.M.; SALAITA, C.G.; SEBRING, N.G.; BRADY, S.M.; PINCHBECK, C.; HOEHL, J.; YANOFF, L.B.; SAVASTANO, D.M.; HAN, J.C.
& YANOVSKI, J.A. (2009). Prediction of maximal oxygen uptake by bioelectrical impedance analysis in overweight adolescents. *Journal of Sports Medicine and Physical Fitness*, 49(3): 240- 245.

ROGOL, A.D.; CLARK, P.A. & ROEMMICH, J.N. (2000). Growth and pubertal development in children and adolescents: Effects of diet and physical activity. *American Journal of Clinical Nutrition*, 72(Suppl.): 521-528.

RONAN, M.; ERIC, D.; JOS, T.; EMMANUEL, V-P. & MARIO, B. (2003). Gender differences in longitudinal changes of maximal short-term leg peak power during growth. *Revista Portuguesa de Ciências do Desporto*, 3(2): 121-171.

SAFRIT, M.J. (1990). *Introduction to measurement in physical education and exercise* (2nd ed.). St. Louis, MO: Times Mirror/Mosby College.

SAUNDERS, D.H.; GREIG, C.A.; YOUNG, A. & MEAD, G.E. (2008). Association of activity limitations and lower-limb explosive extensor power in ambulatory people with stroke. *Archives of Physical Medicine and Rehabilitation*, 89(4): 677-683.

STATISTICS SOUTH AFRICA, Community Survey (2007). Basic results municipalities, South Africa. Report available on Statistics South Africa website: www. statssa.gov.za, 2007.

STEWART, A.; MARFELL-JONES, M.; OLDS, T. & DE RIDDER, H. (2011). *International standards for anthropometric assessment*. Lower Hutt (New Zealand): ISAK.

TEMFEMO, A.; HUGUES, J.; CHARDON, K.; MANDENGUE, S-H. & AHMAIDI, S. (2009). Relationship between vertical jumping performance and anthropometric characteristics during growth in boys and girls. *European Journal of Paediatrics*, 168(4): 457-464.

THOMPSON, A.M.; BAXTER-JONES, A.D.; MIRWALD, R.L. & BAILEY, D.A. (2002). Secular trend in the development of fatness during childhood and adolescence. *American Journal Human Biology*, 14(5): 669-679.

TOMKINSON, G.R. (2007). Global changes in anaerobic fitness test performance of children and

adolescents (1958–2003). *Scandinavian Journal of Medicine and Science in Sports*, 17(5): 497-507.

TRAVILL, A.L. (2011). The relationship between anthropometric characteristics and physical fitness of socially disadvantaged South African boys. *African Journal for Physical, Health Education, Recreation and Dance*, 17: 113-122, June, Supplement.

VANEZIS, A. & LEES, A. (2005). A biomechanical analysis of good and poor performers of the vertical jump. *Ergonomics*, 48(11-14): 1594-1603.

WITVROUW, E.; MAHIEU, N.; DANNEELS, L. & MCNAIR, P. (2004). Stretching and injury prevention: An obscure relationship. *Journal of Sports Medicine*, 34(7): 443-449.

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INFLUENCE OF COMPETITION ON VERTICAL JUMP, KICKING SPEED, SPRINT AND AGILITY OF YOUNG FOOTBALL PLAYERS

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ABSTRACT

The objective of this study was to analyse the influence of competition level (elite group [EG] and sub-elite group [SG]), on the Counter Movement Jump (CMJ), Kicking Speed (KS), sprint and agility in young football players. The subjects were 79 young football players (14 to 18 years old), from Andalusian football teams with mean parameters of 15.68 years (age), 1.74m (height), 64.93kg (weight) and 21.38kg/m^2 (Body Mass Index [BMI]). The results of the Analysis of Covariance showed that players in the EG performed better than the SG on all variables, after adjusting for age and BMI ($p \leq 0.028$). It was concluded that competing in a higher football division, involves higher performance levels for CMJ, KS, sprint speed and agility. This may suggest that training programmes are more effective and accurate at higher competition levels. Physical fitness could be a key factor in determining the level of a player at these ages. These football-specific skills could be used for designing and evaluating training programmes to improve the level of conditioning.

Key words: Power; Strength; Football-specific skills; Football division; Young players.

INTRODUCTION

In recent years, a growing number of studies have evaluated the physical and functional abilities of football players in formative categories (Gissis *et al.*, 2006; Gil *et al.*, 2007; Le Gall *et al.*, 2010; Gissis, 2012; García-Pinillos *et al.*, 2014a; García-Pinillos *et al.*, 2014b; García-Pinillos *et al.*, 2015). In this respect, the role of control and monitoring of these parameters along this evolution stage is vital in the long-term development of football players and may determine future sporting performance (Gil *et al.*, 2007; Gravina *et al.*, 2008; Le Gall *et al.*, 2010; García-Pinillos *et al.*, 2015). This research line supports the

hypothesis that a good physical capacity in football influences the technical performance, as well as tactical decisions, and may reduce the risk of injury (Stølen *et al.*, 2005).

The adolescent stage is the most susceptible period in development of physical abilities (Gissis, 2012; García-Pinillos *et al.*, 2014a). At this stage, a significant increase in skeletal muscle mass and strength, and a better development of anaerobic capacity and agility have been observed (Malina *et al.*, 2005; Philippaerts *et al.*, 2006). The basic movement patterns in

football require rapid force development and high-power output, as well as the ability to use the stretch-shortening cycle in ballistic movements efficiently (Thomas *et al.*, 2009; García-Pinillos *et al.*, 2014a). From this conditioning view, the most interesting events during a football match are represented by high-intensity work, such as sprint, turns, jumps, shots or tackles (Hoff & Hegerud, 2004). In this regard, previous studies have shown that muscle strength, power and speed are the most important physiological characteristics of football players (Reilly *et al.*, 2000; López-Segovia *et al.*, 2011). Moreover, jumping, kicking speed (KS), sprint or agility are highly correlated among themselves, and could be the better options to assess the football player performance (Comfort *et al.*, 2014; García-Pinillos *et al.*, 2014b).

As far as the authors know, just a limited number of studies have focused on sport performance differences between different competition levels in young football players. These studies use a wide variety of tests (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Gissis 2012). Likewise, standard values are unclear and important football-specific parameters such as KS or agility have been analysed poorly (Le Gall *et al.*, 2010; Papaevangelou *et al.*, 2012).

There are other studies with similar characteristics but they are focused on senior football players (Gissis, 2013; Ricotti *et al.*, 2013), specific positions (Gil *et al.*, 2007; García-Pinillos *et al.*, 2014b), or an age category (García-Pinillos *et al.*, 2015). Thus, it is still unclear whether playing in a higher division can lead to better football-specific abilities in young football players.

PURPOSE OF THE RESEARCH

The main objective was to analyse the influence of competition level (elite and sub-elite) on the Counter Movement Jump (CMJ), KS, sprint for 5, 15 and 20 metres (S5m, S15m, S20m) and agility in young football players. It was hypothesised that young football players from a higher competition level would produce better performance scores on the previously mentioned variables than sub-elite young football players.

METHODS

Participants

A total of 79 young male football players (aged: 14 to 18; Body Mass Index [BMI] of 21.38±2.28 kg/m^2), participated in the present cross-sectional study. They were divided into 2 groups according to competition level: the elite group (EG) (n=43) consisted of football

players from national youth football teams of the south of Spain and the sub-elite group (SG) (n=36), consisted of youth football players who participated in regional competitions.

Before participating in this study, parents, coaches and players were informed about the purpose of the research. Written parental consent was obtained for participants under 18 years old. The study was conducted with adherence to the standards of the Declaration of Helsinki (2008 version), and honouring the European Community's guidelines for Good Clinical Practice (111/3976/88 of July 1990), as well as the Spanish legal framework for clinical research on humans (Real Decreto 561/1993). The parental consent and study protocol was approved by the Bioethics Committee from the Director of Research and Teaching in

Physical Activity and Health (University of Jaén, Spain). Clubs were selected taking into account the number of weekly workouts to avoid previous differences (Ricotti *et al.*, 2013). In this way, the study was developed in-season, when participants attended football training 3 times per week and additionally played competitive matches once a week on the weekend. All participants had been involved in football training with this regularity for at least 4 years before the study. Selected players belonged to under-16 and under-18 age categories.

Instruments

Counter Movement Jump (CMJ): For the CMJ, the subjects performed a maximal vertical jump starting from a standing position without using arm swing. Subjects were instructed to keep their arms in akimbo position (hands on hips and elbow out), and they were required to flex their knees to a 90º angle. The participants were experienced players who perform CMJ in their daily training sessions. Moreover, to ensure that the execution of the CMJ was correct, a familiarisation session was carried out prior to the formal testing. The maximum jumping height (m) was recorded using the FreePower Jump Sensorize (Biocorp, Italy), which has been used previously in similar studies (García-Pinillos *et al.*, 2014a). Subjects performed 3 measured trials with a 30-second recovery period after each jump. The best result of the 3 trials was recorded for analysis (García-Pinillos *et al.*, 2014a).

Kicking speed (KS): The KS, in terms of ball speed (ms^{-1}), was measured during goal shooting. Markers were set up at 1m and 2m from the initial position of the ball. The KS was recorded with a high-speed camera (Casio Exilim EXZR-10 high-speed camera, Dover, NJ, USA) at a sampling frequency of 480 Hz for this test and was analysed by means of 2D photogrammetry. The video data were digitised using VideoSpeed (Version 1.38; ErgoSport, Granada, Spain). This methodology has also been used in similar studies previously (García- Pinillos *et al.*, 2014a). For this measurement, a ball of standard size and proper pressure according to the rules of Federation Internationale de Football Association (FIFA) was used. Each participant performed 3 trials with each leg. The best score for each leg were used for statistical analysis (Sedano-Campo *et al.*, 2009). The resting period between trials was 40 seconds. To standardise the procedure, a 2-step run-up was required. Participants were asked to kick the ball as fast as possible toward the goal with the dominant and nondominant leg alternatively. They were instructed not to decrease the speed to improve the accuracy of the shot.

Sprint: Sprint evaluation was accomplished through a speed test that was carried out in a straight 20m-line (Impellizzeri *et al.*, 2008; Comfort *et al.*, 2014). Markers were set up at 5m (S5m), 10m (S10m) and 20m (S20m). In order to eliminate reaction time, the subjects started without any starting signal from a static and standing position with feet parallel behind the start line. Similar to previous studies (Chelly *et al*., 2010; García-Pinillos *et al*., 2014a), sprint times (in seconds) were also measured through 2D photogrammetry. A lateral view of the 20m-sprint was obtained for all trials, using the same high-speed camera at a sampling frequency of 240 Hz for this test. The video camera was placed at a right angle to the running course and 15m away to obtain a sagittal image of the entire run. The video data were digitised using the VideoSpeed programme where the shoulder served as the point of interest to control the start and end of the time spent on performing the test (García-Pinillos *et al.*, 2014a).

Agility: Agility was evaluated be means of the Balsom Agility Test (BAT) (Balsom, 1994). This test evaluates the capacity of the subject to change direction quickly. For sprint and agility tests, players were allowed 2 trials with a 3-minute recovery period in between. The best trial was used for the BAT (Balsom, 1994), and sprint test (Thomas *et al.*, 2009). The times (in seconds) were analysed through 2D photogrammetry in an identical way to the sprint evaluation and KS. The shoulder was considered as the body segment to serve as the start and end of the time spent on performing the test (García-Pinillos *et al.*, 2015).

Experimental procedure

Data was collected, following previous procedures (García-Pinillos *et al.*, 2014a), by trained members of the research group with sufficient experience in football and strength training. For the evaluation, players were measured during two different sessions separated by 24 hours. In the first session, height (m) and weight (kg) were assessed with a portable SECA 214 height scale (Seca 214, Hamburg, Germany), and a type-B class-III ASIMED weight scale (Spain), respectively. These measures were used for the BMI calculation (expressed as kg/m^2). The participants were examined wearing underclothes and without shoes. The first testing day was also used as a familiarisation session with the selected tests, receiving further information about the selected tests and performing them 3 to 4 times (at low-intensity) to ensure the correct execution.

The second testing session was conducted outdoors on artificial turf. Tests were performed individually and in the following order: CMJ, KS, sprint and agility. Prior to the tests, participants began the session with a standard warm-up, consisting of 5 minutes of low-intensity running and 5 minutes of general exercises (high skipping, ballistic stretching, leg flexions, lateral running, front and behind arm rotation and sprints). Participants were instructed to maximise their performance in the different tests. These instructions were emphasised by means of demonstrations and verbal cues. Participants were advised to avoid high-intensity efforts in the 72 hours prior to the testing session.

Statistical analyses

Descriptive statistics were presented as mean and standard deviation (SD) or frequencies and percentages (%). The best result of each test was used in the analysis (Balsom, 1994; Sedano- Campo *et al.*, 2009; Thomas *et al.*, 2009; García-Pinillos *et al*., 2014a). Differences between EG and SG based on socio-demographic variables were evaluated by

applying the One-way ANOVA for continuous variables and the chi-square test for nominal variables. Differences in competition level based on the EG or SG as dependent variables were tested by One-way analysis of covariance (ANCOVA) adjusted for age and BMI. Analyses were performed using SPSS version 19.0 for Windows (SPSS Inc., Chicago). The criterion for statistical significance was $p<0.05$.

RESULTS

Table 1 presents descriptive characteristics of the study sample. There were no differences between the EG and SG regarding age (15.68±1.45 years), weight (64.93±9.7 kg) or specific position (p=0.914). Considering the whole-group, 12.7% were goalkeepers, 20.3% defenders, 25.3% left and right backs, 20.3% midfielders, 11.4% left and right wingers and 10.1%

forwards. In addition, results showed that the EG were taller and had a lower BMI than SG ($p\leq0.033$).

TABLE 1. **CHARACTERISTICS OF STUDY SAMPLE**

Variable	**Total Gr.** (N=79) Mean±SD	**EG** (n=43) Mean±SD	**SG** (n=36) Mean±SD	**p**
Age (years)	15.68±1.45	15.60±1.48	15.78±1.42	0.599
Height (m)	1.74±0.07	1.76±0.06	1.72±0.06	0.001
Weight (kg)	64.93±9.70	65.30±9.20	64.50±10.39	0.721
BMI (kg/m^2)	21.38±2.28	20.88±2.04	21.97±2.42	0.033
Specific position	n (%)			
Goalkeeper	10 (12.7%)	6 (14.0%)	4 (11.1%)	0.914
Defender	16 (20.3%)	9 (20.9%)	7 (19.4%)	
Left and right back	20 (25.3%)	11 (25.6%)	9 (25.0%)	
Midfielder	16 (20.3%)	7 (16.3%)	9 (25.0%)	
Left and right winger	9 (11.4%)	6 (14.0%)	3 (8.3%)	
Forward	8 (10.1%)	4 (9.3%)	4 (11.1%)	
Weekly training (days)	3	3	3	

EG= Elite Group SG = Sub-elite Group Significance $p<0.05$

Table 2. **INTER-GROUP DIFFERENCES FOR ANALYSED PARAMETERS**

Parameters	**Tot. Gr.** (N=79) Mean±SD	**EG** (n=43) Mean±SD	**SG** (n=36) Mean±SD	**Inter-group difference value (%)**	**p**
CMJ (m)	0.39±0.04	0.40±0.03	0.37±0.05	0.03 (7.50)	0.006
KS-Dom (ms^{-1})	25.03±3.76	26.65±3.96	22.70±1.68	3.95 (14.82)	<0.001

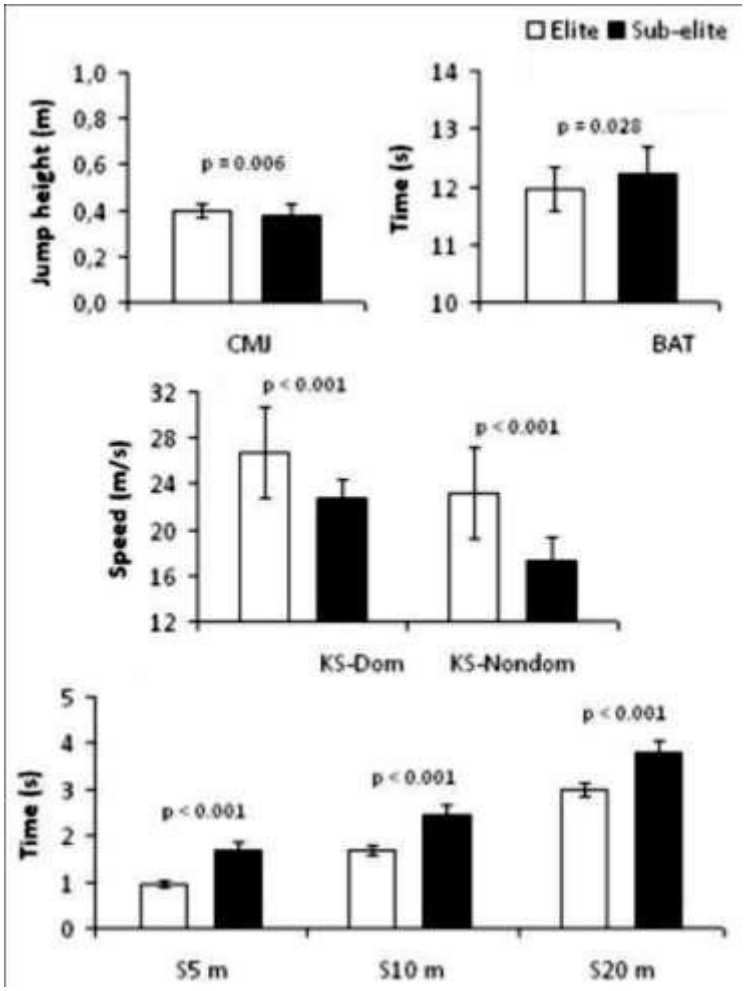
KS-Nondom (ms^{-1})	20.79±4.35	23.19±3.93	17.37±1.98	5.82 (25.10)	<0.001
S5m (s)	1.27±0.39	0.94±0.06	1.67±0.20	0.73 (43.71)	<0.001
S10m (s)	2.03±0.42	1.67±0.99	2.45±0.21	0.78 (31.84)	<0.001
S20m (s)	3.35±0.45	2.99±0.16	3.79±0.25	0.80 (21.11)	<0.001
BAT (s)	12.07±0.45	11.96±0.38	12.21±0.48	0.25 (2.05)	0.028

EG= Elite Group; SG= Sub-elite Group; CMJ= Counter Movement Jump; KS-Dom= Kicking Speed dominant leg; KS-Nondom= Kicking; Speed nondominant leg; S5m= Speed-5m; S10m= Speed-10m; S20m= Speed-20m; BAT= Balsom Agility Test. Significance at $p<0.05$

From the analysis of covariance, Table 2 presents the inter-group differences for the analysed parameters. Results show that the EG displayed a superior performance than the SG on CMJ (+0.03m, 7.5%), in KS with both legs (+3.95ms^{-1}, 14.82% and +5.82ms^{-1}, 25.1% for

dominant and nondominant legs, respectively), in speed (-0.73s, 43.71%; -0.78s, 31.84%; -0.8s, 21.11%; respectively for S5m, S10m and S20m), and agility (-0.25 s, 2.05%).

Analysis of covariance between the EG and SG showed that young football players in the EG had better scores than the SG on the CMJ, KS with both legs, sprint and agility after adjusting by important confounders as age and BMI (Total Group $p\leq0.028$) (Figure 1).



CMJ= Counter Movement Jump; BAT= Balsom Agility Test; KS-Dom= Kicking Speed dominant leg; KS-Nondom= Kicking Speed nondominant leg; S5m= Speed 5m; S10m= Speed 10m; S20m= Speed 20m. Significance at $p<0.05$.

FIGURE 1. **COMPARISON BETWEEN ELITE (n=43) AND SUB-ELITE GROUP (n=36): ANALYSES ADJUSTED FOR AGE AND BMI**

DISCUSSION

The aim of this study was to analyse the influence of competition level (EG and SG) on CMJ, KS, S5 m, S10 m and S20 m, and agility in young football players (14 to 18 years old). It was hypothesised that young football players in a higher competition level (elite) would present a superior performance than sub-elite players. The results obtained support the initial research hypothesis showing that players in the EG achieved better scores than those in the SG on the CMJ, KS with both legs, S5m-, S10m- and S20m-sprints, and agility,

after taking age and BMI into account as confounder variables. To our knowledge, there are no studies that have examined the influence of competition level in young football players on BAT or KS performance and the tests used to assess the CMJ and speed are very diverse (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Gissis, 2012). The scarcity of information about this topic makes it difficult to make comparisons in the discussion of the results obtained.

The CMJ is a popular test that has been widely used to assess the maximal vertical jump in football players (Gravina *et al.*, 2008; Juárez *et al.*, 2010; García-Pinillos *et al.*, 2014a; García-Pinillos *et al.*, 2014b; García-Pinillos *et al.*, 2015). Differences have been found between EG and SG, for young football players in a higher division in previous studies (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Gissis, 2012; Papaevangelou *et al.*, 2012). The data collected in this study were similar to those reported by the previous studies in both the EG, with a CMJ performance of 0.40m (Juárez *et al.*, 2010; Maio-Alves *et al.*, 2010), and the SG with a CMJ performance of 0.38m, being similar scores to those obtained with amateur adults (0.38m) (Impellizzeri *et al.*, 2008; López-Segovia *et al.*, 2011).

Focusing on KS, the results show that players in the EG achieved superior scores than the SG with both legs. Although this ability is strongly associated with other specific football strength abilities, such as vertical jump or sprint (Juárez *et al.*, 2010; García-Pinillos *et al.*, 2014b), most of the studies did not include this test to assess the performance in young football players (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Maio-Alves *et al.*, 2010; López-Segovia *et al.*, 2011; Gissis, 2012; Papaevangelou *et al.*, 2012). Muñoz and González (2012) analysed football kick kinematic differences between experienced and non-experienced young football players, and these authors only found differences on KS for the nondominant leg.

As reported in previous studies, KS could be influenced by various factors, such as the maximal strength of the muscles involved, the rate of force development, neuromuscular coordination, the linear and angular velocities of the ankle in the kicking leg, and the level of coordination between agonists and antagonists (Hoff & Hegerud, 2004; Sedano-Campo *et al.*, 2009; Muñoz & González, 2012; García-Pinillos *et al.*, 2014a). To sum up, scientific literature about KS of football players is still sparse especially with regard to young populations (Muñoz & González, 2012; García-Pinillos *et al.*, 2014a). This calls for more research in this area.

As for the S20m-sprint test, the result obtained (2.99s) is similar to that obtained by previous studies (Impellizzeri *et al.*, 2008; Le Gall *et al.*, 2010). In the SG, players attained 3.79 seconds, which is a similar mean score to that obtained for football players with similar characteristics (García-Pinillos *et al.*, 2014a), and slightly slower than amateur senior players

(3.22s) (López-Segovia *et al.*, 2011). According to competition level, this parameter shows that the EG were significantly faster than the SG (on S5m, S10m and S20m), which is in line with previous findings reported (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Gissis, 2012).

It is risky to compare the results obtained for agility (BAT) because of the diversity of tests used to assess this ability. In spite of this fact, it can be concluded that the results for the SG (12.21s) in the current study are similar to other studies involving non-elite players

(Philippaerts *et al.*, 2006; García-Pinillos *et al.*, 2014a). Considering the difference in performance based on competition level, the current results are identical in the case of CMJ and speed tests. The players in the EG produced better performances than their peers in the SG (Gissis *et al.*, 2006; Le Gall *et al.*, 2010; Gissis, 2012). However, comparisons with similar studies are not possible due to the absence, to the best of our knowledge, of other studies using BAT.

The magnitude of the differences for EG players in all the tests may be as a result of players in a higher division having different muscle strength levels and coordination patterns due to the training programme, which includes elements for the development of these football-specific skills (Gissis, 2012). Or it could be due to the duration, intensity and the types of the exercises used in their training, as well as other variables, such as training status or methods of testing (Markovic & Mikulic, 2010; García-Pinillos *et al.*, 2014a).

Despite its exploratory nature, this study offers some insight into influence of competition level on football-specific skills in a particular population. The present study confirms previous findings and contributes additional evidence. However, these findings are limited by the use of a cross sectional design, which does not allow for establishing causal relationships between variables. This limitation implies that the findings of this study need to be interpreted cautiously.

CONCLUSION

In conclusion, young football players in the EG obtained better scores than the SG on the vertical jump (7.5%), KS with both legs (14.82% and 25.1% for dominant and non-dominant, respectively), S5m-, S10m-, S20m-sprints (43.71%, 31.84% and 21.11% respectively), and agility (2.05%). This suggests that young elite football players participating at a higher level exhibit superior physical capacities than those participating at a sub-elite level. This fact might suggest that training programmes are more effective and precise (more accurate training prescription), at higher competition levels, where physical fitness is also important when determining the level of players at these ages. From a practical point of view, these football-specific skills can be used when designing and evaluating training programmes to improve the conditioning level. Finally, improved levels of conditioning would be a key factor to consider for football players at a lower level, as it could lead to improving sport performance.

REFERENCES

BALSOM, P.D. (1994). Evaluation of physical performance. In B. Ekblom (Ed.), *Football (Soccer)* (pp.102-123). London, UK: Blackwell Scientific.

CHELLY, M.S.; GHENEM, M.A.; ABID, K.; HERMASSI, S.; TABKA, Z. & SHEPARD, R.J. (2010). Effects of in-season short-term plyometric training program on leg power, jump and sprint performance of soccer players. *Journal of Strength and Conditioning Research*, 24(1): 2670-2676.

COMFORT, P.; STEWART, A.; BLOOM, L. & CLARKSON, B. (2014). Relationships between strength, sprint, and jump performance in well-trained youth soccer players. *Journal of Strength and Conditioning Research*, 28(1): 173-177.

GARCÍA-PINILLOS, F.; MARTÍNEZ-AMAT, A.; HITA-CONTRERAS, F.; MARTÍNEZ-LÓPEZ, E.J. & LATORRE-ROMÁN, P.A. (2014a). Effects of a contrast training program without external load on vertical jump, kicking speed, sprint, and agility of young soccer players. *Journal of Strength and Conditioning Research*, 28(9): 2452-2460.

GARCÍA-PINILLOS, F.; RUIZ-ARIZA, A. & LATORRE-ROMÁN, P. (2015). Influence of specific position in power and agility of young soccer players. *Retos. Nuevas tendencias en Educación Física, Deporte y Recreación*, 27: 58-61.

GARCÍA-PINILLOS, F.; RUIZ-ARIZA, A.; NAVARRO-MARTÍNEZ, A.V. & LATORRE-ROMÁN, P.A. (2014b). Performance analysis using vertical jump, agility, speed and kicking speed in young soccer players: Influence of age. *Apunts. Medicina d´Esport*, 49: 67-73.

GIL, S.; GIL, J.; RUIZ, F.; IRAZUSTA, A. & IRAZUSTA, J. (2007). Physiological and anthropometric characteristics of young soccer players according to their playing position: Relevance for the selection process. *Journal of Strength and Conditioning Research*, 21(2): 438-445.

GISSIS, I. (2012). Evaluation of physical capacities of strength and speed of different competition level young football players. *Journal of Physical Education and Sport*, 12(4): 544-549.

GISSIS, I. (2013). Comparison of physical capacities strength and speed of different competition level football player. *Journal of Physical Education and Sport*, 13(2): 255-259.

GISSIS, I.; PAPADOPOULOS, C.; KALAPOTHARAKOS, V.I.; SOTIROPOULOS, A.; KOMSIS, G. & MANOLOPOULOS, E. (2006). Strength and speed characteristics of elite, subelite, and recreational young soccer players. *Research in Sports Medicine*, 14: 205-214.

GRAVINA, L.; GIL, S.; RUIZ, F.; ZUBERO, J.; GIL, J. & IRAZUSTA, J. (2008). Anthropometric and physiological differences between first team and reserve soccer players aged 10-14 at the beginning and end of the season. *Journal of Strength and Conditioning Research*, 22(4): 1308-1314.

HOFF, J. & HELGERUD, J. (2004). Endurance and strength training for soccer players: Physiological considerations. *Sports Medicine*, 34(3): 165-180.

IMPELLIZZERI, F.M.; RAMPININI, E.; CASTAGNA, C.; MARTINO, F.; FIORINI, S. & WISLOFF, U. (2008). Effects of plyometric training on sand versus grass on muscle soreness and jumping and sprinting ability in soccer players. *British Journal of Sports Medicine*, 42: 42-46.

JUÁREZ, D.; LÓPEZ DE SUBIJANA, C.; MALLO, J. & NAVARRO, E. (2010). Análisis del golpeo de balón y su relación con el salto vertical en futbolistas juveniles de alto nivel (*trans*.: Analysis of the soccer kick and its relationship with the vertical jump in young top-class soccer players. *Revista Internacional de Ciencias del Deporte (International Journal of Sport Science)*, 19(6): 29- 41.

LE GALL, F.; CARLING, C.; WILLIAMS, M. & REILLY, T. (2010). Anthropometric and fitness characteristics of international, professional and amateur male graduate soccer players from an elite youth academy. *Journal of Science and Medicine in Sport*, 13(1): 90-95.

LÓPEZ-SEGOVIA, M.; MARQUES, M.C.; VAN DEN TILLAAR, R. & GONZÁLEZ-BADILLO, J.J. (2011). Relationships between vertical jump and full squat power outputs with sprint times in U21 soccer players. *Journal of Human Kinetics*, 30: 135-144, April.

MAIO-ALVES, J.M.; REBELO, A.N.; ABRANTES, C. & SAMPAIO, J. (2010). Short-term effects of complex and contrast training in soccer player´s vertical jump, sprint and agility abilities. *Journal of Strength and Conditioning Research*, 24(4): 936-946.

MALINA, R.; CUMMING, S.P.; MORANO, P.J.; BARRON, M. & MILLER, S.J. (2005). Maturity status of youth football players: A non-invasive estimate. *Medicine and Science in Sports and Exercise*, 37(6): 1044-1052.

MARKOVIC, G. & MIKULIC, P. (2010). Neuro-musculoskeletal and performance adaptations to

lower-extremity plyometric training. *Sports Medicine*, 40(10): 859-895.

MUÑOZ, A. & GONZÁLEZ, J.A. (2012). Soccer kick kinematic differences between experienced and non-experienced soccer players. *Retos. Nuevas tendencias en Educación Física*, *Deporte y Recreación*, 21: 63-66.

PAPAEVANGELOU, E.; METAXAS, T.; RIGANAS, C.; MANDROUKAS, A. & VAMVAKOUDIS, E. (2012). Evaluation of soccer performance in professional, semi-professional and amateur players of the same club. *Journal of Physical Education and Sport*, 12(3): 362-370.

PHILIPPAERTS, R.M.; VAEYENS, R.; JANSSENS, M.; VAN RENTERGHEM, B.; MATTHYS, D.; CRAEN, R.; BOURGOIS, J.; VRIJENS, J.; BEUNEN, G. & MALINA, R.M. (2006). The relationship between peak height velocity and physical performance in youth soccer players. *Journal of Sports Science*, 24(3): 221-230.

REILLY, T.; BANGSBO, J. & FRANKS, A. (2000). Anthropometric and physiological predispositions for elite soccer. *Journal of Sports Science*, 18(9): 669-683.

RICOTTI, L.; RIGOSA, J.; NIOSI, A. & MENCIASSI, A. (2013). Analysis of balance, rapidity, force and reaction times of soccer players at different levels of competition. *PLoS ONE*, 8(10): e77264.

SEDANO-CAMPO, S.; VAEYENS, R.; PHILIPPAERTS, R.M.; REDONDO, J.C.; DE BENITO, A.M. & CUADRADO, C. (2009). Effects of lower-limb plyometric training on body composition, explosive strength, and kicking speed in female soccer players. *Journal of Strength and Conditioning Research*, 23(6): 1714-1722.

STØLEN, T.; CHAMARI, K.; CASTAGNA, C. & WISLOFF, U. (2005). Physiology of soccer: An update. *Sports Medicine*, 35: 501-536.

THOMAS, K.; FRENCH, D. & HAYES, P.R. (2009). The effect of two plyometric training techniques on muscular power and agility in youth soccer players. *Journal of Strength and Conditioning Research*, 23(1): 332-335.

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EFFECTS OF MODIFICATION OF TASK CONSTRAINTS IN 3-VERSUS-3 SMALL-SIDED SOCCER GAMES

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ABSTRACT

In this study, the pedagogical principles of representation and exaggeration of Game-Centred Approaches (GCAs) as task constraints were examined. Youth soccer players' game performance was analysed according to tactical problems. Two different 3-versus-3 games were analysed using the Game Performance Evaluation Tool (GPET), namely a game modified by representation and a game modified by the pedagogical principles of representation and exaggeration that enhanced the problem of attacking the goal. It was found that there were a greater number of decision-making units for attacking during the modified game, which enhanced the problem of attacking the goal, although differences were not found to be significant. The players' tactical problem adaptation was significantly better in the game that was modified by representation with regard to maintaining possession of the ball ($p<0.01$) and advancing on the goal ($p<0.05$). Significant differences were also observed in getting-free decisions and executions ($p<0.05$ and $p<0.05$), and in kicking decisions and executions ($p<0.01$ and $p<0.01$). The findings suggest that a game focused on attacking the goal was more tactically complex than a game that was only modified by representation.

Key words: Sports pedagogy; Complex skill acquisition; Contextual interference; Modified games.

INTRODUCTION

Modern training methods have considered Small-Sided Games (SSGs) as a main tool to develop technical, tactical, and physiological performance in team sport. SSGs are modified forms of professional games, in which the structural elements of play (pitch dimensions, number of players or goals), are adapted in order to achieve the training objectives. However, while a theoretical framework of sport teaching provides ways to adapt SSGs (Oslin & Mitchell, 2006), few studies have provided justification to support the modification strategy in the design of games (Arias *et al*., 2011, 2012; Travassos *et al*., 2012). The question to be addressed is what the pedagogical consequences are of every modification that teachers and coaches make when they design a SSG. In relation to the performer-environment relationship,

the consequences may be explained by the non-linear understanding of sport behaviours (Dias *et al*., 2013). Non-linear pedagogy derived from ecological dynamics, highlights the

relationship between the performer and the environmental and task constraints.

From the learning point of view, task constraints are based on four pedagogical principles known as sampling, task complexity, representation and exaggeration (Thorpe *et al*., 1986; Tan *et al*., 2012). Representation implies that SSGs have the same structure as the related professional games, but the size elements of play are reduced. For example, in a 7-a-side soccer game, the goals, the penalty areas, and the full pitch area are reduced so that the tactical complexity is more or less the same as an 11-a-side soccer game, with the game further adapted to suit the learners' size, age and ability. The principle of exaggeration involves the modification of certain game elements to allow learners to explore a tactical problem, while the primary rules of the game are maintained. For example, if the goal in soccer is changed from having to score into a net to the challenge of scoring by dribbling across a line, the tactical problem of how to advance with the ball will be enhanced.

In accordance with the non-linear pedagogy, previous researchers analysing decision-making in team sport have considered how modifying task constraints can influence different aspects of technical-tactical performance (Travassos *et al*., 2012; Dias *et al*., 2013). For example, the studies of Lapresa-Ajamil *et al*. (2006), Lapresa-Ajamil *et al*. (2008) and Lapresa-Ajamil *et al*. (2010) researched the impact of the representation pedagogical principle using an observational tool to analyse the number of players as a task constraint. Their main findings were that a 5-a-side soccer game presents difficulties for beginners (6 to 7 years old) in terms of adaptation to space and skills; a 3-a-side soccer game is more advantageous than a 5-a-side game for beginners (6 to 7 years old) with regards to understanding the tactical complexity of depth and width; while a 9-a-side soccer game should be considered as an intermediate level game, falling between a 7-a-side and 11-a-side soccer game for players aged 12 to 13 years.

Furthermore, Costa *et al*. (2010) compared the tactical behaviours of youth soccer players in SSGs according to different goal sizes (6m x 2m and 3m x 2m), and concluded that there were no statistically significant differences in the tactical solutions performed for the two sized fields. Similar studies were performed in basketball by Arias *et al*. (2011) in which the effect of two different locations of the three-point line were measured, and by Arias *et al*. (2012) in which the effect of ball mass was analysed on dribbling, passing, and passing-reception in real-game situations.

The studies of González-Víllora *et al*. (2010) and González-Víllora *et al*. (2012), further analysed the decision-making process with their main conclusion being that decision-making was more influenced by tactical problems (in attack: keeping possession, advancing and attacking as defined by Bayer, 1992), than by any other structural elements of play. Serra- Olivares *et al*. (2011) further analysed these findings by comparing the game performance data of 21 soccer players, aged 8 to 9 years old, within a specific tactical context utilising two 3-versus-3 SSG's. For the study, one game was modified by representation and the second game was modified by exaggeration through the tactical problem of keeping possession of the ball. Serra-Olivares *et al*. (2011) found a significantly greater number of keeping-possession situations and improved tactical context-adaptation in the SSG that exaggerated this tactical

problem. However, they found that players made better decisions and thus improved

execution in the SSG that was modified using the representation pedagogical principle.

PURPOSE OF THE RESEARCH

Taking the above into account, it therefore seems important to research the pedagogical principles of the non-linear pedagogy in order to obtain data that informs of the real tactical difficulties of SSGs (Tan *et al*., 2012). This data could contribute to coaches' and teachers' efforts to design appropriate learning progressions. As a result, this research attempted to examine how youth soccer players' game performances (decision-making and execution variables) were influenced by the pedagogical principles of representation and exaggeration as task constraints in two different SSGs. The first game was modified only by representation and the second game was modified by both representation and exaggeration, focusing on the tactical problem of attacking the goal. It was expected that game performance would be different for the two games. Further, it was hypothesised that it would be easier for players to choose the tactical problem of attacking the goal in the SSG modified by pedagogical principles of representation and exaggeration.

METHOD

Participants and procedures

The study sample consisted of 21 skilled soccer players, aged 8 to 9 years old belonging to the youth academy of a 2nd division Spanish football team. They were selected on the basis of being classified as the best performers for their respective teams. All of the players had been participating in soccer for at least 1 year with more than 3 hours specific practice per week of, and all of them had experience in Soccer Federation competitions. This study was approved by a recognised ethics committee and the players' parents signed the relevant informed consent forms allowing their children to participate.

Research design

A comparative design was conducted in which players were assessed in 2 different SSGs (designed by 2 experts with more than 10 years teaching in soccer and games). Both modified games lasted 8 minutes, divided into 2 halves separated by 2 minutes of rest. One game was modified by representation (Figure 1), and the second game was modified by representation and exaggeration (Thorpe *et al*., 1986), while the last game focused on attacking-the-goal tactical problem (Figure 2). This resulted in the analysis of both the effect of the modification of the exaggeration principle, as well as the tactical complexity principle of GCAs as task constraints (Tan *et al*., 2012).

In the ***SSG-R***, the playing rules were similar to the current rules of a game of soccer, except that there were no goalkeepers. The game was played in an area comprising 20 x 30m. The main objective was to score as many points as possible, with one point being scored when a player kicked the ball into the opposing team's goal. Each team defended its own goal and attacked the opposing team's goal which measured 140 x 105cm. Attackers were allowed to

control, pass, dribble, kick and to support (to get-free), their team-mates during the game,

but they could not score from their own half of the field.

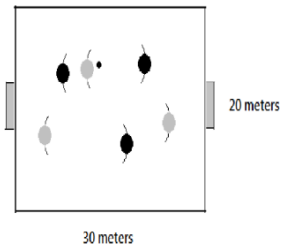

FIGURE 1. **3-VERSUS-3 SSG-R**

SSG-R= Small-Sided Game Representation

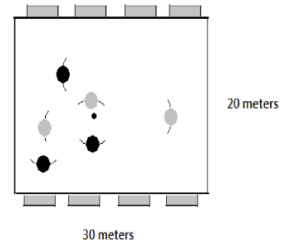

FIGURE 2. **3-VERSUS-3 SSG-R&E**

SSG-R&E= Small-Sided Game Representation & exaggeration

In the ***SSG-R&E***, the attacking-the-goal tactical problem was exaggerated. The game was played in an area comprising 20 x 30m, which contained 8 goal scoring areas. For this game, the shorter field length and greater numbers of separate goals served to increase the possibilities to score. There was also 1 goal more than there were players on each team (4 goals/3 players) for this same reason. The main objective was to score as many points as possible, with 1 point being scored when the ball entered any 1 of the 4 opposing team's goals which measured 140 x 105cm. Each team defended its own 4 goals and attacked the opposing team's 4 goals. Attackers were again allowed to control, pass, dribble, kick and support (to get-free), their team-mates during the game. Players were randomly organised into 7 teams of 3 players each, with seven 3-versus-3 matches randomly organised and video-recorded during 2 of the academy's training sessions for each of the 2, SSGs designed.

It is important to note that one team was required to play 2 matches for each SSG as a result of the uneven team numbers. As a result, the match-up for the 7th match, for each SSG, were randomly organised, but the data of only 1 of the teams was codified. The video-recording protocol included: (a) having a video camera in place; (b) having a similar warm-up prior to the 2 games; and (c) giving an explanation of the game rules. The game performances of the 21 young soccer players were compared between the SSG-R and the SSG-R&E modified games, in accordance with the 3 tactical problems proposed by Bayer (1992), which are, keeping possession of the ball, advancing towards the opposing goal and attacking the goal.

Coding instrument

The offensive game performances of players were codified for both SSGs using the Game Performance Evaluation Tool (GPET) (García-López *et al*., 2013). The GPET differs from previous game-performance assessment instruments, such as the French and Thomas (1987) and the Nevett *et al*. (2001) tools in the context of adaptation in decision-making analysis. Decision-making in the GPET was categorised into 2 levels, with the first level assessing decision-making and execution related to technical-tactical skills, while the second level assessed tactical context-adaptation performance. For the second level, the tactical intentions of players are analysed with regard to the principal tactical problem in which the action is located (Bayer, 1992). These can include keeping possession of the ball, advancing towards

the opposing goal and attacking the goal. For both levels, decision-making was coded as 1 (correct) or 0 (incorrect). The execution component of game performance was coded as 1 (successful) or 0 (unsuccessful). Table 1 describes the coding categories for the 2 levels of decision-making, and the execution component of the game performance.

TABLE 1. **GAME PERFORMANCE CODING CATEGORIES IN GPET**

Level 1. Technical-tactical skills	**Level 2.** Tactical context-adaptation performance
Attacker, on the ball: Decision-making and Execution Passing, Dribbling, Kicking *Attacker, off the ball*: Decision-making and Execution Getting-free skills	*Tactical context-adaptation*: Efficiency in selecting actions to keep the ball when the tactical problem is coded as "keeping-the-ball" context *Tactical context-adaptation performance*: Efficiency in selecting actions regarding advancing towards the opposing goal when the tactical problem is coded as "advancing-towards-the-opposing-goal" context *Tactical context-adaptation performance*: Efficiency in selecting actions to attempt to score when the tactical context is coded as "attacking-the-goal" context *Observing players' behaviour*: A player is coded as a "observing-player" when he or she does not show tactical intentions or involvement in the game

GPET= Game Performance Evaluation Tool

For Level 1, game performance (decision-making and execution variables), was grouped according to the attacking player's role, which could be either the on-the-ball player or the off-the-ball player. For Level 2, tactical context-adaptation performance was analysed as a single variable, with regard to invasion-games tactical problems. The "observing players' behaviour" was also analysed in this category (Table 1). For coding purposes, playing time was divided into decision-making units (DMUs) (Nevett *et al*., 2001), as was done in previous research (Gutiérrez-Díaz *et al*., 2011; González-Víllora *et al*., 2012). A decision-making unit ends after 4 seconds of action, whenever the player performed a different technical-tactical skill, or when the tactical problem changes. The GPET was validated by García-López *et al*. (2013) when their study demonstrated appropriate intra-observer and inter-observer correlations for all categories of the instrument, and has been proven to be a reliable tool for game-performance assessments (α=0.97). In addition, in the present study the observer was re-trained in the instrument showing similar intra-observer correlations ranging

from 0.77 to 1.00, as was found in the study of García-López *et al*. (2013) for all categories of the instrument.

Statistical analysis

Means and standard deviations were calculated for all offensive game performance variables in each of the SSGs. Players' game performances were compared between the same groups of variables (for example, differences in decision-making and in dribbling to keep the possession of the ball, between the SSG-R and the SSG-R&E). The Kolgomorov-Smirnov test for assumption of normality and the Levene test for homogeneity of variance showed that the sample did not meet these assumptions for all variables. Therefore, the Wilcoxon test was conducted to analyse differences in game performances between the two SSGs. Effect size (r)
was calculated using the following formula $r=Z/\sqrt{N}\sqrt{N}$, where N is the number of participants. Values of r=0.2, r=0.5 and r=0.8, were considered as small, moderate and large effect sizes, respectively.

RESULTS

The tactical context-adaptation performance of players was significantly better in the SSG-R for 2 situations, keeping possession of the ball and advancing towards the opposing goal. Large and moderate values of the effect size were reported in each of these cases, respectively. These differences were not found in tactical context-adaptation to attacking the goal or in the observer-player behaviour.

In relation to the decision-making and execution components of the game performance, no significant differences were found between games for keeping-the-ball contexts. However, players scored significantly higher for getting-free decision-making for the execution of advancing towards the opposing goal and for kicking decision-making and execution in the SSG-R, while exhibiting moderate values of the effect size.

After the video recording process, 1.747 DMUs were analysed, 887 in the SSG-R (17.7% in keeping possession of the ball; 76.7% in advancing towards the opposing goal; and 5.5% in attacking-the-goal situations), and 860 DMUs in the SSG-R&E (12.9% in keeping possession of the ball; 79.18% in advancing-towards-the-opposing-goal situations; and 7.9% in attacking-the-goal contexts). No significant differences were found between games for the number of DMUs in each of the 3 tactical problems: keeping possession of the ball ($Z= 0.65$; $p=0.51$; $r=0.14$), advancing towards the opposing goal ($Z=0.07$. $p=0.94$, $r=0.01$), and attacking the goal ($Z=1.42$; $p=0.15$; $r=0.30$). Table 2 presents the summary of results for every modified game, which compares the decision making and execution components of the game performance within each tactical problem.

Finally, no significant differences were found in the remaining analysed variables between games, although it is important to highlight, that there were observed differences for decision- making with regard to dribbling, getting-free to keep the ball, and for the execution of dribbling and passing to advance towards the opposing goal (Table 2).

TABLE 2. **DIFFERENCES IN GAME PERFORMANCES BETWEEN SSG-R AND SSG-R&E MODIFIED GAMES (n=21)**

Variable	**SSG-R** M±SD	**SSG-R&E** M±SD	Z	p	**Effect size (r)**
Tactical context-adaptation in keeping-the-ball problems	84.00±18.63	62.72±27.48	-3.91	0.00	0.85
Tactical context-adaptation performance in advancing-towards-the-opposing-goal problems	82.91±11.56	70.03±23.37	-2.10	0.03	0.45
Tactical context-adaptation performance in attacking-the-goal problems	81.20±31.52	82.28±21.68	-0.19	0.84	-
Observing players' behaviour	1.70±2.07	4.55± 8.33	-0.90	0.36	-
Keeping possession of ball context					
Ball control	87.27±14.59	91.35±12.04	0.91	0.36	-
Passing decision-making	89.58±26.44	93.13±15.65	0.70	0.48	-
Dribbling decision-making	80.18±20.40	87.50±21.24	1.63	0.10	-
Getting-free decision-making	93.75±17.67	41.94±39.29	1.47	0.14	-
Passing execution	76.87±39.35	81.37±29.97	0.11	0.90	-
Dribbling execution	80.35±34.02	87.50±21.24	0.73	0.46	-
Getting-free executions	93.75±17.67	76.00±35.13	0.73	0.46	-
Advancing towards opposing goal context					
Passing decision-making	84.20±27.01	81.12±14.77	0.54	0.58	-
Dribbling decision-making	74.32±31.72	58.85±35.29	1.05	0.29	-
Getting-free decision-making	83.86±25.15	74.11±17.44	2.16	0.03	0.47
Passing execution	62.14±30.65	76.09±18.78	1.68	0.09	-
Dribbling execution	86.94±24.13	77.39±28.22	1.59	0.11	-
Getting-free execution	79.39±23.08	68.71±18.78	2.16	0.03	0.45
Attacking the goal context					
Kicking decision-making	100.00±00.00	68.99±28.17	2.81	0.005	0.61
Kicking execution	75.98±30.02	31.09±26.87	3.28	0.001	0.71

M= Mean SD= Standard Deviation

DISCUSSION

The aim of this research study was to analyse how the exaggeration of the attacking-the-goal tactical problem influenced the game performance of youth soccer players in 3-versus-3 SSGs, thus indicating the manner in which game performance was influenced by the type of game modification. The 3-versus-3 SSG-R, which is similar in format to the professional game of soccer, was shown to be easier in terms of tactical context-adaptation than the 3-versus-3 SSG-R&E, where the attacking-the-goal tactical context was exaggerated. However,

improved results were found for certain variables of game performances, namely decision-making and execution for the 3-versus-3 SSG-R. For both SSGs, a similar total number of DMUs was found, with the DMUs analysed in relation to the tactical context in which they were made.

It is surmised that SSGs improve learning as they increase the number of opportunities for the players to practise the ability which is being focused on specifically (Serra-Olivares *et al*., 2011; Travassos *et al*., 2012). With this in mind and even though the SSG-R&E increased the number of advancing-towards-the-opposing goal and attacking-the-goal DMUs, the differences proved not to be significant. Despite the similar opportunities to practise advancing-towards-the-opposing-goal and attacking-the-goal tactical problems (quantitative view), significant differences were only observed for the tactical context adaptations of keeping-possession-of-the-ball and for advancing-towards-the-opposing-goal tactical problems (qualitatively).

These results are consistent with the study results of Serra-Olivares *et al*. (2011) who compared a 3-versus-3 SSG-R with a SSE-R&E in which the tactical problem of keeping-possession-of-the-ball was exaggerated. Here significant differences were found in the number of situations of the exaggerated tactical problem, and with players having a better tactical context adaptation. However, these results were observed because the exaggeration of the keeping-the-ball tactical problem eliminated the notion of attacking the goal. In this sense, the key purpose for this game was to not lose the ball, as there was no definitive purpose in advancing and attacking a goal. It should be stressed that the tactical problems of advancing and attacking the goal are closely connected. If players want to kick and score, they must have a previous success in advancing towards the opposing goal. In this sense, SSE-R&E did not provide kicking decisions and they did not allow a better tactical context-adaptation to advancing towards the opposing goal, although there were several goals and scoring options.

From the learning point of view, coaches should not consider the introduction of more goals in an SSG as a task constraint as it does not facilitate the tactical problems of learning how to advance towards the opposing goal nor how to attack the goal. On the other hand, in the SSG- R, players had better results in tactical context-adaptation to the tactical problems of keeping possession and of advancing towards the opposing goal. In this sense, if the main purpose is to facilitate the tactical problems of learning to keep possession of the ball and to advance towards the opposing goal, coaches might consider using a 3-versus-3 SSG in which elements of play are reduced (number of players, areas) as a method of teaching new programmes. This should be done before using a 3-versus-3 SSG in which the number of goals is augmented or where the field length is reduced and the field width is increased. These results differ from existing research in which other task constraints were altered to study players' behaviour in invasion games (Lapresa-Ajamil *et al*., 2006; 2008; Costa *et al*., 2010; Lapresa-Ajamil *et al*., 2010; Arias *et al*., 2011, 2012), or for other sport (Dias *et al*., 2013), in which only structural elements, such as the number of players or the goals and/or areas sizes were changed. This finding highlights the importance of studying the pedagogical principles for invasion games (Tan *et al*., 2012).

Related to game performance, players scored significantly higher in getting-free decision making and executions for advancing towards the opposing goal and for kicking

decision-

making and executions in the SSG-R modified game. Previous research has shown that off-the-ball skills are especially relevant in the learning process during invasion games (González-Víllora *et al*., 2010; González-Víllora *et al*., 2011). Getting-free has a great impact on the achievement of high levels of tactical-context adaptation. Getting-free for keeping possession of the ball was shown to be more difficult than getting-free for advancing towards the opposing goal, as was observed in the studies of González-Víllora *et al*. (2010) who analysed under-10 players during a 3-versus-3 SSG-R (32 x 22 metres), and that of González- Víllora *et al*. (2012), which involved games with under-8 players in a 2-versus-2 SSG-R (20 x 10m). In this sense, coaches should consider that the exaggeration and representation of the pedagogical principles used in this study would have made it easier to strengthen some abilities but not others, such as the getting-free movements and kicking skills.

The SSG-R&E analysed in this study could increase the difficulty in getting-free and kicking decisions and executions because there were not as many free spaces for the attackers to use as there were in the SSG-R, because of the reduced length of the field. The study yielded no differences in tactical context-adaptation in the attacking-the-goal tactical problem between games. Furthermore the players showed significantly better decisions and executions in kicking ability in the SSG-R-modified game, even though for the SSG-R&E, there were more goals in which players could score. For this study, modifying the game by exaggerating the options for attacking the goal and increasing the number of goals and the width of the field did not facilitate improved kicking decisions and executions. Even so, if coaches want to decrease the tactical complexity in the attacking-the-goal tactical problem, they should bear in mind that the modification of key elements does not necessarily decrease the difficulty of the game.

It could be argued that perhaps the SSG-R&E should have been modified through increasing of the size of the goals or through lengthening the field. If the main purpose was to facilitate the application of the tactical problems of attacking the goal and the ability to kick, it could be recommended using an additional attacking-the-goal game, such as 2-versus-1 plus goalkeeper situations with greater goals than those used by SSG-R&E. As has been suggested in non-linear pedagogy, this kind of modification, based on the variability conditions and task constraints, could improve the self-organisation process and the emergence of new movement patterns under the associated constraints (Tan *et al*., 2012; Dias *et al*., 2013). This aspect must be studied as, when games are modified to improve learning, it is necessary to know the real effects of these modifications.

Physical education teachers and coaches must control the representation and exaggeration pedagogical principles of GCAs. It is therefore recommended that they ensure this by providing feedback to re-orientate the behaviours of players during sport. Even though previous pedagogical studies have indeed shown methods to modify games (Oslin & Mitchell, 2006; Arias *et al*., 2011, 2012), no scientific studies have yet provided any justification to explain these modifications.

The questions that arise are firstly, why would a coach or teacher choose one of these methods when teaching games, and secondly, how can the representation and exaggeration

pedagogical principles be used to facilitate tactical learning? As there are several possibilities when modifying games, namely, increasing the number or players, altering the playing time,

or varying the kind of shot to score, the importance of manipulating key variables lies in confirming the representative task-constraint designs that induce player-context functional interactions in invasion-games training.

Regardless of this, the players observed in this study had acceptable game performance, and thus they made good decisions and executions in all tactical problems. This suggests that both analysed games could be used in soccer teaching/learning programmes for players at the same age and level of experience. The only question that remains is with regard to the method employed when modifying structural task constraints in terms of the size of the area or number of players, as this affects the creation of free spaces, and thus becomes important to modify in order to facilitate tactical learning.

REFERENCES

ARIAS, J.L.; ARGUDO, F.M. & ALONSO, J.I. (2011). Effect of two different forms of three-point line on game actions in girls' mini-basketball. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 33(1): 9-22.

ARIAS, J.L.; ARGUDO, F.M. & ALONSO, J.I. (2012). Effect of ball mass on dribble, pass, and pass reception in 9-11-year-old boys' basketball. *Research Quarterly for Exercise and Sport*, 83(3): 407-412.

BAYER, C. (1992). *La enseñanza de los juegos deportivos colectivos (trans.*: The teaching of collective sports games). Barcelona (Spain): Hispano Europea.

COSTA, I.; GARGANTA, J.; GRECO, P.; MESQUITA, I.; SILVA, B.; MÜLLER, E.; CASTELÃO, D.; REBELO, A. & SEABRA, A. (2010). Analysis of tactical behaviours in small-sided soccer games: Comparative study between goalposts of society soccer and futsal. *Open Sports Sciences Journal*, 3: 10-12.

DIAS, C.; MARTINS, F.M.L.; COUCEIRO, M.S.; CLEMENTE, F.M. & MENDES, R. (2013). A non-linear understanding of golf putting. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 36(1): 29-47.

FRENCH, K.E. & THOMAS, J.R. (1987). The relation of knowledge development to children's basketball performance. *Journal of Sport Psychology*, 9(1): 15-32.

GARCÍA-LÓPEZ, L.M.; GONZÁLEZ-VÍLLORA, S.; GUTIÉRREZ, D. & SERRA-OLIVARES, J. (2013). Development and validation of the Game Performance Evaluation Tool (GPET) in soccer. *Revista Euroamericana de Ciencias del Deporte*, 2(1): 89-99.

GONZÁLEZ-VÍLLORA, S.; GARCÍA-LÓPEZ, L.M.; CONTRERAS-JORDÁN, O.R. & GUTIÉRREZ-DÍAZ, D. (2010). Tactical awareness and decision making in youth football players 12 years: A descriptive study. *Journal for the Study of Education and Development*, 33(4): 489- 501.

GONZÁLEZ-VÍLLORA, S.; GARCÍA-LÓPEZ, L.M.; GUTIÉRREZ-DÍAZ, D. & PASTOR-VICEDO, J.C. (2012). Football players' game performance (8 years) in 2 vs. 2 small-sided games. *Revista de Investigación en Educación*, 10(1): 115-126.

GONZÁLEZ-VÍLLORA, S.; GARCÍA-LÓPEZ, L.M.; PASTOR-VICEDO, J.C. & CONTRERAS-JORDÁN, O.R. (2011). Tactical awareness and decision-making in 10 year old youth football players: A descriptive study. *Revista de Psicología del Deporte*, 20(1): 79-97.

GUTIÉRREZ-DÍAZ, D.; GONZÁLEZ-VÍLLORA, S., GARCÍA-LÓPEZ, L.M. & MITCHELL, S. (2011). Differences in decision making between experienced and inexperienced invasion games players. *Perceptual and Motor Skills*, 112(3): 871-888.

LAPRESA-AJAMIL, D.; AMATRIA-JIMÉNEZ, M.; EGÜÉN-GARCÍA, R.; ARANA-IDIÁKEZ, J. & GARZÓN ECHEVERRÍA, B. (2008). Análisis descriptivo y secuencial de la fase ofensiva en fútbol 5 en la categoría prebenjamín (*trans.*: Descriptive and sequential analysis of the 5 football game's offensive play for the age of 6 years old). *Cultura, Ciencia y Deporte*, 3: 107-118.

LAPRESA-AJAMIL, D.; ARANA-IDIÁKEZ, J. & GARZÓN-ECHEVERRÍA, B. (2006). El fútbol 9 como alternativa al fútbol 11, a partir del estudio de la utilización del espacio de juego (*trans.*: 9- football as an adjustment alternative for 11-football based on the control of the space). *Apunts. Educación Física y Deportes*, 86(4): 34-44.

LAPRESA-AJAMIL, D.; ARANA-IDIÁKEZ, J.; GARZÓN-ECHEVERRÍA, B.; EGÜÉN-GARCÍA, R. & AMATRIA-JIMÉNEZ, M. (2010). Adaptando la competición en la iniciación al fútbol: estudio comparativo de las modalidades de fútbol 3 y fútbol 5 en categoría prebenjamín (*trans.*: Adapting the competition for football beginners: A comparative study of the modalities 3-vs-3 and 5-vs.-5 football for U-8 players). *Apunts. Educación física y deportes*, 101, 43-56.

NEVETT, M.; ROVEGNO, I. & BABIARZ, M. (2001). Fourth-grade children's knowledge of cutting, pass and tactics in invasion games after a 12-lesson unit of instruction. *Journal of Teaching in Physical Education*, 20(4): 389-401.

OSLIN, J. & MITCHELL, S. (2006). Game-centred approaches to teaching Physical Education. In D. Kirk, D. MacDonald & M. O'Sullivan (Eds.), *The handbook of Physical Education* (pp.627–651). London, UK: Sage.

SERRA-OLIVARES, J.; GONZÁLEZ-VÍLLORA, S. & GARCÍA-LÓPEZ, L.M. (2011). Game performance differences between 8-9 years football players in two 3 vs. 3 small sided games. *Cuadernos de Psicología del Deporte*, 11(2): 77-91.

TAN, C.W.K.; CHOW, J.Y. & DAVIDS, K. (2012). How does TGfU work?' Examining the relationship between learning design in TGfU and a nonlinear pedagogy. *Physical Education and Sport Pedagogy*, 17(4): 331-348.

THORPE, R.; BUNKER, D. & ALMOND, L. (1986). A change in focus for the teaching of games. In M. Piéron, M. & K.C. Graham, *The 1984 Olympic Scientific Congress Proceedings, 6. Sport Pedagogy* (pp.163-169). Champaign, IL: Human Kinetics.

TRAVASSOS, B.; DUARTE, R.; VILAR, L.; DAVIDS, K. & ARAÚJO, D. (2012). Practice task design in team sports: Representativeness enhanced by increasing opportunities for action. *Journal of Sports Sciences*, 30(13): 1447-1454.

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EFFECT OF TRUST AND RISK ON PURCHASE INTENTIONS IN ONLINE SECONDARY TICKETING: SPORT CONSUMERS AND TICKET RESELLING

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ABSTRACT

The current research focused on examining how perceived risk and trust are related to consumers' purchase intentions within the online secondary ticket marketplace. Furthermore, this study attempted to identify the relationship between perceived risk and trust associated with online secondary ticketing. The Structural Equation Modelling (SEM) method with a convenience sample of 302 participants was employed to analyse the conceptual framework and psychometric property of the scale. The results indicate that trust significantly and negatively influenced perceived risk and trust exerts a significant impact on consumers' purchase intentions of online secondary tickets. Consumers' perceived risk had a direct negative effect on consumers' online purchase intentions of secondary ticketing. However, the findings of the current study showed that the impact does not reach a significant level. These results and future implications for practical and theoretical research are also discussed.

Key words: Sport consumer; Online secondary ticketing; Trust; Perceived risk.

INTRODUCTION

Online secondary ticketing is a market where sport and event tickets are resold to the public after being originally purchased by the public from the primary seller (Drayer *et al*., 2008). The online secondary ticket market is an estimated $5 billion business that continues to grow at an annual rate of 12% (Schroeder, 2013). A couple examples of this international market are „Viagogo" – Europe"s biggest online secondary ticket company and partner with the French Tennis Federation – and „Webtickets", a leading online ticket company in South Africa (*iSportConnect*, 2012; *eCommerceNews,* 2014). While the growth and popularity of the online secondary ticket market has created economic benefits for both sport fans and online secondary ticket providers, criticism of reselling tickets on the Internet has been raised related to areas, such as ticket scams and fraud (Giovanetti, 2013). Even

though companies strive to provide a safe and secure ticket-purchasing experience, consumers are not free from perceived risk when they purchase a particular product or service on the Internet (Chang & Chen, 2008).

Because of the continued rise in usage and business in the online secondary ticket market and the often uncertainty that accompanies transactions in the cyber marketplace (Cozart, 2010), the principal question of the current research is whether „risk" and „trust" play a crucial role in consumers" online secondary ticket purchase intentions. Several studies have suggested that trust is a critical success factor for e-commerce (Crowell, 2001; Kesharwani & Bisht, 2012; Kim *et al*., 2007), and „risk" negatively influences consumers" willingness to buy tickets online (Im *et al*., 2008; Kim *et al*., 2005). For instance, Kesharwani and Bisht (2012) asserted that „trust" is an antecedent of „risk", reducing behavioural uncertainty and associated risks in e-commerce transactions. According to Yousafzai (2010), consumers" beliefs can be increased by „trust" in an online environment and „trust" plays a significant role in reducing perceived „risk" involved in online transactions with e-retailers.

However, some researchers challenge the argument that „trust" reduces perceived „risk". For example, Pavlou (2003) noted that perceived „risk" is significantly and positively related to
„trust" in the online marketplace because perceived „risk" is a potential determinant of „trust". Yousafzai (2010) also emphasised that online „trust" can be increased by diminishing perceived environmental „risks", such as perceived security and privacy. As a result, there has been no consensus in the literature related to online „trust" and perceived „risk". Furthermore, only limited research within the sport management context has explained the relationships among „trust", „risk" and „purchase intentions" associated with online ticketing. In particular, no study in this area has empirically investigated how perceived „risk" and „trust" are associated with consumers" purchase „intentions" in online secondary ticket websites. Sport consumers, according to Stewart *et al.* (2003), can be regarded as customers who purchase sporting game and event tickets regularly or occasionally.

Little effort has been devoted to understand the needs of sport consumers associated with online secondary ticketing. Furthermore, just like other non-sport e-commerce websites, these sport ticket reselling portals can have uncertain and risky factors, such as scalpers, hackers, and unknown new technologies (Cozart, 2010). More importantly, compared to the online primary ticket process, there are more risk factors in online secondary ticketing transactions, such as counterfeit tickets offered by unauthorised sellers (Ahn *et al*., 2014).

FOCUS OF RESEARCH

This research focuses on how perceived „risk" and „trust" are related to sport consumers" purchasing „intentions" when they buy tickets through online secondary ticket websites. In addition, this study seeks to identify the relationship between perceived „risk" and „trust" associated with online secondary ticketing. Results from this investigation will enlighten online secondary ticket providers to consumers" „trust" and „risk" perceptions, as well as help ticket reselling professionals better understand the needs of sport consumers related to online secondary ticketing transactions. The following section describes the theoretical background related to each hypothesis in this study.

LITERATURE REVIEW

Trust

Various scholars who have studied online transactions have indicated that trust is a significant element for the success of e-businesses because the online transaction is challenging since there are no physical interactions between sellers and buyers (Lai *et al*., 2013). Trust can be defined as consumers‟ positive expectations that the online shopping and transaction processes are safe (Wu *et al*., 2008). According to Wang (2003), consumers are likely to make decisions about online shopping stores based on their degree of trust and this trust (or lack thereof), has an effect on consumers‟ behaviours. Thus, a lack of trust produces negative consumer attitudes toward web stores (Kesharwani & Bisht, 2012).

Perceived risk

According to Mayer *et al*. (1995), trust is essential when uncertainty in the results of future events exists. In other words, trust and perceived risk are connected features, which influence consumers‟ choices because not all actions of consumers can happen with complete certainty (Chen & Dhillon, 2003). Perceived risk in online e-commerce can be defined as consumers‟ perceptions about the potential negative outcomes from online transactions (Kim *et al*., 2007). Kim *et al*. (2005) indicate that perceived risk is a crucial barrier for online consumers when they purchase products or services on the Internet. In addition, perceived risk originating from uncertainty can convey more negative outcomes involved with consumers‟ purchasing behaviours (Kim *et al*., 2009). Thus, it is expected that perceived risk could influence consumers not to engage in online transactions.

Relationships among trust, perceived risk and purchase intentions

In e-commerce transactions, consumers tend to choose websites or companies that they trust in order to minimise potential risks. For that reason, the concept of trust also involves perceived risk and scholars have examined this trust-risk relationship (Gefen, 2002; Yousafzai, 2010). One of the primary arguments for the relationship between trust and perceived risk is that positive expectations from consumers can reduce the perceived uncertainty. In other words, trust provides a solution for particular problems of perceived risk and it is expected that trust is an antecedent of perceived risk (Gefen, 2002; Kim *et al*., 2007). In addition, trust can improve consumers‟ beliefs about online transactions and trusted websites can reduce perceived risks (privacy, security issues) associated with environmental uncertainty in the Internet (Lai *et al*., 2013). Based on these expectations and relationships, the following is the first hypothesis related to the study‟s proposed model:

H1: Trust is negatively associated with perceived risk in online secondary ticketing.

As mentioned earlier, the degree of trust and perceived risk will have an effect on consumers‟ purchase intentions in the online environment. According to Pavlou (2003), the concept of purchase intention is defined as individuals‟ willingness and intentions to make an online purchase. Several scholars have indicated that trust is a crucial factor in influencing purchase intentions (Gefen, 2002; Pavlou, 2003). For instance, consumers with a higher degree of trust in retailers are likely to have a higher degree of purchase intentions (Gefen & Straub, 2003) and there is a direct relationship between trust and purchase intentions (Grabner-Krauter & Kaluscha, 2003). Thus, trust can be a powerful factor that leads to consumers‟ purchase intentions. According to Fam *et al*. (2004), consumers‟

overall purchase decisions tend to

increase with a renowned website, which influences their trust towards that particular website. Several scholars also indicate that trust plays a crucial role in attracting customers to make a purchase (Reichheld & Schefter, 2000; Kuan & Bock, 2007). For example, Kuan and Bock (2007) found that a positive relationship exists between trust and purchase intentions in online grocery shopping.

The risk that a consumer perceives also has been found to have a significant influence in the consumer purchasing process. Many efforts have been devoted to understand the relationship between perceived risk and purchase intentions (Jarvenpaa *et al*., 2000; Gefen, 2002; Kim *et al*., 2007; Chang & Chen, 2008). According to Chang and Chen (2008), perceived risk has an influence on purchase intention and consumers tend to purchase fewer products when their perceptions of risk increase. Gefen (2002) also suggests that consumers with low perceived risk are more likely to engage in purchasing activities than consumers with high perceived risk. In an online environment, the spatial gap between consumers and e-retailers generates more unpredictability and uncertainty in purchasing transactions. Especially, Internet threats, such as hacking and phishing, lower consumers‟ behavioural intentions to engage in online transactions (Kesharwani & Bisht, 2012). Therefore, perceived risk can be negatively related to consumers‟ purchase intentions. Based on the preceding review of consumer characteristics in the online purchasing environment, the following are the final two hypotheses presented relating to the proposed model:

H2: Trust is positively associated with purchase intentions in online secondary ticketing.
H3: Perceived risk is negatively associated with purchase intentions in online secondary ticketing.

METHOD

Sample and procedures

The sample for this investigation was from undergraduate students at an institution of higher education located in Northeastern region of the United States. The sample is suitable for this study because college students are actively involved in various online ticketing activities (concerts) and arguably better understand how to use secondary ticket websites compared to other segments of the population. Sport marketing professors assessed face and content validity and the questionnaire was slightly changed based on their comments. After receiving permission from the Institutional Review Board (IRB), a self-administered survey was distributed in various business-related courses.

To investigate experiences associated with online secondary ticketing, respondents were asked to answer whether they had ever purchased secondary ticket online for sport events. While 372 students responded and submitted questionnaires, there were 70 of the respondents who were eliminated due to them providing incomplete answers or because they did not use secondary ticket websites for sport events. Thus, 302 questionnaires were used for the data analysis in this investigation. Of the sample, 60.9% of the participants were male and 39.1% female. The vast majority (88.1%) of the respondents were Caucasian and the highest remaining racial and ethnic percentages in the study were Hispanic (6%), African American (3%), Asian (1.3%) and Native American (0.3%).

Measures

In addition to several demographic variables, the questionnaire contained 3 major research constructs pertaining to the areas of perceived risk (PR), perceived trust (PT) and purchase intention (PI). All 3 constructs were measured on a 7-point Likert-type scales ranging from 1 (strongly disagree) to 7 (strongly agree). Three items of the trust scale were adopted and modified from the Jarvenpaa *et al*. (2000) study. The scales to measure perceived risks with 3 items were modified from the work by Featherman and Pavlou (2003). The purchase intention scale measures sport consumers‟ intention to purchase tickets from a secondary ticket website in the future. The scale for measuring purchasing intention was adopted and modified from the study by Im *et al*. (2008). Internal consistency for reliability was calculated using Cronbach‟s alpha. The reliabilities of the variables ranged from 0.78 to 0.88, all of which exceeded the minimum cut-off Cronbach‟s alpha level of 0.70 (Nunnally & Bernstein, 1994). However, in Structural Equation Modelling (SEM) studies, it is recommended to assess construct reliability (standardised loadings, measurement error for each item) for the measurement and structural models (Shook *et al*., 2004). Thus, construct reliability assessment was performed with this study and the results of this testing are revealed in Table 1.

TABLE 1. **CRONBACH'S ALPHA (A), FACTOR LOADINGS, CONSTRUCT RELIABILITY (CR), AVERAGE VARIANCE EXTRACTED (AVE), AND MEANS**

Factor and items	**Loading**	**CR**	**AVE**	**Means**
Trust (α = 0.89)		0.83	0.62	
TR 1: Based on my experience with the website in the past, I know it cares about customers	0.78			5.06
TR 2: Based on my experience with the website in the past, I know it is predictable	0.80			5.07
TR 3: Based on my experience with the website in the past, I know it is trustworthy	0.79			5.19
Perceived risk (α = 0.88)		0.81	0.59	
PR 1: The security systems built into the website are not strong enough to protect my checking account.	0.71			2.87
PR 2: What are the chances that using the website will cause you to lose control over the privacy of your payment information?	0.78			2.85
PR 3: My signing up for and using the website would lead to a loss of privacy for me because my personal information would be used without my knowledge.	0.82			2.85
Purchase intention (α = 0.89)		0.83	0.63	
PI 1: I predict I would purchase tickets from the website.	0.76			5.38
PI 2: The website would be one of my favourite technologies for purchasing tickets	0.78			5.03
PI 3: I intend to purchase tickets from the website.	0.84			5.26

Data analysis

The collected data and the psychometrics of the scale were analysed with the SPSS 20.0 and AMOS 20.0. Descriptive statistics and internal consistency reliability were examined by SPSS. Prior to testing, the proposed model, a Confirmatory Factor Analysis (CFA) (reliability, convergent validity, discriminant validity), was analysed to examine the appropriateness of the latent factors. Then SEM was conducted to test the hypothesised relationships among constructs. To assess adequately the goodness-of-fit and the parsimony of the proposed model, a chi-square with related degrees of freedom (df), the Root Mean Square Error of Approximation (RMSEA) and the Comparative Fit Index (CFI) were examined.

RESULTS

Measurement model

The CFA of the measurement model was analysed to identify the relationships observed and latent variables. The RMSEA, CFI and the Tucker-Lewis Index (TLI) were examined in order to assess adequately the goodness-of-fit and parsimony of the model. The measurement model was found to be at an acceptable level of S-B χ^2/df ratio (2.49; $p<0.001$), which is lower than the recommended threshold of 3.0 (Kline, 2005). Other fit indices also showed that the measurement model fit the data well (RMSEA=0.07, CFI=0.98, NFI=0.97, IFI=0.98, TLI=0.97).

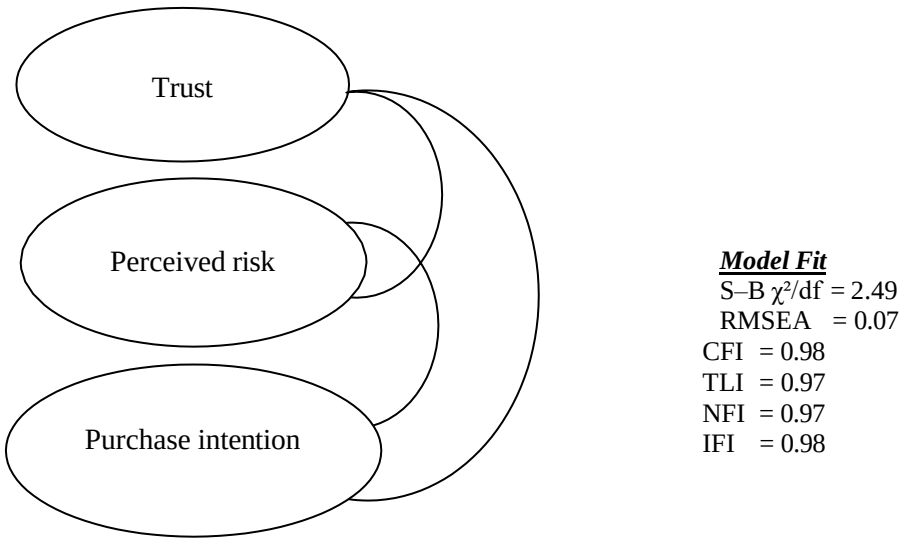

FIGURE 1. **MEASUREMENT MODEL**

The construct reliability of measures for each of the latent variables ranged from 0.88 to 0.96, all of which exceed the recommended standard of 0.70 (Nunnally & Bernstein, 1994). Convergent validity was measured through an examination of both the significance of factor loadings and the Average Variance Extracted (AVE). All loadings were statistically significant at the 0.001 level and all of the AVEs were greater than 0.50, thus

demonstrating

convergent validity (Fornell & Larcker, 1981). Discriminant validity was measured through a correlation analysis among the latent factors (Table 2). The estimated correlations between the latent factors were lower than the 0.85 recommended threshold (Kline, 2005).

TABLE 2. **FACTOR CORRELATIONS BETWEEN CONSTRUCTS**

	TR	PR	PI
TR	—	—	—
PR	-0.55	—	—
PI	0.77	-0.39	—

TR= Trust PR=Perceived Risk PI= Purchase Intention

Structural model

The structural model was tested to understand further the hypothesised relationships of each construct. The overall model fit of the SEM analysis was acceptable (S-B χ^2/df ratio= 2.73, *p* <0.001; RMSEA=0.086; CFI=0.95; NFI=0.92; IFI=0.95, TLI=0.94). In addition, Table 3 summarises path coefficients for the hypothesised relationships for *H1*, *H2*, and *H3*. The results of the SEM testing indicate that all of the path coefficients for the 3 hypotheses were well balanced. A significant path coefficient (-0.55; $p<0.05$) was found from trust to perceived risk (*H1*). Consistent with the hypothesis expectations put forward above, there was a negative relationship between trust and perceived risk. The path coefficient of trust to purchase intention was 0.77, which means that trust was found to be a significant predictor of purchase intentions (*H2*). Furthermore, the path coefficient of perceived risk to purchase intentions was 0.02 (*H3*). As expected, the influence of trust was positive while the influence of perceived risk was negative.

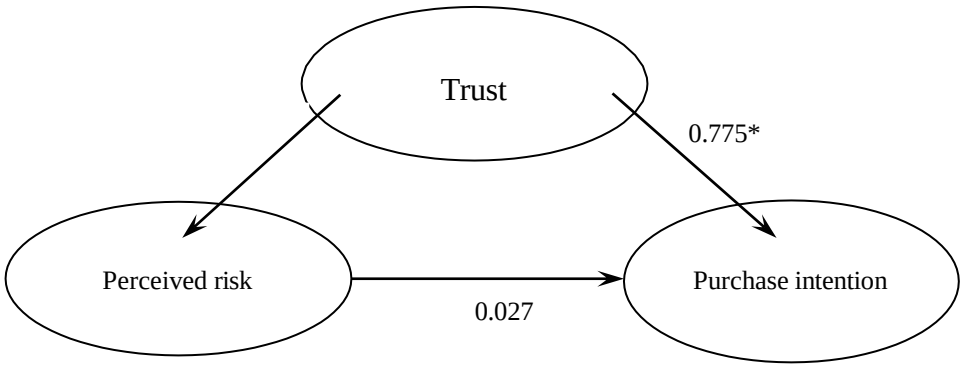

FIGURE 2. **PROPOSED MODEL**

TABLE 3. **ANALYSIS OF PROPOSED MODEL**

Path	**Estimate**
TR → PR	0.079
TR → PI	0.164*
PR → PI	0.658*
S-B χ^2/df=2.73; RMSEA=0.086	CFI=0.95; NFI=0.92; IFI=0.95; TLI=0.94; AIC=303.43

TR= Trust PR= Perceived Risk PI= Purchase Intention * p <0.05

DISCUSSION

The current study focused on examining how trust and perceived risk influence sport consumers‟ purchase intentions within the online secondary ticket marketplace. In addition, this research identified the relationship between trust and perceived risk associated with online secondary ticketing. The SEM results supported the study‟s first hypothesis (*H1*) that trust significantly and negatively influenced perceived risk. This first finding is consistent with a previous study that trust might be a key antecedent factor of perceived risk (Gefen, 2002). This result is in line with earlier research that found that trust plays a significant role in reducing risk factors in the online environment (Kim *et al*., 2007). Thus, an increase in consumer trust might be related to a reduction in perceived risk in online transactions.

Sport marketers and managers can use this concept to make more reliable and trustworthy online environments in order to decrease some harmful elements (security issues, privacy concerns, non-immediate responses, technical problems), that at the time are affiliated with online secondary ticket websites. Providing precise regulations and consumer protection programmes make online secondary ticket websites more trustworthy and responsible. For instance, such websites should provide specific functions (frequently asked consumer questions), and options (online live chatting services), so that sport consumers can better understand the website operators‟ attitudes and approaches related to problem-solving. Sport consumer behaviour and management professionals should create different marketing strategies for various sport consumer groups on both how to increase online trust and how to minimise perceived risk. Consumers should also be cautious when dealing with unauthorised ticket resellers as some unscrupulous ticket brokers and entrepreneurs can at times take advantage of their online buyers.

The research findings of the current investigation also supported the second hypothesis (*H2*) that online trust exerts a significant impact on consumers‟ purchase intentions of online secondary tickets. This finding is in line with previous studies of Gefen (2002) and Pavlou (2003), and can be explained by noting that increases in trust, will directly and positively affect the purchase intentions of consumers. When a consumer purchases a sport industry ticket in the physical world, there are many potential bases of trust, such as a seller‟s professional appearance or location. However, the online secondary ticket market has no physical cues and personal interactions and, furthermore, involves more risk than the general online, primary ticket market. Therefore, sport practitioners need to recognise that the real

possible way to improve consumers‟ purchase intentions for secondary tickets is to provide structural assurance, such as guarantees, which are important to build consumers‟ trust in online transactions. This trust will then result in consumers‟ performing actions, such as buying a ticket. Furthermore, detailed descriptions about customer support and service should be mentioned clearly on online secondary ticket websites in order to assist and ease the mind of consumers in their purchase processes.

Regarding the third hypothesis (*H3*) that consumers‟ perceived risk has a direct negative effect on consumers‟ online purchase intentions of secondary ticketing, the findings of the current study showed that the impact does not reach a significant level. Therefore, this finding does not match with the past studies of Gefen (2002) and Kesharwani and Bisht (2012). One possible explanation for this novel finding could be that perceived risks are not significantly related to consumers‟ purchase intentions could be presented as an example. Certain consumers can simply make a risky online transaction with a low level of trust because there may be a highly discounted price. Alternatively, there may be some powerful incentives from a suspicious online seller that works to attract consumers into making a purchase decision. Furthermore, consumers may become less sceptical of online secondary ticket websites if those ticket-reselling portals offer some protection or potential reimbursement. Some recent online secondary ticket vendors have adopted new technologies and improved their expertise and offerings, which have in turn decreased the often latent risks that are at times associated with online transactions. For instance, a number of sellers include pictures of the secondary tickets with their websites, which may protect consumers from scammers. Thus, consumers‟ purchase decisions can be made with a decreased concern related to the perceived risks involved with online secondary ticketing.

By identifying the relationship between trust, perceived risks and purchase intentions, this study provides a better understanding of the influences of trust and perceived risk on online secondary ticket websites. The current investigation sought to provide theoretical explanations and empirical validation of the understanding of the psychological components of consumers, as well as their behavioural intentions, especially how trust and perceived risk are linked to consumers‟ purchase intentions. Therefore, the proposed theoretical model in this study might be helpful to understand consumers‟ needs and concerns when they buy secondary tickets from online vendors. The results of this study also strongly support that trust plays a significant role to increase consumers‟ purchase intentions, as well as to decrease risk perceptions associated with online secondary ticket websites.

Although the findings of this research provide some new insights to researchers and suggestions for practitioners, there are some limitations. The sample of the current study focused on only student populations who already have some experiences in engaging with online purchase transactions. This research did not include potential customers who may not have experience of the online secondary ticketing process, but have some intentions to engage in online purchase activities. By including these potential customers, it would enhance the generalisability of the results. It is recommended that future studies identify the impact of gender differences with the proposed model in this research because Jayawardhena *et al*. (2007) indicated that gender has a critical influence on online purchase intentions. Furthermore, it is proposed that an evaluation be made of the differences among

online secondary ticketing, general online ticketing and on-site ticketing in terms of consumers‟

psychological components (trust, perceived risk). The reason for this suggestion for future research is that online secondary ticketing has more perceived risk than other ticketing environments (Giovanetti, 2013).

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REFERENCES

AHN, T.; SUH, Y.I.; LEE, J. & PEDERSEN, P.M. (2014). The effects of perceived risks and trust on purchase intentions in secondary ticket websites: Application of extended Technology Acceptance Model (TAM). *International Journal of Sports Marketing and Sponsorship*, 16(1): 40-54.

CHANG, H.H. & CHEN, S.W. (2008). The impact of online store environment cues on purchase intention: Trust and perceived risk as a mediator. *Online Information Review*, 32(6): 818-841.

CHEN, S.C. & DHILLON, G.S. (2003). Interpreting dimensions of consumer trust in e-commerce. *Information Technology and Management*, 4: 303-318.

COZART, E.S. (2010). The relationship between the online secondary ticket market and college athletics. Unpublished Master‟s thesis. Chapel Hill, N.C.: Department of Exercise and Sport Science, University of North Carolina. [Retrieved from Proquest]

CROWELL, W. (2001). Trust, the e-commerce difference. *Credit Card Manager*, 14(5): 80.

DRAYER, J.; STOTLAR, D.K. & IRWIN, R. (2008). Tradition vs. trend: A case study of team response to the secondary ticket market. *Sport Marketing Quarterly*, 17: 235-240.

eCOMMERCENEWS (2014). “Online ticketing industry tightens security controls”. *eCommerceNew*s.co.za. Hyperlink [http://ecommercenews.co.za/online-ticketing-industry- tightens-security-controls/]. Retrieved on 1 October 2014.

FAM, K.S.; FOSCHT, T. & COLLINS, R.D. (2004). Trust and the online relationship: An exploratory study from New Zealand. *Tourism Management*, 25(2): 195-207.

FEATHERMAN, M.S. & PAVLOU, P.A. (2003). Predicting e-services adoption: A perceived risk facets perspective. *International Journal of Human-Computer Studies*, 59*:* 451-474.

FORNELL, C. & LARCKER, D. (1981). Structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1): 39-50.

GEFEN, D. (2002). Reflections on the dimensions of trust and trustworthiness among online consumers. *Data Base for Advances in Information Systems*, 33(3): 38-53.

GEFEN, D. & STRAUB, D. (2003). Managing user trust in B2C e-services. *e-Service Journal*, 2(2): 7- 23.

GIOVANETTI, T. (2013). “Protecting secondary markets for tickets.” Hyperlink [http://www. ipi.org/ipi_issues/detail/protecting-secondary-markets-for-tickets]. Retrieved on 5 August 2014.

GRABNER-KRAUTER, S. & KALUSCHA, E.A. (2003). Empirical research in on-line trust: A review and critical assessment. *International Journal of Human-Computer Studies*, 58: 783-812.

IM, I.; KIM, Y. & HAN, H. (2008). The effects of perceived risk and technology type on users‟ acceptance of technologies. *Information Management*, 45(1): 1-9.

iSPORTCONNECT (2012). “VIAGOGO named as official secondary ticket market place for Roland

Garros." iSportConnect.com. Hyperlink [http://www.isportconnect.com/index.php?option=com_content&view=article&id=11896:viagogo-named-as-official-secondary-ticket-market-place-for-roland-garros&catid=7:sports-sponsors&Itemid=17]. Retrieved on 1 October 2014.

JARVENPAA, S.L.; TRACTINSKY, N. & VITALE, M. (2000). Consumer trust in an Internet store. *Information Technology and Management*, 1(1-2): 45-71.

JAYAWARDHENA, C.; WRIGHT, L.T. & DENNIS, C. (2007). Consumers online: Intentions, orientations and segmentation. *International Journal of Retail and Distribution Management*, 35(6): 515-526.

KESHARWANI, A. & BISHT, S.S. (2012). The impact of trust and perceived risk on internet banking adoption in India: An extension of technology acceptance model. *International Journal of Bank Marketing*, 30(4): 303-322.

KIM, D.J.; FERRIN, D.L. & RAO, H.R. (2007). A trust-based consumer decision-making model in electronic commerce: The role of trust, perceived risk, and their antecedents. *Decision Support Systems*, 44(2): 544-564.

KIM, L.H.; KIM, D.J. & LEONG, J.K. (2005). The effect of perceived risk on purchase intention in purchasing airline tickets online. *Journal of Hospitality and Leisure Marketing*, 13(2): 33-53.

KIM, L.H.; QU, H. & KIM, D.J. (2009). A study of perceived risk and risk reduction of purchasing air- tickets online. *Journal of Travel and Tourism Marketing*, 26(3): 203-224.

KLINE, R.B. (2005). *Principles and practice of structural equation modelling* (2nd ed.). New York, NY: Guilford Press.

KUAN, H.H. & BOCK, G.W. (2007). Trust transference in brick and click retailers: An investigation of the before-online-visit phase. *Information and Management*, 44(2): 175-187.

LAI, Y.; HUANG, H.; LU, R. & CHANG, C. (2013). The effects of website trust, perceived ease of use, and perceived usefulness on consumers" online booking intention: Evidence from Taiwan B&B sector. *Life Science Journal*, 10(2): 1516-1523.

MAYER, R.C.; DAVIS, J.H. & SCHOORMAN, F.D. (1995). An integrative model of organizational trust. *Academy of Management Review*, 20(3): 709-734.

NUNNALLY, J.C. & BERNSTEIN, I.H. (1994). *Psychometric theory* (3rd ed.). New York, NY: McGraw-Hill.

PAVLOU, P. (2003). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International Journal of Electronic Commerce*, 7(3): 69-103.

REICHHELD, F. & SCHEFTER, P. (2000). E-loyalty: Your secret weapon on the Web. *Harvard Business Review*, 78(4): 105-113.

SCHROEDER, E. (2013). "Ticket scalping laws, secondary markets and StubHub". bizjournals.com. Hyperlink [http://www.bizjournals.com/stlouis/print-edition/2013/01/25/ticket-scalping-laws-secondary.html]. Retrieved on 1 October 2014.

SHOOK, C.L.; KETCHEN, D.J.; HULT, T. & KACMAR, J.M. (2004). An evaluation of structural equation modelling in strategic management research. *Strategic Management Journal*, 25: 397-404.

STEWART, B.; SMITH, A.C.T. & NICHOLSON, M. (2003). Sport consumer typologies: A critical review. *Sport Marketing Quarterly*, 12(4): 206-216.

WANG, S.L. (2003). Customer testimonials and news clips as contextual cues in the consumer cognitive processing of online shopping: How do they build trust and then increase purchase intention? *Journal of Promotion Management*, 9: 145-162.

WU, Y.; CHU, S. & FANG, W. (2008). An empirical study of trust and TAM: An example of online shopping. *Journal of Information Management*, 15(1): 123-152.

YOUSAFZAI, S. (2010). Why do certain individuals adopt new technologies whereas others don't? Exploring the role of technology readiness in internet banking adoption. Unpublished paper presented at the International Conference of AGBA South Asia Chapter, Bhurban, Pakistan, 21-23 July 2010.

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THE VOICE OF MARGARET TALBOT ON PHYSICAL EDUCATION AND SCHOOL SPORT: A TRIBUTE

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ABSTRACT

On 2 December 2014, Professor Margaret Talbot sadly passed away after a long illness. In this tribute, the focus will be on her advocacy efforts regarding school Physical Education (PE) in the UK. She believed that PE was the greatest asset in education, but that the Western body-mind dualism was one of the greatest threats to the survival of PE. PE benefited from the high profile enjoyed by sport in 2001 in the UK. In 2007, it was declared that children in the UK would receive five hours of PE and school sport, with two hours devoted to school PE. Although PE is a statutory requirement for all children, a systemic weakness in initial Physical Education Teacher Education (PETE) for primary schools existed. There was limited recognition and support for the unique role of school PE, as the only means to provide every child the chance to learn the skills and knowledge to achieve physical literacy and social competences. A case for PE could be made on health grounds alone, but the UK based Association for Physical Education (afPE), believed that it must be made in educational terms. The year 2008 saw an 'independent review' of the primary school curriculum, led by Sir Rose, but his remit did not include PE as a subject. The afPE made a strong case for PE to this Review. Safely, it could be said that Sir Rose had been consistent in promising nothing and in keeping his word.

Key words: Margaret Talbot; Tribute; Physical education; School sport; Politics, advocacy and policy.

INTRODUCTION

In this section, a brief account will be provided on the most important positions that Margaret Talbot held. She was appointed Officer of the Order of the British Empire (OBE) in 1993 for the exceptional work she had done in the field of school Physical Education (PE) and sport. From 1997 to 2005, she served as the President of the International Association of Physical Education and Sport for Girls and Women (IAPESGW) and became an Honorary Life Member in 2005. From 1999 to 2009, Margaret acted as Vice President for Physical Education in the UK. She was the founding Chief Executive of the Association for Physical Education (afPE) and served in this position from 2006 to 2009. She also acted as the Chief Executive of the Central Council of Physical Recreation, an

umbrella organisation for English and UK non-governmental sport organisations (Talbot, 2015).

In 2009, Margaret was appointed President of the International Council of Sport Science and Physical Education (ICSSPE), a position she held until her death. In 2011, she was appointed the Chair of the Education Committee of the International Paralympic Committee where she served until she passed away. She was appointed as Expert to the Committee on Culture and

Education of the International Olympic Committee in 2014. A position she also held until her death (Talbot, 2015).

Other positions held and awards received were: Carnegie Research Professor and Head of Sport at Leeds Metropolitan University; an Honorary Fellowship of the University of Chichester in 2008; AD Munrow Award (1998) in university sport and physical education; Fellowship of the Royal Society of Arts; the Ling Award of the Physical Education Association UK; Honoured Member of the Association for Physical Education (UK); Championship of the Institute of Sport and Recreation Management; and Pathfinder Award (2006) from the USA National Association of Girls and Women in Sport (Talbot, 2015).

Posthumous, the Margaret Talbot Memorial Scholarship at the Institute of Technology, Tralee, was launched in February 2015 and in March 2015, the Lifetime Achievement Award was awarded to her at the Leeds Sports Awards (Talbot, 2015).

In December 1995, the author had the privileged to meet Margaret Talbot in person for the first time at the 7th International Rainbow Week Symposium that was held at the University of Cape Town, South Africa. Her passion for children in the first place, and secondly, for physical education (PE) and the role that PE and School Sport (PESS) could play in the lives of children were clearly illustrated in the paper she presented at this event, as well as in most of her published works. In this tribute, an attempt will be made to discuss in retrospect her viewpoints on PE as a school subject, as well as other aspects, such as advocacy, policy and school sport as it relates to PE. It has been 20 years since Margaret Talbot coined the phrase: "The game"s not the thing – the child is", which must be at the heart of the PE practice (Talbot, 2007a:7).

This article will mainly focus on the period in her life, 1993-2014.

PURPOSE AND METHODOLOGY

With this brief background, the aim of this tribute is to focus on her work regarding PE as a school subject prior to and during her time as Chief Executive of the Association for Physical Education (afPE). This research was conducted by means of a literature study of mainly primary, as well as secondary sources. The methodology applied in this study can thus be typified as qualitative research within the interpretative science paradigm.

In this tribute, the discussions will be based on two pillars: (1) the universal provision of primary and secondary school PE and sport; and (2) politics, advocacy and policy. These two pillars will be elaborated upon in the following sections.

SETTING THE SCENE OF SCHOOL PHYSICAL EDUCATION

Margaret believed that youth worldwide *need* PE (Talbot, 2001:39). With its unique educational value, she believed that PE was "one of our greatest national assets" (Talbot, 1997:1). To ensure that PE is not lost, she was passionately committed to raise an awareness of the dangers currently threatening its survival.

PE content is not limited to the traditional practices of Physical Activity (PA) known as "sport", because it is not merely in the physical, but *through* the physical that it aims to make a unique, vital and lasting impact to children‟s health, self-esteem and growth (Talbot, 1997:3). "Sports Education" is:

> … the introduction of the forms, conventions and skills of the activities known as sport; the critical place of the body and the process of learning [*through* the physical] are either marginalised or omitted, … (Talbot, 1997:2).

The practice of school sport in a competitive extracurricular system does not concentrate on the process, but rather on the product. The status of these schools depends heavily on winning success and positions on logs. Unfortunately, competitive sport excludes most learners (only so many players can be on a team and only so many teams are in a specific age league), and especially late developers.

While Sport Science has been an effective way for PE to achieve academic propriety, it seems as if it has been at the expense of Physical Education Teacher Education (PETE) programmes. The gap between PETE programmes and sport science has increased and has given rise to programmes in which sport forms the core, even in PETE programmes, at the expense of curriculum theory, practical teaching ability and the ethical and social concerns of sport (Talbot, 1997; Talbot, 2001). In teacher education courses in her frame of reference, the dominance of sport and sport science are seldom questioned (Talbot, 1997). She was determined to see that national policy on youth sport is informed by PE‟s core values (Talbot, 1997).

In 2003, she wrote that the dominance of the sport sciences, that are relatively young compared to the parent science Physical Education, seems to have placed PE in an inferior or even submissive position. This relates to a performance discourse in sport science, which tends to focus solely on top performance sport and winning and not on the physical and movement experiences of ordinary people (Talbot, 2003).

The "World Crisis in Physical Education" refers to the fact that globally PE in school curricula is under threat or declining, while the sport sciences are going from strength to strength at Higher Education Institutions where they are presented. The World Summit on Physical Education in November 1999, tried to put the case for school PE and to raise political support for investment in PE. The global audit, performed on the state and status of school PE, indicated that there is less time available in school curricula; PE specialists are being dispatched to other school subjects; and other „academic‟ subjects are replacing PE (Talbot, 1998:5-6; 1999:112-113; Hardman & Marshall, 2001). The legacy of the Western body-mind dualism, and the over-intellectual view on human development, are ideologies

which are difficult to address (Talbot, 2001), but it is "the most powerful *false dichotomy*, which continues to bedevil PE" (Talbot, 2003:116).

In 1997, Talbot stated that because of the concern for literacy and numeracy in UK schools, PE had to compete, usually in vain, against these two categories of subjects who already received the lion‟s share of resources, and as a result, the significance of physical literacy seemed to be overlooked (Talbot, 1997:9-10). According to Bailey (2015), the situation for

PE and youth sport has changed drastically during the 2000s, with huge amounts of money directed in that direction.

Education has always been a stable patron for sport, by providing the most comprehensive and effective structure to introduce all school-going youth to the skills and knowledge required for participation in sport, dance and physical activities (PA‟s) through PE (Talbot, 2001). In the case of PE, its contributions to the health and well-being of young people, as well as future sport participation are the most significant aspects (Talbot, 1997; Talbot, 2001). Through meaningful PA, that is fun and enjoyable, young people can develop self-confidence, a prerequisite for resistance to the risk behaviours related to school absenteeism, drug abuse, early sexual activity and delinquency (Talbot, 2001). The above-mentioned features of the case for PE seem so conclusive, so why does the case have to be made at all? There seems to be various reasons for this (Talbot, 2001:44-45):

1. *The world recession - education budgets are cut*. Non-examinable subjects are often seen as a disposable in such circumstances.
2. *Parent concerns regarding their children's employment*. Parents and policy makers have not yet been convinced by the PE profession that it is in fact a significant prevocational area.
3. *The youth are under great pressure to attain academic qualifications*. The result is that subjects that have intrinsic benefits, but are not examinable, are sidelined.
4. *The Western view of dualism*. Activities that are beyond the cognitive domain are not valued.
5. *The strength of the sport culture*. It is ironic that PE is often sidelined in both education and sport policy.
6. *Community sport programmes*. Policymakers saw the opportunity to reduce spending within education by trading PE for community sport programmes. The result, an inclusive system of introducing ALL children to the joys of learning through movement no longer existed. Due to various circumstantial issues, many youths will be excluded from these programmes, such as the poor, the less talented, etc.

Since 2001, PE has benefited from the high political profile now enjoyed by sport and the belief that investment in sport invests in wide-ranging health benefits, social inclusion and fighting crime (Talbot, 2006). In July 2007, the England Prime Minister at the time announced a new strategy for children to receive at least five hours of PESS, with two hours of PE within curriculum time (Talbot, 2007c; Talbot, 2008a).

Two main and unique features set PE apart from other delivery systems in the educational and sporting systems. They are, (1) the processes of learning and teaching; and (2) inclusion

(Talbot, 2007b:6). Firstly, it is imperative in PE that teachers shift their focus away from curriculum *content* towards learning, which implies the teaching *process*. In PE, teachers need to collect suitable evidence of reflection and action to expand the learning process. Lastly, PE is a legal requirement for all children in the four home countries of the UK. The ideology and policy position is secured by the legal basis in the UK, and a range of

international agencies[1] support PE as a right for all children, which affords both a sustainable and ethically secure position for PE in schools. PE programmes cannot claim „high quality" if these two aspects are not adequately addressed. Even before considering other quality criteria, they are prerequisites to be addressed (Talbot, 2007b).

As stated by Talbot (2007b), there remained a systemic weakness in the delivery of PE in UK primary schools, which could be attributed to the lack of sufficient time in initial Physical Education Teachers Education (PETE) programmes. The four-year BEd programme became a one-year postgraduate programme in which prospective PE teachers in effect only received eight months training. Even worse, in initial degree programmes data collected by the afPE in the UK showed that 40% of newly qualified PE primary school teachers had less than six hours training. The minimum suggested by the profession is 30 hours (Talbot, 2007b), therefore, six hours are simply not acceptable. For a subject with in-built risks, it is a licence to kill, which is a national disgrace (Talbot, 2006/2007a/2007b/2007c/2008d).

This systemic weakness was brought under the attention of former England Prime Minister, Gordon Brown. The Minister of State for Schools and Families defended the existing system, but agreed that newly qualified teachers would require further professional development. The Ministerial response also failed to recognise that government agencies failed to protect standards of teacher education. To address the poor quality of initial teacher training providers at the time, there was apparently little appetite (Talbot, 2007c; Talbot, 2008a).

In preparation for the 2012 Olympic and Paralympic Games in London, legacy became a familiar term in the UK (Talbot, 2009b). To ensure that the 2012 Olympic Games would be awarded to the UK, the commitment to legacy featured as the central element of the bid. Lord Sebastian Coe, after making the successful bid, pledged a lasting legacy for the youth: "Our vision is to inspire young people and change lives" (Talbot, 2009b:7). Because of this commitment, the manifesto of the afPE (*www.afpe.org.uk*), professed that PE, as a right for all young people, is at the base of this legacy for the youth (Talbot, 2009b).

> The aim of physical education is to develop physical competence so that all children are able to move efficiently, effectively and safely and understand what they are doing. The outcome, physical literacy, along with numeracy and literacy, is the essential basis for learners to access the whole range of competencies and experiences. (Talbot, 2009b:7)

The task of the afPE was to validate and articulate clearly what „physical competence" entailed and its impact on children"s experiences and learning, and which Talbot has often termed „stating the obvious". Yet, how many times have the PE profession been seduced

into defining PE in terms other than the physical? All PE professionals believe that PE can offer a wealth of situations for learning social, environmental, emotional and personal skills. Yet, PE‟s focus on the physical is its distinctive role. This dimension is so frequently absent from

[1]See International Council of Sport Science and Physical Education (ICSSPE) Berlin Agenda for Action 1999; and Magglingen Commitment 2005 *www.icsspe.org*; UNESCO 1978 Declaration on Physical Education; MINEPS III (Minister of Physical Education and Sport) Conference, Declaration of Punta del Este; MINEPS IV Conference Declaration, Athens 2004.

the learning „pantheon‟ that even the PE profession often fail to notice its absence. PE should do what the term suggests, but rarely is it communicated satisfactorily (Talbot, 2009b:7).

There is still limited recognition of the distinctive role of curriculum time PE as the *only* means of providing *every* child with the opportunity to learn the skills, knowledge and understanding to achieve the physical and social competences required for life-long participation. Yet, the largest allocation of funds goes to the elements of sport, which in reality are not accessible for every child. How is it then, even in the face of their own commissioned studies (Quyick *et al.*, 2008 cited in Talbot, 2009c:6), that strategic leaders still seem not to have grasped the fact that school PE can be the most all-inclusive and efficient component of the system (Talbot, 2009c)?

POLITICS, ADVOCACY AND POLICY

According to Talbot, in 1998 the PE profession urgently needed to persuade education policy makers and those who influence them (parents, sport bodies, teachers, and businesses), that school PE is important for children‟s development and that of sport. The same arguments are essential to make a case for school PE in establishing successful partnerships (Talbot, 1998).

There has been little agreement on the unique features of the educational experiences of PE and numerous calls for more actual and convincing research (Talbot, 1987 cited in Talbot, 2003:103; Bailey *et al.*, 2009; Hardman, 2010; Green, 2012a, b). These cynics would not accept a view of PE, which entails acceptance of hidden and incalculable practices and learning (Talbot, 2003).

The PE profession needs to play a leading role, mainly at national level, which is the only place where effective intervention could be made (Talbot, 2001). The challenges for governments were (Talbot, 2001:48), and still are:

- Recognise both the immediate benefits for the youth and longer term benefits for society;
- Provide a secure place for school PE in the curriculum and commit to investment in PE;
- Allocate resources for initial and post-PETE;
- Research PE‟s contributions to educational, social and economic development;
- Integrate education and sport policies; and
- Cooperate with the PE profession.

At the close of the World Summit on Physical Education, there was an overwhelming agreement that PE faces a two-fold global challenge. Firstly, secure PE‟s place in school curricula and secondly, improve the quality of teaching PE through initial and in-service PETE (Talbot, 2003). Among academics and the PE profession, there was a shared feeling that the need for political activity was either not acknowledged or resisted (Talbot, 2003). Talbot (2003:104) used a citation of Datnow (1998:2) to illustrate this point:

> We seldom recognise the importance of the seedy underside … - the micro-politics. We do not focus on the politics … One reason for this is that the language of politics has long been taboo in educational settings.

Datnow‟s analysis offers a case study of processes with which the PE profession are familiar, but often lack the skills to manage it. Three key elements define her theoretical framework, which are relevant to address PE‟s global challenges. They are *discourse*, *ideology* and *social location*. The importance of *power* is constant, although the forces between the latter elements are complex and often subject to change (Talbot, 2003:104). Another key element is *agency*, which is defined as the capacity of people to sway events. In politics and policy- making practices of PE, *agency* is absent (Talbot, 2003).

Access to information on the dynamics of agency is often hard to obtain, because they are usually endorsed in private and might not be documented. This left PE negotiators involved in the political process, disempowered and misunderstood. Their agency is often constrained in ways, which the disinterested *post-hoc* observer simply could not appreciate, apart from their best efforts to ensure that the interests of PE are reflected in decision-making (Talbot, 2003). Central to the discourse analysis is the link between power and discourse and the ways in which the undercurrents of power within the political process are enacted by people that are seldom seen as significant by researchers (Talbot, 2003).

A three-stage process is required for political change (Talbot, 2007c:7; Talbot, 2014:422), namely (1) recognition of a problem; (2) the political will to challenge the problem; and (3) earmarking resources to do so. In the UK at the time, the first stage of political recognition regarding the systemic weakness in primary education had not yet been attained (Talbot, 2007c). The afPE, bearing in mind the various international efforts to guard the status of PE, could learn lessons in setting out its challenge to government policy. According to this political litany, PE professionals lack political experience and skills (Talbot, 2007c).

In presiding governments, politicians are less fascinated by problems than solutions. They do not dwell on problems for which their government may be held responsible; they rather seek ready-made solutions, which will show their government‟s success. However, opposition politicians are able to raise the profile of the problem, or even make a scandal out of the government‟s inability to solve the problem (Talbot, 2007c).

A crucial principle of policy and advocacy work is that if politicians are to hear and take notice, the message needs to be simple, consistent and repeated regularly over a period of time. Hence, organisations such as the afPE have to be willing to sustain their efforts. It is enticing to wonder how clear messages have to be and how often they need to be re-stated for politicians to „get it‟. Such a case is school PE (Talbot, 2007c:7). According to Talbot,

in 2007 there was evidence that some providers in the UK were failing to adequately prepare prospective primary schools PE teachers. The task of the afPE, at the time, was to commit to a sustained campaign aimed at providing the mechanisms necessary for delivery and upkeep of high quality PE. The components of the campaign were, quality PE for all children; quality PETE; and time in school curricula (Talbot, 2007c).

In 2006, the Minister for the Third Sector in England made funds available to strengthen the „voice" of voluntary and community organisation at the time (Talbot, 2007d:6):

> It"s not government that changes society; it"s the third sector – through its campaigning, building communities, promoting volunteering … My job is to enable people to do the inspiring things they do best.

The Shadow Minister of Sport and the Olympics was asked at the National Conference of the afPE in July 2007 (Talbot, 2007d:6): "What is the role of the afPE in national policy development?" His reaction was instant and concise:

> [The] afPE is now the only independent voice for physical education … it is vitally important that its voice is heard and recognised (Robertson, 2007 cited in Talbot, 2007d:6).

Although it seems that the role of independent organisations in challenging government departments have high-level political support, political rhetoric is not always converted into practice. Regardless of inspiring extensive support from within the PE profession and its associates in sport and health to improve the quality of initial PETE for primary teachers, the afPE had less positive replies from government departments responsible for teacher workforce development (Talbot, 2007d).

As stated earlier, 40% newly qualified PE teachers entering schools in England at the time received less than six hours training. The official response was that time cannot be equated with quality and that school-based experiences, which trainee teachers received were not taken into account in these assessments. Yet, in a follow up letter from afPE, it was highlighted that it is not possible for trainees, who lack confidence due to a lack of training, to develop it during the school experience (Talbot, 2007d). The following official responses were received (Talbot, 2007d:7):

- The required standards were met and there was no indication that they were not; and
- The responsibility lies with head teachers to safeguard that teachers were capable to deliver the curriculum safely.

These responses were not startling, as they protected long-term policies established by previous governments that seemed to respect high quality, managing demand and supply, and fast turn-around of suppliers when demographics needed it. The loyalty to this policy seems definite notwithstanding the fact that the UK required less training for its graduate teachers than any other West European country (Talbot, 2008d), and despite the fact that primary postgraduate PETE was viewed the most serious systemic weakness. This systemic weakness was severe for PE, not only because of the fears about health, but also because of the very high political expectations for PE at that time, which had to play its part in three

policy areas: educational provision and the national curriculum; the sport system; and contributing towards child and public health (Talbot, 2007d).

Although PE does have high status in England, given that PE is mandatory for all children in the 5-16 age range, as is the case with five so-called core subjects (English, Mathematics, Science, Information Technology), it is not a core subject. Unlike other "foundation" subjects, PE should at least have two hours per week within curriculum time, accompanied by three hours of extra-curricular sport as mentioned earlier. Notwithstanding differences, PE

enjoyed a high political profile in three of the UK home countries, but these countries shared the same professional anxiety about primary school teachers‟ insufficient initial PETE (Talbot, 2008a).

Why PE could not exploit its enhanced status and the extensive investment in PE in these countries, was a question the profession needed to ask itself. There was no doubt that much existing policy was sport-led rather than educationally-led and, therefore, the PE profession had to accept that it still needed to express a solid case for PE, which would attract investment on its own worth, rather than relying on its accredited role as a vital base for sport skills and knowledge (Talbot, 2008a). She agrees with Carney and Winkler (cited in Talbot, 2008a:6), that physical literacy is just as important as literacy and numeracy, but that a case still needs to be made to education policy makers to show the worth of curricula that stimulate physical literacy.

It was inviting to make the case for PE on health grounds alone, but the afPE believed that this was not the route to follow. The afPE wanted to argue the case for PE‟s *contribution* to health promotion through PA, within a multi-agency policy framework (Talbot, 2008b:6-7). (See the Health Position Paper of the afPE, 2008b at www.afpe.org.uk.) Though PE could contribute meaningfully to health promotion, its key function (as stated earlier) remains paramount:

> … to develop physical competence so that all children are able to move efficiently, effectively and safely and understand what they are doing (afPE Manifesto, 2008 cited in Talbot, 2008b:7; Talbot, 2009b:7).

Therefore, PE must continue to make its case in *educational terms*. The Manifesto for PE outlines its contribution to children‟s development and the policy measures essential to safeguard a vigorous system of provision and enhancement (Talbot, 2008b:7-8). The reasoning based on "learning to move" and "moving to learn" has been applauded by curriculum leaders as making clear both the intrinsic and instrumental values of PE (Talbot, 2001; Talbot, 2008b:8). (See the Manifesto for Physical Education, 2008, afPE.)

"Learning to move" includes learning inherent to PE, such as the skills and understanding needed for participation in PA and knowledge of the body and its range of and capability for movement. In contrast, "moving to learn", involves learning outcomes not inherent to PE, but are valuable extrinsic educational lessons. These outcomes include, social skills; managing co-operation and competition; applying aesthetic decisions; using language; numbers, etc. (Talbot, 2001:39).

Nonetheless, it is decisive that the forces coming from the sport culture and from PE‟s place within school sport, which unavoidably tend to place PE at the service of the national sport strategy at the expense of children‟s needs and PE‟s place in education, is recognised and managed (Talbot, 2008c). Talbot (2008c:8) elaborates:

> Those advocating for physical education have long experienced the frustration of distinguishing it from sport, frequently in defence, falling back on characterising physical education as ***what it is not***, i.e. that it is more than sport, or that sport is part
>
> of physical education‟s content. It has been less common to see assertive articulation of what physical education ***is***.

In policy arenas with the acceptance of performance targets, there is potential for conflict with the market values, which plague delivery in the public sector. Over the last 20 years across education and higher education, this has been as obvious as in health. Here the domination of clinical targets has helped to avoid essential approaches to preventive measures in health promotion, including promoting PA. Naturally, in sport, the final form is expressed in policies unashamedly targeted at „more medals‟. How this acceptance of market values, which effect its investment, infrastructure and delivery, has impacted on PE, needs to be activated by means of deliberation (Talbot, 2008b).

PE faces a dichotomous challenge. Leaders must manage the prospects placed on PE by its obligation within the sport system as the basis for children to be introduced to the skills and knowledge needed for performance. PE‟s contributions to public health must also be voiced and managed by them. Most notably, PE‟s unique core purpose to empower informed and critical learners through physical learning must be secured. The willingness of the profession to challenge market-led values is acknowledged by the welcome given to the title of the 2008 National Conference of the afPE, “Hitting the Target, Missing the Point” (Talbot, 2008b:8). A statement made by Ball captures the challenge (cited in Talbot, 2008b:8):

> It is time to think differently about education policy before it is too late. We need to move beyond the tyrannies of improvement, efficiency and standards to recover a language of and for education …

The media coverage of the tensions between investment in grass roots and performance sport regarding the budget shortfall to support Team Great Britain‟s preparation for the 2012 Olympics and Paralympics, was raised constantly. Often it seemed as if politicians believed that one section must flourish at the expense of another. History has revealed that most host countries have directed investment into a hunt for medals, at the expense of participation in sport and PA (Talbot, 2008c; Talbot, 2008d).

Talbot (2008c) was convinced that the potential of a country to be successful in sport at international level, a good quality PE system in all schools could make a substantial impact. Yet, no evidence to support this belief exists. Talbot was invited to the Beijing Olympic Games. The then IOC President wanted to know how the youth were influenced in their

choices of sport and PA in different parts of the world and whether participation patterns were sustained over time. The question that arose was why the IOC asked PE researchers for help when they have massive resources (Talbot, 2008c). She believed that the answer was simple: in most cases, the research expertise available to the IOC does not relate to pedagogy and cultures, but to performance sport, which led her to ponder on the effect of sport science on PE research (Talbot, 2008c).

To deliver a key perspective and value position, which place the interest of the youth beyond extrinsic luxuries, such as success through competition and economic value through earned income, is a vital aspect of PE‟s role, which is ignored. The main focus on PA, the participant and the interactions between them, has often been ignored in academic studies. In these

studies, the disposition has been to drift towards what Whitson and Macintosh (1990:48 cited in Talbot, 2008c:6), called "performance discourse", with little concern for the way in which the:

> … rationalised pursuit of high performance collides with … the practice of sport as a medium of personal education and growth.

An understanding of the complex and dynamic relationships between people, their lives and participation in PA is needed so that a shared scientific pedagogy can be established for work in PE and sport science using multidisciplinary viewpoints. If these challenges could be met, the PE profession would be closer to the common pedagogy so badly needed, more likely to retain creative people and much more likely to attain high quality and creative researchers for PE (Talbot, 2008c).

The afPE Board stated (Talbot, 2009a:6):

> … [The] afPE is committed „to establish and sustain physical education at the heart of school life and whole-school development, through support for high quality learning and teaching; research; ethical leadership; and politically informed advocacy and representation.

As the representative voice for PE, this role requires (Talbot, 2009a:6):

> … awareness of policy innovations and their implications; and where possible, early influence or intervention to ensure that the interests of physical education and those who deliver it are not harmed; … If early intervention is not effective, then it may be necessary to resort to lobbying and campaigning.

Talbot (2009a) provided a case study of advocacy and influence using the policy progress at that time in England. This case study had significance for any proposed change to the status of PE, right across the UK and internationally. Early in 2008, Government commissioned an

„independent review‟ of the primary school curriculum in England, led by Sir Jim Rose. The features of Sir Rose‟s remit did not make mention of PE as a subject, not even in the Early Years Curriculum, which implied that any analysis of the place of PE would be

subordinate to these features. Thus, it was vital to gather information about the evolution of the review, which was piloted in private, with inputs from „experts" who were carefully chosen by the Review Team (Talbot, 2009a).

Previous curriculum reviews allowed subject associations to make inputs to thinking and the agendas allowed much more time than the Rose Review. This Review asked for contributions to its rationale, subsequent to publishing the remit. The afPE submitted an official reply to questions posed in April 2008 and made a strong case for PE to become a core subject (Talbot, 2009a:7). (See the afPE website www.afpe.org.uk.) During late 2008, information about the progress of the Review was received by the afPE causing concern. Unavoidably, there were leaks through which the afPE became aware that PE would be integrated into the
„Health and Emotional Well-Being" Area of Learning. Of greater concern was that the Review was being influenced by two different viewpoints, each with an incorrect, but sadly,

common view of PE. One viewpoint was that PE was limited to competitive team games, which were unfitting for this age range, and a unit within Arts and Design, dance and movement could meet their needs. The other view was that there should be no need for PE to be taught, as schools should be committed to daily exercise to meet the health requirements of children. This clearly showed the sustained threat to the status of school PE (Talbot, 2009a).

The above-mentioned position also risked the progress of the Physical Education, School Sport and Young People (PESSYP) strategy and the Government"s ambitious statement of two hours high quality PE within curriculum time and three hours extra-curricular school sport by 2012. In addition, it would jeopardise the legacy promises by Government in 2012 and would be contrary to the aims of the „Every Child Matters" and childhood obesity objectives. As a result, the afPE notified their partners within the PESSYP Consortium for Continuing Professional Development (CPD) – Sportscoach UK and the Youth Sport Trust (YST). The Consortium partners then notified colleagues in the Departments of Children, Schools and Families (DCSF) and Culture, Media and Sport (DCMS). A joint letter from the Consortium partners was sent to the Secretary of State for Children, Schools and Families (Talbot, 2008a; Talbot, 2009a).

In December 2008, the original suggestions published by the Rose Review requested responses. The afPE submitted a formal response and a media release, which highlighted major concerns (Talbot, 2009a:7-8):

- Within the Area of Learning, "Understanding Health and Well-Being", PE was being reduced almost invisible. Where PE had been included under another heading, for example in South Africa under Life Orientation, PE in the curriculum disappeared (Hardman & Marshall, 2001);
- Children could follow the proposed curriculum without moving a muscle; and
- A strong case was also made for the integrity of PE and for location in a context with similar concepts.

The reaction of the afPE led to a high level meeting at the Department of Children, Families

and Schools, where a Rose team representative heard the views of the afPE and members of the CPD Consortium, Sportscoach UK and the YST, which were intensely supported by high- ranking officials from government departments and agencies concerned. The agreement shown at the meeting, along with ensuing awareness raising and advocacy, may well have contributed to greater visibility of PE in the official suggestions, which were then looming (Talbot, 2009a).

With the last „Key Matters" that Talbot wrote as Chief Executive of the afPE, she unveiled what had been learned and what still needs to be done from the involvement with the Rose Review (Talbot, 2009d). From the outset, it was a highly politicised process. On 19 November 2009, Ed Balls quietly issued a letter "representing an important decision based on imperfect knowledge". The letter indicated that the Ministers accepted the recommendations of Sir Rose. Both Sir Rose and Ed Balls sadly chose to ignore the joint professional advice from the lead officials of the afPE, the YST and the then Qualifications and Curriculum Authority (QCA) (Talbot, 2009d).

It was Talbot"s belief that Sir Rose was a stalwart to reasoned arguments to uphold linguistic orderliness at the expense of a vital element of the primary curriculum. No counter arguments have been made in the numerous representations during the „consultation" process. It could safely be said that he has been consistent, in promising nothing and keeping his word. As a typical bureaucrat, defined as "an official who is rigidly devoted to the details of administrative procedure", he simply stuck to his brief, as he saw it, and omitted any influence, which might have made it more complex (Talbot, 2009d:6).

CONCLUSION

It can be concluded that Margaret Talbot was the true Olympian, one of the leading academics and researchers, not only in defining what the content of school physical education entails and its benefits to society, but also in fighting for its rightful place in school curricula. Furthermore, her advocacy work as Chief Executive of the afPE clearly indicates how bureaucratic red tape within the political world can turn around what has been stated as a given. It is unfortunate to learn from her work that autonomous associations like the afPE do not have a strong enough voice, although it has been stated that it is the third sector that can change society.

RECOMMENDATIONS

Margaret Talbot"s work should not end here, but her legacy should be honoured and continued. The global battle for school PE should still be high on the agenda of the International Council of Sport Science and Physical Education (ICSSPE), which was the last base where Margaret served. The ICSSPE, with its 300 organisations and institutions, which work with and within PE and Sport Science, should take the lead in activism internationally and come forth with the *dream team* that Margaret referred to in 2014 (Talbot, 2014:423). A strong leader with the vigour and passion of a Margaret Talbot is needed to drive the whole process.

Epilogue

The situation in the UK in the 1990s, regarding resource allocation towards literacy and numeracy and PE and school sport, is currently applicable in the South African context. According to the South African Curriculum and Assessment Policy Statement (CAPS), PE is a topic within the subject Life Orientation (LO), and the different topics are allocated various hours of contact time throughout the year in all the different phases of the CAPS. South Africa is also a signatory towards the MINEPS declarations.

However, in 2009, 60% of the teachers who presented PE within LO in the Western Cape Province were not qualified in PE (Van Deventer, 2009). In a follow-up study in the Eastern Cape, Free State, North West and Western Cape Provinces, 50% of the teachers were not qualified in PE (Van Deventer, 2012). It would thus seem that South African PE programmes could not claim high quality because the *learning and teaching* and *inclusion* of all children cannot be guaranteed by the Department of Basic Education.

Most South African children have already fallen in to what is called movement poverty, lacking the necessary physical literacy to engage in a healthy lifestyle, free of social ills (drug, crime, teenage pregnancy, etc.), now and as future adults.

A lesson to be learned by South Africa, from the sterling and exemplary professional legacy left by Margaret Talbot, is that even with a recognised association for PE, the reinstatement of PE as a stand-alone school subject will not materialise without the political will do it. Valuable knowledge for South African policy makers can be gained especially on the subject of her advocacy for PE within the broader context of politics in the UK.

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REFERENCES

BAILEY, R. (2015). “Margaret Talbot”. Comments on article via private e-mail discourse. [baileyrichard1@me.com]. April 2015.

BAILEY, R.; ARMOUR, K.; KIRK, D.; JESS, M.; PICKUP, I.; SANDFORD, R. & the BERA (PE and Sport Pedagogy Special Interest Group) (2009). The educational benefits claimed for PE and school sport: An academic review. *Research Papers in Education*, 24(1): 127.

GREEN, K. (2012a). Mission impossible? Reflecting upon the relationship between PE, youth sport and lifelong participation. *Sport, Education and Society,* 1-19, iFirst Article.

GREEN, K. (2012b). Physical Education and youth sport: In search of the „Holy Grail‟. Keynote address (unpublished version) presented at the VIth International Conference on Youth Sport, Bled, Slovenia, 6 December.

HARDMAN, K. & MARSHALL, J. (2001). Worldwide survey on the state and status of Physical Education in schools. In Gudrun Doll-Tepper & Deena Scoretz (Eds.), *World Summit on Physical Education* (pp.15-37). Proceedings of the “World Summit on Physical Education”, 3-5 November 1999. Berlin (Germany): International Council of Sport Science and Physical Education (ICSSPE).

HARDMAN, K. (2010). PE: The future ain‟t what it used to be. Keynote address (unpublished version) presented at the International Congress, Youth Sport 2010, “Knowledge for Sport”,

Ljubljana, Slovenia, 2-4 December.

TALBOT, D. (2015). "Information re Margaret Talbot". Comments on article re Margaret Talbot via private e-mail discourse. [davidtalbot1@btconnect.com], May 2015.

TALBOT, M. (1997). Young people, health, sport, healthy nation? Unpublished paper presented at the Institute of Sport and Recreation Management Conference, "Taking Sport to Heart", Glasgow, Scotland, 16 October.

TALBOT, M. (1998). Women and sport: Partnerships with education. Unpublished paper presented at the 3rd European Conference on "Women and Sport", Athens, Greece, 26 September.

TALBOT, M. (1999). Charting the future. In M. Ann Hall & Gertrud Pfister (Eds.), *Honouring the legacy: Fifty years of the International Association of Physical Education and Sport for Girls and Women* (pp.109-116). Northampton, MA: Smith College.

TALBOT, M. (2001). The case for physical education. In Gudrun Doll-Tepper & Deena Scoretz (Eds.), *World Summit on Physical Education* (pp.39-50). Proceedings of the "World Summit on Physical Education", 3-5 November 1999. Berlin, Germany: International Council of Sport Science and Physical Education (ICSSPE/CIEPSS).

TALBOT, M. (2003). Deconstruction-reconstruction of physical education: Gender perspectives. In Ken Hardman (Ed.), *Physical education: Deconstruction and reconstruction - Issues and directions* (103-124). Berlin, Germany: Verlag Karl Hofmann Schorndorf.

TALBOT, M. (2006). Olympic talent pool. *The Times Educational Supplement*, "OPINION", No. 4671, 3 February, p. 23.

TALBOT, M. (2007a). 2007: The agenda for physical education. *Physical Education Matters*, 2(1): 6-7, Spring.

TALBOT, M. (2007b). Quality. *Physical Education Matters*, 2(2): 6-8, Summer.

TALBOT, M. (2007c). Parent power: Parents" view of the importance of physical education for primary age range children. *Physical Education Matters*, 2(3): 6-11, Autumn.

TALBOT, M. (2007d). An independent voice for physical education: A precious asset. *Physical Education Matters*, 2(4): 6-8, Winter.

TALBOT, M. (2008a). Ways forward for primary physical education. *Physical Education Matters*, 3(1): 6-8, Spring.

TALBOT, M. (2008b). Valuing physical education: Package of pedagogy? *Physical Education Matters*, 3(3): 6-8, Autumn.

TALBOT, M. (2008c). Physical education research: Emerging from the shadow. *Physical Education Matters*, 3(4): 6-8, Winter.

TALBOT, M. (2008d). Member news - Professor Margaret Talbot. [afPE.ePolitix.com], 29 August.

TALBOT, M. (2009a). The Rose primary review: A case study in influence and advocacy.

Physical
Education Matters, 4(1): 6-10, Spring.

TALBOT, M. (2009b). Physical education: What legacy? *Physical Education Matters*, 4(2): 6-8, Summer.

TALBOT, M. (2009c). Physical education: Can we achieve a tipping point? *Physical Education Matters*, 4(3): 6-8, Autumn.

TALBOT, M. (2009d). Valedictory reflections on politicians, bureaucrats and experts: The case of the Rose Review of primary education 2009. *Physical Education Matters*, 4(4): 6-8, Winter.

TALBOT, M. (2014). When good science is not enough: The need for advocacy for physical activity. *ASPETAR Sports Medicine Journal*, 3(2): 422-429, July.

VAN DEVENTER, K.J. (2009). Perspectives of teachers on the implementation of Life Orientation in

Grade R-11 from selected Western Cape schools. *South African Journal of Education*, 29(1): 127- 145.

VAN DEVENTER, K.J. (2012). School physical education in four South African provinces: A survey. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 34(1): 153-166.

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DIE KWANTITATIEWE EN KWALITATIEWE STAND VAN FUNDAMENTELE BEWEGINGSVAARDIGHEDE VAN SENIOR FASE LEERDERS IN DIE POTCHEFSTROOM-OMGEWING, SUID-AFRIKA

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ABSTRACT

The purpose of this study was to determine the quantitative and qualitative level of Fundamental Movement Skills (FMS) of Senior Phase learners in Potchefstroom, South Africa. A total of 239, 13 to 14 year old learners were randomly selected from eight schools. The Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT-2), was used to assess six fundamental movement skills quantitatively, and the Fundamental Movement Pattern Assessment Instrument (FMPAI), was applied to analyse the same skills qualitatively. The results of the quantitative assessment showed that the total group of learners, including the boys and girls separately, performed below the norm for their age. The qualitative analysis showed that balancing on one leg on the balance beam was the skill in which the participants performed poorest. The quantitative and qualitative assessment results showed no statistically significant correlations in the tests of bouncing and catching a ball in the total group, nor in the boys' and girls' groups, and ball dribbling in the boys' group. Based on the results of the study, it is recommended that the mastering of FMS should be included in the Senior Phase Physical Education curriculum, and that both quantitative and qualitative assessment should be used when assessing these skills.

Key words: Fundamental movement skills; Quantitative; Qualitative; Assessment;

Adolescents.

INLEIDING

Met die implementering van Liggaamlike Opvoeding as deel van Lewensoriëntering in die nuwe skoolkurrikulum (SADBE, 2011), geniet die stand van Suid-Afrikaanse leerders se fundamentele bewegingsvaardighede toenemende aandag in die literatuur. Fundamentele bewegingsvaardighede vorm die grondslag vir 'n leerder se fisieke, perseptuele, kognitiewe en sosiaal-affektiewe ontwikkeling (Haywood & Getchell, 2009; Lubans *et al*., 2010), en weerspieël die vlak van 'n leerder se groot- en perseptueel-motoriese ontwikkeling (Gallahue & Donnelly, 2003). Volgens Gallahue en Donnelly (2003) is die vroeë kinderjare (tussen twee en sewe jaar) die kritiese periode vir die ontwikkeling van fundamentele bewegingsvaardighede, en behoort fundamentele bewegingsvaardighede goed bemeester te wees teen sewejarige ouderdom, hoewel verskeie navorsers beweer dat sekere fundamentele bewegingsvaardighede tot op 10-jarige ouderdom ontwikkel (Cavallari *et al.*, 2001; Getchell & Whitall, 2003; Getchell, 2006; Bobbio *et al.*, 2009).

Die gepaste ontwikkeling van fundamentele bewegingsvaardighede vir ouderdomsgroepe vorm die basis vir die ontwikkeling van gespesialiseerde sportvaardighede (Gallahue & Ozmun, 2006), en word verder geassosieer met akademiese prestasie (Vuijk *et al*., 2011; Westendorp *et al*., 2011). Verskeie navorsers beklemtoon die noodsaaklikheid van goed-bemeesterde fundamentele bewegingsvaardighede vir adolessente, dus leerders in die Senior Fase, met die oog op die suksesvolle deelname aan sport (Hardy *et al*., 2012; Malina, 2012), en fisieke aktiwiteit (Lubans *et al*., 2010; Lloyd *et al*., 2014). Die bydrae van hierdie bewegingsvaardighede tot akademiese prestasie word in die literatuur toegelig (Morales *et al*., 2011; Haapala, 2013). Swak fundamentele bewegingsvaardighede word dikwels met leer (Vuijk *et al.*, 2011; Westendorp *et al*., 2011), sosiale (Bart *et al.*, 2011), psigologiese (Pratt & Hill, 2011) en fisieke (Lubans *et al*., 2010) probleme geassosieer.

Fundamentele bewegingsvaardighede word soms „funksionele" of „basiese" vaardighede genoem (Haywood & Getchell, 2009), en verskillende klassifikasies wat wissel van basiese bewegingsvaardighede soos hop, gooi en vang (Gallahue & Donnelly, 2003), tot meer ingewikkelde koördinasie vaardighede (Bobbio *et al*., 2009), word in die literatuur gebruik. Vir die doeleindes van hierdie studie word fundamentele bewegingsvaardighede beskou as enige bewegingsvaardigheid wat nie gespesialiseerde sportvaardighede is nie, insluitend fundamentele grootmotoriese vaardighede, perseptueel-motoriese vaardighede en inter- ledemaat koördinasie vaardighede.

Enkele studies het die stand van fundamentele bewegingsvaardighede van Suid-Afrikaanse leerders ondersoek (Du Toit, 2001; Monyeki, 2001; Van Niekerk *et al*., 2007; Draper *et al*., 2012; Pienaar & Kemp, 2014). In 'n studie wat gerig was op die bepaling van die stand van fundamentele bewegingsvaardighede van Suid-Afrikaanse voorskoolse leerders, het Du Toit (2001), 462 drie- tot ses-jarige kinders getoets met betrekking tot agt motoriese vaardighede, naamlik staande verspring, eenbeenspring, huppel, eenbeenstand, balansloop, gooi-vir-afstand, balvang en stersprong. Volgens die resultate het die drie-, vier- en vyfjariges agterstande getoon met betrekking tot balansloop, balvang en die gooi vaardigheid, terwyl die sesjariges agterstande getoon het in al die toetse behalwe die staande verspring.

In ooreenstemming hiermee het Pienaar en Kemp (2014), 816 Graad 1 leerders in die Noordwes Provinsie se motoriese behendigheid met behulp van die Bruininks-Oseretsky-2 toets (BOT-2) (Bruininks & Bruininks, 2005) gemeet. Die toets evalueer die vyf fundamentele bewegingsvaardighede van lynloop, eenbeenstand, bons en vang van 'n bal, dribbel van 'n bal en wisselspronge. Die grootste persentasie van die groep skoolbeginners se motoriese behendigheid is geklassifiseer as ondergemiddeld (n=383; 49.63%) en gemiddeld (n=405; 48.16%) vir hul ouderdom (Pienaar & Kemp, 2014). Monyeki (2001) het die flamink-balansstand, staande verspring en wisselloop by 298 ses- tot negejarige leerders in die landelike gebied van Ellisras getoets en gevind dat die resultate van hierdie onder die derde tot 50ste persentiel vir die leerders se ouderdomme gelê het.

In ooreenstemming het Van Niekerk *et al*. (2007) gevind dat die fundamentele bewegingsvaardighede, gemeet aan hardloopspoed, ratsheid en bilaterale koördinasie, agterstande getoon het by 'n groep van sewe- tot 14-jarige straatkinders in Potchefstroom. In kontras hiermee het Draper *et al*. (2012), in 'n studie wat die effek van 'n grootmotoriese

intervensieprogram ondersoek het, 203 vierjarige kinders in twee voorheen-benadeelde woonbuurte in die Johannesburg-area getoets, en met die voor- asook die na-toets gevind dat hulle fundamentele bewegingsvaardighede bogemiddeld vir hulle ouderdomme was.

Africa en Van Deventer (2005) het gevind dat die fundamentele bewegingsvaardighede van sewe- tot negejarige meisies in Stellenbosch verswak het oor „n periode van 27 jaar. Hierdie navorsers het die resultate van 11 bewegingstoetse, wat verskeie hardloop- en springvaardighede insluit, vergelyk met die resultate van 'n studie wat in 1976, deur Katzenellenbogen, op meisies van dieselfde ouderdom gedoen is, en gevind dat die hedendaagse meisies swakker in die meeste van die toetse gevaar het (Africa & Van Deventer, 2005).

Die fokus van die voorafgaande Suid-Afrikaanse studies was grootliks op kinders van 12 jaar en jonger. Met betrekking tot die stand van fundamentele bewegingsvaardighede by ouer kinders in Suid-Afrika, kon geen ander studie gevind word nie. Die erns hiervan is dat dit blyk dat leerders met agterstande dikwels nie die agterstand sonder intervensie ontgroei nie (Hands, 2008; Hardy *et al*., 2012; Fransen *et al*., 2014). Hands (2008) het in 'n vyf-jaar opvolgstudie by Australiese vyf- en sewejarige kinders wat gekategoriseer is as kinders met lae motoriese behendigheid, gevind dat dieselfde kinders deur die loop van die vyf jaar steeds lae motoriese behendigheid getoon het. Hierdie bevindinge, asook soortgelyke resultate van Fransen *et al*. (2014) by ses- tot tienjarige Belgiese kinders oor 'n tydperk van twee jaar, ondersteun die opvatting dat bewegingsvaardighede wat onvoldoende ontwikkel het in die kinderjare, 'n negatiewe effek op motoriese prestasie later in die lewe het (Gallahue & Ozmun, 2006).

In die lig van die bogenoemde tendense, asook die probleme wat geassosieer word met ondergemiddelde prestasie, is dit belangrik om die vaardighede wat fundamenteel is tot die ontwikkeling van meer komplekse vaardighede by ouer leerders te evalueer en te verbeter, indien nodig. Haywood *et al*. (2012) beklemtoon dat die evaluasie van ouer leerders se bewegingsvaardighede omvattend en akkuraat moet wees. In hierdie opsig

beveel Gallahue en Ozmun (2006) en Zuvela *et al*. (2011) aan dat beide norm- en kriteriumgebaseerde evaluering, oftewel kwantitatiewe sowel as die kwalitatiewe evaluering van bewegings- uitvoering, gebruik moet word.

Slegs een Suid-Afrikaanse studie kon gevind word wat die kwalitatiewe en kwantitatiewe uitvoering van 'n fundamentele bewegingsvaardigheid vergelyk. In die studie van Du Toit en Pienaar (2001) was sesjarige leerders swakker as die norm vir vyfjariges met betrekking tot die kwalitatiewe uitvoering van die eenbeenstandvaardigheid, hoewel die kwantitatiewe meting gemiddeld was volgens die ouderdomsnorm. Hierdie bevindinge ondersteun die opvatting van Gallahue en Ozmun (2006) en Zuvela *et al*. (2011) dat verskille ten opsigte van kwalitatiewe en kwantitatiewe ontwikkeling daartoe kan lei dat leerders in die Liggaamlike Opvoeding klas verskillende vlakke van fundamentele bewegingsvaardighede toon. Dit is dus belangrik vir die Liggaamlike Opvoeding-onderwyser om aandag te skenk aan beide die kwalitatiewe en die kwantitatiewe ontwikkeling van hierdie vaardighede. Dit is voorts noodsaaklik dat die Liggaamlike Opvoeding-onderwyser van ouer leerders bewus is van beide die kwantitatiewe sowel as die kwalitatiewe stand van leerders se fundamentele bewegingsvaardighede. Ten einde sal dit 'n meer volledige beeld van die stand van

bemeestering van hierdie vaardighede kan vorm en sodoende gepaste aandag te kan skenk aan spesifieke komponente wat kan verbeter (Gallahue & Donnelly, 2003; Zuvela *et al*., 2011; Haywood *et al*., 2012).

NAVORSINGSPROBLEEM

Aangesien die literatuur beperk is oor die stand van fundamentele bewegingsvaardighede by Suid-Afrikaanse leerders, en veral geen literatuur oor ouer leerders beskikbaar is nie, is die doel van hierdie studie om die kwalitatiewe en kwantitatiewe stand van fundamentele bewegingsvaardighede by 'n groep Senior Fase-leerders van Potchefstroom te ondersoek.

METODOLOGIE

Navorsingsontwerp

Hierdie studie behels nie-eksperimentele kwantitatiewe navorsing en maak gebruik van 'n eenmalige dwarssnit-ontwerp.

Proefpersone

Hierdie studie is deel van 'n groter studie, naamlik die PAHL-studie (Physical Activity and Health Longitudinal Study), wat 'n multidissiplinêre longitudinale projek is waarin verskeie gesondheidsaspekte van 13- tot 18-jarige leerders oor 'n tydperk van 5 jaar ondersoek is. Proefpersone is vir die doel van hierdie studie geïdentifiseer deur van steekproefneming, gebaseer op die groter projek met veelvoudige fases, gebruik te maak volgens die riglyne van Gay en Airasian (2000) en Leedy en Ormrod (2005). Die verspreiding van die proefpersone wat op hierdie wyse geïdentifiseer is, is binne die verskillende bevolkings-groepe en proporsioneel in die steekproef verteenwoordig. Die totale aantal proefpersone wat spesifiek vir die doel van hierdie studie getoets is, was 239 Senior Fase-leerders wat

13.8±0.68 jaar oud was en 98 seuns (13.9±0.98 jaar) en 141 meisies (13.4±0.78 jaar) ingesluit het.

Meetinstrumente

Kwantitatiewe bewegingsanalise: Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT-2)

Die proefpersone se motoriese behendigheid is deur middel van die Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT-2) (Bruininks & Bruininks, 2005) bepaal. Die BOT-2 is ontwikkel vir persone van 4 tot 21 jaar en bestaan uit 4 komponente, naamlik fynmotoriese koördinasie (presisie en integrasie), manipulasie koördinasie (tweehandigheid en boonste ledemaat koördinasie), liggaamskoördinasie (balans en bilaterale koördinasie) en krag en ratsheid (hardloopspoed, ratsheid en krag).

Vir die doeleindes van hierdie studie is die verkorte weergawe, soos voorgeskryf deur die outeurs, van die meetinstrument gebruik. Hoewel al die subitems uitgevoer is met die oog op die bepaling van die totale motoriese behendigheidstelling, is daar vir die bepaling van die ontwikkelingsvlakke van fundamentele bewegingsvaardighede vir die doel van hierdie studie op die volgende addisionele sub-items, naamlik wisselspronge (spring op een plek met

dieselfde been en arm voor, en ruil dan om), loop op 'n lyn, eenbeenstand op 'n balanseerbalk met oop oë, bons en vang 'n bal, en dribbel 'n bal met afwisselende hande, gefokus.

Die totale toetstelling wat 'n norm van algehele motoriese behendigheid bied, is verwerk na standaardtellings en persentiele. Volgens die normskaal van die BOT-2 lê 'n totale telling van 67 tot 69 op die 14de tot 16de persentiel vir 13- tot 14-jarige seuns en meisies (Bruininks & Bruininks, 2005). 'n Telling wat tussen die 3de en 17de persentiel lê, word volgens hierdie normskaal as ondergemiddeld vir leerders van hierdie ouderdom beskou, terwyl tellings wat tussen die 18de en 83ste persentiele val, word as gemiddeld beskou. Die BOT-2 is 'n betroubare en effektiewe meting van fyn- en groot-motoriese vaardighede met 'n geldigheidskwosiënt van r=0.80 (Bruininks & Bruininks, 2005).

Kwalitatiewe bewegingsanalise: Fundamentele Bewegingspatroon-assesseringsinstrument (FMPAI)

Die leerders se uitvoering van geselekteerde sub-items van die BOT-2, naamlik loop op 'n lyn, eenbeenstand op 'n balanseerbalk, bons en vang 'n bal, en dribbel 'n bal, is geanaliseer en vergelyk met die ontwikkelingsfase kriteria van die uitgebreide weergawe van die Fundamentele Bewegingspatroon Assesseringsinstrument (FMPAI) (Gallahue & Donnelly, 2003). Hierdie sisteem is gebaseer op die navorsing van McClenaghan (1976), De Oreo (1980), Halverson en Williams (1985), Cratty (1994), asook op die ontwikkelingsvolgorde van fundamentele bewegingsvaardighede van kinders. Volgens Gallahue en Donnelly (2003) is daar bewys dat die FMPAI hoogs betroubaar onder hoogs opgeleide waarnemers is en waar inhoudsbetroubaarheid bepaal is.

Volgens die kriteria van die sisteem (Gallahue & Donnelly, 2003) kan die uitgevoerde vaardigheid kwalitatief geklassifiseer word in 3 fases van fundamentele motoriese ontwikkeling, naamlik die Aanvangs-, Elementêre- en die Volwasse Fase. 'n Telling van

"1" word toegeken vir die Aanvangsfase, 'n telling van "2" vir die Elementêre fase, en "3" vir die Volwasse fase. Indien die uitgevoerde bewegingsvaardigheid eienskappe van beide die Aanvangsfase en die Elementêre fase toon, word daar 'n telling van "1.5" toegeken. Dit dui op die oorgangsfase tussen die Aanvangs- en Elementêre fase. Dieselfde geld vir die oorgangsfase tussen die Elementêre- en Volwasse fase, waar "2.5" toegeken word.

Prosedure

Die studie het goedkeuring ontvang van die etiese komitee (NWU–0058-01–A1) van die Potchefstroom kampus van die Noordwes Universiteit. Toestemming is verder verkry van die distrikshoof van die Departement van Onderwys. Die skoolhoofde van die onderskeie skole is ook genader om toestemming vir verkry, waarna etiesevrywaring vir die studie verkry is en daar toestemmingsbriewe vir die Graad 8-leerders voor die aanvang van die studie uitgedeel is. Ingeligte, geskrewe toestemming is bekom van die skool se gesagsfigure, die ouers, wetlike voogde en die leerders van die deelnemende skole. Die toetse is by die skole afgeneem deur die navorsers en honneursstudente wat spesifiek opgelei is om die toetse af te neem. Vir die kwalitatiewe evaluasies is die bewegingsuitvoerings op video vasgelê en daarna geanaliseer.

Statistiese analise

Beskrywende statistiek is gebruik om gemiddeldes (Gem.), standaardafwykings (SA) en die minimum- en maksimumwaardes te bereken met behulp van die Statistica vir Windows rekenaar program (StatSoft, 2012). Verbande tussen die kwantitatiewe en kwalitatiewe resultate is ontleed met behulp van Spearman korrelasie. Om praktiese betekenisvolheid te bepaal is die korrelasie-koëffisiënt gebruik as effekgrootte (EG) volgens die riglyne van Cohen (1988:69) en Steyn (2006), waarvolgens 'n korrelasie-koëffisiënt van 0.1 'n klein effek verteenwoordig, 0.2 'n medium effek en 0.5 'n groot effek (Steyn, 2006). Die onafhanklike t- toets is gebruik om te bepaal of die verskille tussen geslagte statisties betekenisvol is ($p<0.05$). Ten einde praktiese betekenisvolheid van geslagsverskille te interpreteer is effekgroottes bereken deur die gemiddelde verskil te deel met die grootste standaardafwyking (SA) (Cohen, 1988; Steyn, 2006). In hierdie verband word daar aanbeveel dat 'n EG van 0.2 'n klein effek verteenwoordig, 0.5 'n medium effek en 0.8 'n groot effek (Steyn, 2006).

RESULTATE

Die toetsresultate van die ***kwantitatiewe*** evaluasie volgens die BOT-2 word getoon in Tabel 1. Die fundamentele bewegingsvaardighede wat deur die BOT-2 ontleed is, was wisselspronge, loop-op-'n-lyn, eenbeenstand, bons-en-vang bal en bal dribbel. Terselfdertyd word die resultate van die fynmotoriese kontrole toetse, manipulasie koördinasie toetse en krag-en-ratsheid toetse ook aangetoon ter wille van 'n volledige beeld, aangesien hierdie sub-items bydra tot die totale motoriese behendigheidstelling.

TABEL 1. **BESKRYWENDE STATISTIEK KWANTITATIEWE EVALUASIE VIR FUNDAMENTELE BEWEGINGSVAARDIGHEDE**

Bewegingsitem (maks. telling)	**Totale groep** (N=239)		**Seuns** (n=98)		**Meisies** (n=141)	
	Gem±SA	Omvang	Gem±SA	Omvang	Gem±SA	Omvang
Trek lyn tussen 2 lyne (0 foute)	1.36±1.75	0 – 9	1.45±1.31	0 – 7	1.23±1.67	0 – 9

Vou papier op lyne (12 korrekte voue)	9.85±2.92	0 – 12	9.72±2.03	0 – 12	10.0±1.98	0 – 12
Kopieer 'n vierkant (5 punte)	4.18±0.92	0 – 5	3.96±0.76	1 – 5	4.34±0.78	0 – 5
Kopieer 'n ster (5 punte)	3.07±1.06	0 – 5	2.95±1.04	0 – 5	3.37±0.98	0 – 5
Verplaas muntstukke (20 muntstukke)	17.18±2.47	8 – 20	17.24±2.65	9 – 20	17.15±2.44	8 – 20
Bons en vang bal (5 vangskote)	**4.98**±0.21	3 – 5	**4.99**±0.10	4 – 5	**4.96**±0.26	3 – 5
Dribbel bal (10 dribbel)	**9.04**±2.01	3 – 10	**9.06**±1.89	3 – 10	**8.96**±2.09	3 – 10
Tik voete & vingers (10 tikke)	9.88±0.64	4 – 10	9.9±0.65	4 – 10	9.87±0.63	5 – 10
Wisselspronge (5 spronge)	**3.34**±1.73	0 – 5	**3.3**±1.78	0 – 5	**3.37**±1.70	0 – 5

TABEL 1. (vervolg)

Bewegingsitem (maks. telling)	**Totale groep** (N=239) Gem±SA	Omvang	**Seuns** (n=98) Gem±SA	Omvang	**Meisies** (n=141) Gem±SA	Omvang
Lynloop (6 treë)	**5.53±0.89**	1 – 6	**5.44±1.05**	1 – 6	**5.61±0.77**	3 – 6
Eenbeenstand (10 sek.)	**9.37**±1.69	2 – 10	**9.39**±1.75	2 – 10	**9.34**±1.66	3 – 10
Eenbeenspring (≥50 spronge)	41.50±10.5	12 – 80	42.5±11.54	12 – 69	40.8±9.63	16 – 80
Opstote (≥36 opstote)	13.81±5.87	0 – 40	16.3±6.22	2 – 40	12.0±4.93	0 – 30
Opsitte (≥36 opsitte)	11.59±5.14	0 – 25	13.5±4.71	2 – 25	10.2±5.03	0 – 22
BOT-2 (Totale telling)	**67.5**±5.18	55 – 85	**69.53**±6.35	55 – 84	**67.40**±7.67	56 – 80

Gem= Gemiddelde waarde SA= Standaardafwyking; Omvang= Minimum tot Maksimum waarde

Dit blyk uit die resultate dat die wisselspronge die 1 sub-item was waarin die totale groep en die seuns en meisies afsonderlik, die swakste was. Die totale groep kon slegs gemiddeld 3.34 (±1.73) uit die vereiste 5 korrekte wisselspronge uitvoer, asook die seuns (3.30±1.78) en die meisies (3.37±1.70). Die fundamentele vaardigheid wat die beste uitvoering van die 5 sub- items getoon het, was bons-en-vang waarin die totale groep en die seuns en meisies, 'n gemiddelde telling van 4.97 uit 'n totaal van 5 behaal het. Daar was geen statisties-betekenisvolle verskille tussen die gemiddelde tellings van die seuns en die meisies by enige van die 5 toetse nie.

Hoewel die BOT-2 totale telling van die groep (67.5±5.18) ooreenstem met dié van die meisies (67.40±7.37), is dit effens laer vir die seuns (69.53±6.35). Die gemiddelde totale punt van die seuns val dus op die 16de persentiel, en dié van die meisies en die totale groep op die 14de persentiel onderskeidelik. Volgens die kategorieë van die BOT-2 is die fundamentele bewegingsvaardighede van die totale groep, sowel as van die seuns en meisies afsonderlik, gevolglik ondergemiddeld vir hul ouderdom. Die meisies se totale

telling is verder statisties betekenisvol laer as dié van die seuns (p=0.03), met praktiese betekenisvolheid van 'n klein effek (EG=0.28).

Tabel 2 toon die resultate van die ***kwalitatiewe*** analise van die BOT-2 vaardighede van loop- op-'n-lyn, eenbeenstand op 'n balanseerbalk, bons en vang 'n bal en die dribbel van 'n bal. Die sub-item, eenbeenstand op die balanseerbalk, vertoon die swakste van al vier die vaardighede, waar die telling van die totale groep (2.54±0.52 uit 3) ooreenstem met die tellings van die seuns en meisies (2.52±0.52 en 2.56±0.53, onderskeidelik). Die bons-en-vang blyk hier die vaardigheid te wees waarin die proefpersone die beste gevaar het (2.88±0.35 uit 3 vir die totale groep). Hoewel die meisies beter tellings as die seuns behaal het in eenbeenstand en lynloop, en swakker tellings in die bons-en-vang en die dribbel van die bal, was die verskille nie statisties betekenisvol nie.

TABEL 2. **KWALITATIEWE EVALUASIE VAN FUNDAMENTELE BEWEGINGSVAARDIGHEDE**

Sub-item (punt uit maks. van 3)	**Totale groep** (N=239)		**Seuns** (n=98)		**Meisies** (n=141)	
	Gem±SA	Omvang	Gem±SA	Omvang	Gem±SA	Omvang
Lynloop	**2.79±**0.41	2 – 3	**2.77±**0.41	2 – 3	**2.79±**0.44	2 – 3
Staan op eenbeen op balanseerbalk	**2.54±**0.52	1 – 3	**2.52±**0.52	1 – 3	**2.56±**0.53	1 – 3
Bons-en-vang bal	**2.88±**0.35	1 – 3	**2.91±**0.29	2 – 3	**2.87±**0.38	1 – 3
Dribbel bal	**2.71±**0.47	1 – 3	**2.72±**0.45	2 – 3	**2.70±**0.48	1 – 3

Gem= Gemiddelde waarde SA= Standaardafwyking Omvang= Minimum tot Maksimum waarde

Die resultate van hierdie studie word in perspektief gestel deur te kyk na die aantal en persentasie leerders wat onder gemiddeld gevaar het, soos aangedui in Tabel 3. Aangesien die BOT-2 nie ouderdomsnorme of gemiddelde waardes daarstel vir elke sub-item in die toets nie, is daar vir die doel van hierdie tabel gemiddelde waardes vir elke vaardigheid bereken volgens die vereiste maksimum wat deur die BOT-2 vir elke toets gestel is, asook die gemiddelde waarde volgens ouderdom aangedui vir elke vaardigheid.

Met betrekking tot die *wisselspronge* sub-item is die vereiste van die BOT-2, 5 korrekte spronge (met dieselfde arm en been gesinchroniseer). Volgens Bobbio *et al*. (2009) kan kinders van ongeveer 10-jarige ouderdom hierdie vaardigheid vir 20 sekondes lank korrek uitvoer. Die aantal proefpersone wat minder as 3 keer die wisselsprong vaardigheid korrek kon uitvoer, word in Tabel 3 aangedui as leerders wat ondergemiddeld gevaar het vir hulle ouderdom. Met betrekking tot die *lynloop* vaardigheid, behoort die gemiddelde kind reeds op 6-jaar minstens 6 treë op 'n lyn te kan loop (Gallahue & Donnelly, 2003; Haywood *et al*., 2012), daarom is 'n telling van minder as 6 treë ondergemiddeld vir 13- tot 14-jarige kinders. Die *eenbeenstand* van die BOT-2 vereis dat die proefpersoon vir 10 sekondes op 1 been moet kan balanseer op 'n balanseerbalk wat die tydsduur is wat 'n kind op 6-jaar op 1 been op 'n plat oppervlak kan balanseer (Mutti, 1998; Gallahue & Donnelly, 2003; CDC,

2008). Die EUROFIT toetsbattery (Eurofit, 1988) vereis dat 'n 10- tot 18-jarige kind tot 1 minuut op 'n balanseerbalk kan balanseer. 'n Telling van minder as 10 sekondes kan dus as onder- gemiddeld beskou word vir 13- tot 14-jariges (Tabel 3).

Volgens Gallahue en Ozmun (2006) verloop die ontwikkeling van die *bons en vang* vaardigheid sodanig dat 'n kind gewoonlik op 6-jaar 'n bal gemaklik kan bons en vang. Dit strook met die norm van 5 keer bons en vang wat gestel is vir 5-jariges deur Johnston *et al*. (1987), en 10 keer vir 8-jarige leerders in die Movement ABC-toets (Henderson & Sugden, 1992). Tellings van minder as 5 korrekte vangskote in die bons-en-vang sub-item van die BOT-2 word gevolglik as ondergemiddeld vir 13- en 14-jariges beskou (Tabel 3). Die BOT- 2 vereis verder dat 'n proefpersoon 'n bal 10 keer moet kan bons, wat ooreenstem met die

gemiddelde ontwikkelingsvlak van hierdie vaardigheid op 10-jaar (Gallahue & Donnelly, 2003; Ulrich, 2005).

TABEL 3. **PERSENTASIE LEERDERS MET ONDERGEMIDDELDE TELLINGS: KWANTITATIEWE EN KWALITATIEWE EVALUASIE**

Toetsitems	Totale groep (N=239) n	%	Seuns (n=98) n	%	Meisies (n=141) n	%
Kwantitatief						
Wisselspronge (≤2 spronge)	85	35.6	34	34.7	51	36.2
Lynloop (<6 treë)	66	27.6	29	29.6	37	26.2
Eenbeenstand (≤10 sek.)	50	20.9	18	16.4	25	17.7
Bal dribbel (≤4 keer)	16	6.7	5	5.1	11	7.8
Bal bons en vang (<5 keer)	4	1.7	1	1.02	3	2.1
Totale telling *	76	31.8	24	24.0	25	55.5
Kwalitatief **						
Lynloop	20	8.5	8	8.0	1	2.2
Eenbeenstand op balanseerbalk	54	22.6	24	24.5	10	7.1
Bal dribbel	25	10.5	6	6.1	2	4.4
Bons en vang	13	3.4	3	3.0	10	7.1

* ≤17de persentiel volgens die BOT-2 ** Elementêre Fase 2 of laer

Wanneer opsommend na Tabel 3 gekyk word, het die grootste persentasie van leerders in die totale groep, en die seuns en meisies onderskeidelik, ondergemiddeld in die kwantitatiewe evaluasie by die *wisselspronge* (tussen 34.7% en 35.6%), *lynloop* (tussen 26.2% en 29.6%) en *eenbeenstand* (tussen 16.4% en 22.7%), gepresteer. Die *eenbeenstand* (tussen 22.2% en 24.5%) is die vaardigheid waar die meeste leerders in die totale groep, en

seuns en meisies onderskeidelik ondergemiddeld gepresteer. Die persentasie meisies wat ondergemiddeld presteer het met betrekking tot die totale BOT-2 telling (kwantitatief), sowel as die kwalitatiewe uitvoering van die *eenbeenstand*, was statisties betekenisvol beter as by die seuns (p=0.01 en p=0.02 onderskeidelik), met 'n praktiese betekenisvolheid van 'n medium effek (EG=0.38 en 0.23 onderskeidelik).

Ten einde die verband tussen die resultate van die kwantitatiewe en kwalitatiewe evaluasie te ondersoek, is die kwantitatiewe en kwalitatiewe uitvoering gekorreleer. In Tabel 4 kan gesien word dat daar by die *lynloop* en die *eenbeenstand* by die totale groep en die seuns en meisies onderskeidelik, en in die die *bal dribbel* toets by die totale groep en die meisies, statisties betekenisvolle korrelasies tussen die kwantitatiewe en kwalitatiewe tellings gevind

was, met praktiese betekenisvolheid van 'n medium tot groot effek (r= tussen 0.31 en 0.60). Geen betekenisvolle korrelasies is egter gevind ten opsigte van die *bons en vang* in die totale groep of die seuns en meisies onderskeidelik, asook die *bal dribbel* toets by die seuns nie.

TABEL 4. **KORRELASIE VAN KWANTITATIEWE MET KWALITATIEWE PARAMETERS**

Veranderlikes	**Totale groep** (N=256) r	**Seuns** (n=100) r	**Meisies** (n=156) r
Lynloop	0.45*	0.57*	0.31*
Staan op eenbeen op balansbalk	0.48*	0.32*	0.60*
Bons en vang die bal	0.27	-0.32	0.12
Dribbel die bal	0.38*	-0.37	0.34*

* $p \leq 0.05$ Prakties betekenisvol: r>0.1= klein effek; >0.3= medium effek; >0.5= groot effek

BESPREKING

Die resultate van hierdie studie dui op uitvoering en bemeestering tekorte met betrekking tot sekere fundamentele bewegingsvaardighede by Senior Fase leerders in die Potchefstroom omgewing. Dit geld vir die vergelyking van die kwantitatiewe norme vir hulle ouderdom, asook die kwaliteit van uitvoering van die vaardighede. In die kwantitatiewe evaluasie toon veral die *wisselspronge*, *lynloop* en *eenbeenstand* agterstande by 20 tot 35% van die leerders. Met betrekking tot die kwalitatiewe uitvoering van die fundamentele bewegingsvaardighede is die *eenbeenstand* by 22.6 tot 24.5% van die leerders nog nie in die volwasse stadium van bemeestering nie, soos dit gewoonlik op ses- tot sewe-jaar behoort te wees (Gallahue & Donnelly, 2003; Haywood *et al*., 2012).

Wisselspronge is 'n aanduiding van die kind se ontwikkelingsvlak van bilaterale koördinasie, wat gedefinieer kan word as die perseptueel-motoriese vermoë om, hetsy die twee kante, die boonste en onderste ledemate van die liggaam gesinchroniseerd saam te gebruik (Getchell & Whitall, 2003; Bruininks & Bruininks, 2005; Bobbio *et al*., 2009).

Hierdie vaardigheid behoort volgens Bobbio *et al*. (2009) teen die ouderdom van 10-jaar reeds bemeester te wees. Bilaterale koördinasie is onontbeerlik vir algemene motoriese behendigheid en sport prestasie (Gallahue & Donnelly, 2003; Bobbio *et al.*, 2009), en het ook in verskeie studies 'n verband getoon met akademiese prestasie (Du Toit *et al.*, 2011; Haapala, 2013; Rigoli *et al*., 2013). Aangesien die twee kante van die liggaam moet saamwerk om te kan lees en skryf, asook om sportvaardighede te kan uitvoer (Haapala, 2013; Rigoli *et al.*, 2013), kan die onvoldoende ontwikkeling van bilaterale koördinasie selfs in adolessensie bydra tot onvoldoende akademiese prestasie en onvoldoende deelname aan fisieke aktiwiteit en sport (Haywood *et al*., 2012; Malina, 2012).

Die *lynloop*- en *eenbeenstand* vaardighede verteenwoordig beide die perseptueel-motoriese komponent van balans of stabiliteit (Haywood *et al.*, 2012), wat beskou word as die onderbou van alle groot- en perseptueel-motoriese bewegingsvaardighede (Payne & Isaacs,

2012). Die agterstande wat in hierdie studie gevind is, kan in verband gebring word met die bevindinge van Do en Chong (2008) en Viel *et al*. (2009), dat die neurologiese prosesse en meganismes wat balans onderlê, nog tot in middel adolessensie ontwikkel, veral vanweë die fisieke veranderinge wat kinders tydens puberteit ondergaan. Bronikowski en Bronikowski (2008) en Milojević en Stanković (2010), ondersteun hierdie stelling in hulle studies waar gevind is dat motoriese vermoëns, veral spoed, koördinasie en balans beïnvloed word deur die kind se vlak van ryping tussen die ouderdom van 14- en 15-jaar. Hoewel die fundamentele bewegingsvaardighede van die deelnemers in hierdie studie agterstande toon, moet die kind se vlak van ryping in die interpretasie van die resultate in ag geneem word.

Die *algehele motoriese bekwaamheid* van die leerders in hierdie studie was ondergemiddeld vir hulle ouderdom. Hoewel dit in ag geneem moet word dat die tellings van die fynmotoriese koördinasietoetse, manipulasie-koördinasietoetse, en die krag-en-ratsheid toetse 'n invloed kon uitoefen op die totale telling, veral die tellings van die kragtoetse wat ook ondergemiddeld blyk te wees vir die leerders se ouderdom (Payne & Isaacs, 2012), blyk dit dat die tellings van die fundamentele bewegingsvaardigheidstoetse 'n wesenlike invloed op die totale tellings uitgeoefen het. Die tekorte met betrekking tot die vlakke van ontwikkeling van die fundamentele vaardighede van die leerders in hierdie studie is dus soortgelyk aan die tekorte wat by jonger leerders in vorige Suid-Afrikaanse studies verkry is (Monyeki; 2001; Africa & Van Deventer, 2005; Van Niekerk *et al.*, 2007), wat moontlik daarop dui dat tekorte en agterstande nie vanself ontgroei word of verdwyn soos wat leerders ouer word nie.

Die ondergemiddelde algehele motoriese bekwaamheid wat by die leerders in hierdie studie gevind is, kan verder vergelyk word met resultate van Boes en Krell (2010) met betrekking tot Duitse kinders, en Runhaar *et al.* (2010) met betrekking tot Nederlandse kinders. Hulle het gevind dat tussen 27 en 61% van die adolessente onderskeidelik motoriese agterstande getoon het. In ooreenstemming hiermee toon navorsing met betrekking tot die kwalitatiewe uitvoering van fundamentele bewegingsvaardighede van 11-jarige Brasiliaanse kinders dat tussen 28 en 38% van die kinders se hardloop-, galop-, bal bons en vang vaardighede nie in die volwasse fase van motoriese ontwikkeling is nie (Valentini *et al*., 2007). 'n Rede vir swakker fundamentele bewegingsvaardighede by

adolessente kan volgens Hardy *et al*. (2012), Kalaja *et al*. (2012) en Malina (2012), in die tendens dat veral meisies minder fisiek aktief raak vanaf puberteit, gesetel wees. Dit ondersteun die swakker resultate van die meisies in hierdie studie.

In hierdie studie toon die verband tussen die resultate van die kwantitatiewe en kwalitatiewe evaluasie by al die fundamentele bewegingsvaardighede dat daar geen korrelasie was nie. Die implikasie hiervan is dat 'n Liggaamlike Opvoeding-onderwyser fundamentele bewegings-vaardighede beide kwantitatief en kwalitatief behoort te analiseer, aangesien 'n leerder kwantitatief aanvaarbaar kan presteer terwyl die kwaliteit van die uitvoering moontlik nie aan die norm voldoen nie (Gallahue & Ozmun, 2006; Haywood *et al*., 2012). Deur van beide evaluasies gebruik te maak, kan die onderwyser ook spesifieke komponente van 'n vaardigheid identifiseer wat aandag benodig (Gallahue & Ozmun, 2006; Zuvela *et al*., 2011).

GEVOLGTREKKINGS

In die skoolkurrikulum vir Liggaamlike Opvoeding in die Senior Fase val die fokus op opvoedkundige dans en gimnastiek, die ontwikkeling van sportvaardighede en spanbou rekreasie aktiwiteite (SADBE, 2011). Volgens bogenoemde resultate kan aanbeveel word dat daar in die Senior Fase ook gefokus moet word op die volle bemeestering van fundamentele bewegingsvaardighede, veral bilaterale koördinasie en balansvaardighede, wat kwalitatiewe en kwantitatiewe eise betref. Kalaja *et al*. (2012) ondersteun hierdie aanbeveling in hulle studie waar gevind is dat vroeë adolessensie 'n meer effektiewe tyd vir die aanleer en verbetering van motoriese vaardighede is en dat die verbetering kan lei tot verhoogde vlakke van fisieke aktiwiteit. Hierdie stelling word ondersteun deur die resultate van Lloyd *et al*. (2014), waar 'n betekenisvolle verband tussen goed ontwikkelde fundamentele bewegings- vaardighede op ses-jaar en fisieke aktiwiteit vlakke in volwassenheid gevind is.

'n Verdere aanbeveling is dat geslagsverskille ten opsigte van fundamentele bewegings-vaardighede en motoriese behendigheid by adolessente verder ondersoek moet word aangesien dit blyk dat veral die seuns se totale motoriese behendigheidspunt beter as dié van meisies is. Die literatuur (Butterfield *et al.*, 2012; Hardy *et al*., 2012; Malina, 2012) ondersteun dié aanbeveling vir toekomstige navorsing met betrekking tot geslagsverskille.

Die resultate van hierdie studie moet geïnterpreteer word in die lig van enkele tekortkominge, naamlik dat 'n relatief klein proefgroep uit slegs een omgewing gebruik is, wat die veralgemeenbaarheid van die resultate beperk. Die bevindings beklemtoon egter die belangrikheid van die bemeestering, akkurate evaluering en verbetering van fundamentele bewegingsvaardighede van Senior Fase-leerders.

SUMMARY

Quantitative and qualitative status of fundamental movement skills of Senior Phase learners in Potchefstroom

Fundamental movement skills form the foundation for physical, perceptual, cognitive and social-affective development and reflect the level of a learner's gross- and perceptual-motor

development. The importance of mastering fundamental movement skills, usually at seven years of age, provides the foundation for the development of sport-skills and fundamental movement competency contributes to academic performance. Furthermore, the literature shows a relationship between fundamental movement competency and participation in physical activity, which is the focus of the South African Physical Education curriculum. Recent studies have shown that the developmental levels of fundamental movement skills of learners (12 years and younger) in South Africa are below average for their age. This has led to concern regarding the status of fundamental movement skills among adolescent learners.

The purpose of this study was to determine the quantitative and qualitative status of fundamental movement skills of Senior Phase learners in Potchefstroom, an urban area.

Non-experimental, quantitative research was employed using a one-time cross-sectional design. The participants included 239 learners between the ages of 13 and 14 years who were

selected randomly from eight schools in the Potchefstroom region. The skills of walking-on- a-line, one-legged balancing on a balance beam, jumping-in-place (same sides synchronised), dribbling a ball and bouncing and catching a ball were assessed quantitatively using the Bruinninks-Oseretsky Test of Motor Proficiency 2 (BOT-2). The same skills were qualitatively analysed using the Fundamental Movement Pattern Assessment Instrument (FMPAI). Using the Statistica statistical programme (StatSoft, 2012), descriptive statistics (mean, standard deviation, minimum and maximum values), were computed to analyse the status of the skills. Spearman's correlation coefficient was applied to determine the relationship between the quantitative and qualitative data, while independent t-tests were used to determine differences between genders ($p<0.05$) and effect sizes were interpreted for practical significance.

The results show that 35.6% of the learners performed below average for their age in the quantitative assessment of jumping in place, while 27.6% performed below average with walking-on-a-line and 20.9% performed poorly in the one-legged balance tests. Similar results were found for the gender groups. The results of the qualitative analyses show that the one-leg balance skill item of 22.6% was not even in the mature-stage of fundamental skills development, which is the stage that is reached usually at seven years of age.

These results are disturbing, as these skills are representative of the perceptual-motor components of bilateral coordination and balance, which are abilities that underlie requirements for success in sport participation and academic performance. The correlation statistics show that the quantitative and qualitative results of the skills of bouncing-and-catching-the-ball in the total group, as well as the line-walk and dribbling-the-ball in some of the sub-groups, were not significantly correlated, indicating that the results of the two types of assessment of fundamental skills are not always in agreement. These results indicate that learners could show good results in quantitative tests, but that the quality of the performance of the skills might not be adequate.

Based on the results of the study, it is recommended that mastery of fundamental movement skills should be included as an outcome in the Senior Phase Physical Education curriculum,

especially bilateral coordination and balancing skills. For future research, both quantitative and qualitative assessment should be used when assessing fundamental movement skills.

VERWYSINGS

AFRICA, E.K. & VAN DEVENTER, K.J. (2005). Movement abilities of 7-9 year old girls in the Stellenbosch region: A comparison. *South African Journal for Research in Sport, Physical Education & Recreation*, 27(1): 1-16.

BART, O.; JARUS, T.; EREZ, Y. & ROSENBERG, L. (2011). How do young children with DCD participate and enjoy daily activities? *Research in Developmental Disabilities*, 32(4): 1317-1322.

BOBBIO, T.; GABBARD, C. & CAÇOLA, P. (2009). Interlimb coordination: An important facet of gross-motor ability. *Early Childhood Research and Practice*, 11(2): 1-9.

BOES, K. & KRELL, J. (2010). Physical activity and motor fitness of children and adolescents: Approaches for serious games. *International Journal of Computer Science in Sport*, 9(2): 18-26.

BRONIKOWSKI, M. & BRONIKOWSKI, M. (2008). Motor fitness in relation to the maturation process of pubertal boys and girls. *Papers of Anthropology*, 15(2): 28-37.

BRUININKS, R.H. & BRUININKS, B.D. (2005). *Bruininks-Oseretsky Test of Motor Proficiency* (2nd ed.). Circle Pines, MN: AGS Publishing.

BUTTERFIELD, S.A.; ANGELL, R.M. & MASON, C.A. (2012). Age and sex differences in object control skills by children ages 5 to 14. *Perceptual and Motor Skills*, 114(1): 261-274.

CAVALLARI, P.; CERRI, G. & BALDISSERA, F. (2001). Coordination of coupled hand and foot movements during childhood. *Experimental Brain Research*, 141(3): 398-409.

CDC (CENTRES FOR DISEASE CONTROL AND PREVENTION) (2008). "Developmental milestones." Hypwerlink [http://www.cdc.gov/ncbddd/actearly/milestones/milestones-5yr.htm]. Retrieved on 12 December 2013.

COHEN, J. (1988). *Statistical power analysis* (2nd ed.). New York, NY: Academic Press.

CRATTY, B.J. (1994). *Perceptual and motor development in infants and children* (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.

DE OREO, K.L. (1980). Performance of fundamental motor tasks. In C.B. Corbin (Ed.), *A text book of motor development* (pp.178-198). Dubuque, IA: W.C. Brown.

DO, M. & CHONG, R.K. (2008). Balance recovery from a forward fall: Developmental aspects of sensorimotor organization and the role of supraspinal control. *Neuroscience Letters*, 422(3): 300- 304.

DRAPER, C.E.; ACHMAT, M. & FORBES, J. (2012). Impact of a community-based programme for motor development on gross motor skills and cognitive function in preschool children from disadvantaged settings. *Early Child Development and Care*, 182(1): 137-152.

DU TOIT, D. (2001). *Motor skill development and obesity of preschool children*. Unpublished PhD dissertation. Potchefstroom: North-West University.

DU TOIT, D. & PIENAAR, A.E. (2001). Current status and assessment of quantitative and qualitative one leg balancing ability in 3-6 year old children. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 23(2): 51-62.

DU TOIT, D.; PIENAAR, A.E. & TRUTER, L. (2011). Relationship between physical fitness and academic performance in South African children. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 33(3): 23-13.

EUROFIT (1988). *European Tests of Physical Fitness*. Rome (Italy): Committee for development of sport.

FRANSEN, J.; DEPREZ, D.; PION, J.; TALLIR, I.B.; D'HONDT, E.; VAEYENS, R.; LENOIR, M. & PHILIPPAERTS, R.M. (2014). Changes in physical fitness and sports participation among children with different levels of motor competence: A 2-year longitudinal study. *Pédiatrie Exercise Science*, 26(1): 11-21.

GALLAHUE, D.L. & DONNELLY, F.C. (2003). *Developmental physical education for all children* (4th ed.). Champaign, IL: Human Kinetics.

GALLAHUE, D.L. & OZMUN, J.C. (2006). *Understanding motor development: Infants, children, adolescents, adults* (6th ed.). New York, NY: McGraw-Hill.

GAY, L.R. & AIRASIAN, P. (2000). *Educational research: Competencies for analysis and application* (6th ed.). Upper Saddle River, NJ: Merrill.

GETCHELL, N. (2006). Age and tasks-related differences in timing stability, consistency and natural frequency of children's rhythmic, motor coordination. *Developmental Psychobiology*, 48(8): 675- 685.

GETCHELL, N. & WHITALL, J. (2003). How do children coordinate simultaneous upper and lower extremity tasks? The development of dual motor task coordination. *Journal Experimental Child Psychology*, 85(2): 120-140.

HAAPALA, E.A. (2013). Cardiorespiratory fitness and motor skills in relation to cognition and academic performance in children: A review. *Journal of Human Kinetics*, 36(3): 55-68.

HALVERSON, L. & WILLIAMS, K. (1985). Developmental sequences for hopping over distance: A prelongitudinal screening. *Research Quarterly for Exercise and Sport*, 56(1): 37-44.

HANDS, B. (2008). Changes in motor skill and fitness measures among children with high and low motor competence: A five-year longitudinal study. *Journal of Science and Medicine in Sport*, 11(2): 155-162.

HARDY, L.L.; REINTEN-REYNOLDS, T.; ESPINEL, P.; ZASK, A. & OKELY, A.D. (2012). Prevalence and correlates of low fundamental movement skill competency in children. *Pediatrics*, 130(2): e390-e398.

HAYWOOD, K.M. & GETCHELL, N. (2009). *Life span motor development* (5th ed.). Champaign, IL: Human Kinetics.

HAYWOOD, K.M.; ROBERTON, M.A & GETCHELL, N. (2012). *Advanced analysis of motor development.* Champaign, IL: Human Kinetics.

HENDERSON, S.E. & SUGDEN, D.A. (1992). *Movement assessment battery for children (MABC).* London, UK: Psychological Corporation.

JOHNSTON, O.; CRAWFORD, J.; SHORT, H.; RAYMOND SMYTH, T. & MOLLER, J. (1987). Poor Co-ordination in 5-year-olds: A screening test for use in schools. *Australian Pediatric Journal*, 23(3): 157-161.

KALAJA, S.P.; JAAKKOLA, T.T.; LIUKKONEN, J.O. & DIGELIDIS, N. (2012). Development of junior high school students' fundamental movement skills and physical activity in a naturalistic Physical Education setting. *Physical Education and Sport Pedagogy*, 17(4): 411-428.

LEEDY, P.D. & ORMROD, J.E. (2005). *Practical research: Planning and design* (8th ed.). Upper Saddle River, NJ: Merrill.

LLOYD, M.; SAUNDERS, T.J.; BREMER, E. & TREMBLAY, M.S. (2014). Long-term importance of fundamental motor skills: A 20-year follow-up study. *Adapted Physical Activity Quarterly*, 31: 67-78.

LUBANS, D.R.; MORGAN, P.J.; CLIFF, D.P.; BARNETT, L.M. & OKELY, A.D. (2010). Fundamental movement skills in children and adolescents: Review of associated health benefits. *Sports Medicine*, 40(12): 1019-1035.

MALINA, R.M. (2012). Movement proficiency in childhood: Implications for physical activity and

youth sport. *Kinesiologia Slovenica*, 18(3): 19-34.

MCCLENAGHAN, B.A. (1976). Development of an observational instrument to assess selected fundamental movement patterns of low motor functioning children. Unpublished PhD dissertation. Bloomington, Indiana: Indiana University.

MILOJEVIĆ, A. & STANKOVIĆ, V. (2010). The development of motor abilities of younger adolescents. *Physical Education and Sport*, 8(2): 107-113.

MONYEKI, K.D. (2001). Tracking physical growth and health status of South African rural children: Ellisras longitudinal study. Unpublished MA thesis. Potchefstroom: Potchefstroom University for Christian Higher Education (PU vir CHO).

MORALES, J.; GÓMEZ, M. X. A.; GOMIS, M. & GONZÁLEZ, L. (2011). Relation between physical activity and academic performance in 3rd-year secondary education students. *Perceptual and Motor Skills*, 113(2): 539-546.

MUTTI, M.C.; MARTIN, N.A.; STERLING, H.M. & SPALDING, N.V. (1998). *Quick neurological screening test* (2nd ed.). Novato, CA: Academic Therapy Publications.

PAYNE, V.C. & ISAACS, L.D. (2012). *Human motor development: A lifespan approach* (5th ed.). Dubuque, IA: McGraw-Hill.

PIENAAR, A.E. & KEMP, C. (2014). Motor proficiency profile of Grade-1 learners in the North-West province of South Africa: NW-child study. *South African Journal for Research in Sport, Physical Education and Recreation Social Sciences*, 36(1): 183-198.

PRATT, M.L. & HILL, E.L. (2011). Anxiety profiles in children with and without developmental coordination disorder. *Research in Development Disabilities*, 32(4): 1253-1259.

RIGOLI, D.; PIEK, J.P.; KANE, R.; WHILLIER, A.; BAXTER, C. & WILSON, P. (2013). An 18-month follow-up investigation of motor coordination and working memory in primary school children. *Human Movement Science*, 32(5): 1116–1126.

RUNHAAR, J.; COLLARD, D.C.M.; SINGH, A.S.; KEMPER, H.C.G.; VAN MECHELEN, W. & CHINAPAW, M. (2010). Motor fitness in Dutch youth: Differences over a 26-year period (1980- 2006). *Journal of Science and Medicine in Sport*, 13(3): 323-328.

SADBE (SOUTH AFRICAN DEPARTMENT OF BASIC EDUCATION (2011). Curriculum and assessment policy statement (CAPS). Life Orientation Grades 7-9. Final draft. Pretoria: Department of Education.

STATSOFT (2012). *Statistica for Windows. Release 5.5: General conversations and statistics.* Tulsa, OK: StatSoft.

STEYN, H.S. (2006). *Handleiding vir bepaling van effekgrootte-indekse en praktiese betekenisvolheid*. Potchefstroom: North-Wes Universiteit, Potchefstroom Kampus

ULRICH, D.A. (2005). *Test of gross motor development.* Austin, TX: Pro-

Ed.

VALENTINI, N.C.; BARBARÁ, C.S. & RUDISILL, M.E. (2007). Fundamental motor skills: A description of most common errors demonstrated by children. *Journal of Sport and Exercise Psychology*, 29: S47.

VAN NIEKERK, L.; COETZEE, M. & PIENAAR, A. (2007). Anthropometric and motor development profiles of street children living in a shelter. *African Journal for Physical, Health Education, Recreation and Dance*, 13(2): 127-134.

VIEL, S.; VAUGOYEAU, M. & ASSAIANTE, C. (2009). Adolescence: A transient period of proprioceptive neglect in sensory integration of postural control. *Motor Control*, 13(1): 25-42.

VUIJK, J.P.; HARTMAN, E.; MOMBANG, R.; SCHERDER, E.; VISSCHER, C. & VISSCHER, C. (2011). Associations between academic and motor performance in a heterogeneous sample of children with learning disabilities. *Journal of Learning Disabilities*, 44(3): 276-282.

WESTENDORP, M.; HARTMAN, E.; HOUWEN, S.; SMITH, J. & VISSCHER, C. (2011). The relationship between gross-motor skills and academic achievement in children with learning disabilities. *Research in Development Disabilities*, 32(6): 2773-2779.

ZUVELA, F.; BOZANIC, A. & DURDICA, M. (2011). POLYGON, a new fundamental movement skills test for 8-year-old children: Construction and validation. *Sport Science and Medicine*, 10(1): 157-163.

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RELATIONSHIP AMONG FITNESS, MORPHOLOGICAL CHARACTERISTICS, SKILLS AND PERFORMANCE IN MEN'S FAST-PITCH SOFTBALL

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ABSTRACT

Men's fast pitch softball does not have a specific battery of tests and relies on the tests and norms of baseball. The specific morphological and fitness demands of the sport are, therefore, not fully understood. The purpose of this study was to establish whether morphological and fitness characteristics are related to skill and performance measures in men's fast-pitch softball players. The sample was purposively selected and consisted of 15 provincial and 15 club male players. Anthropometric, fitness and skills test were conducted. Match statistics were obtained from the provincial softball federation for the provincial players and from the club for its members. Data were analysed and interpreted both collectively as a group and separately as teams for the purpose of comparison. The results identified a number of strong significant relationships between the different variables tested. Stature and percentage body fat were found to interact significantly with the two key performance areas, batting and base running. The findings convincingly suggest that coaches should include fitness, morphological and skills tests in their coaching and fitness programmes, team selection and talent

identification processes.

Key words: Fast-pitch softball; Fitness; Anthropometry; Skills; Performance; Correlations.

INTRODUCTION

There are two forms of softball, which are played around the world, fast-pitch softball and slow-pitch softball and the International Softball Federation governs both forms (International Softball Federation, 2003).

Success in softball, like in any other competitive sport, depends on the optimal combination of various factors, including the fitness, skill and morphological characteristics of the players. In a study conducted by Carvajal *et al*. (2009) on Cuban baseball players, they found significant differences in games won, body weight, bone mass and residual mass when they divided the pitchers into „lower performance" and „higher performance" groups. The same study found first basemen to be the tallest and heaviest players; the second baseman, shortstop and third baseman (infielders) were lighter and leaner than other players and they had a slightly larger muscle mass than pitchers; while catchers and outfielders had the highest mean fat mass (Carvajal *et al*., 2009).

Despite the fact that fast-pitch softball is an established sport with a long history, it has received little scientific attention. For example, it does not have a specific battery of fast-pitch softball fitness tests and relies on the tests and norms of baseball. The specific morphological and fitness demands of the sport are, therefore, not fully understood. An understanding of the structure, function and performance relationships in different sport, including softball, would allow for improved coaching approaches, development of sport specific fitness and skills training programmes, team selection and talent identification in young players (Brown, 2001).

PURPOSE OF STUDY

The purpose of this study was to establish whether morphological and fitness characteristics are related to skill and performance measures in men"s fast-pitch softball players. A secondary aim was to compare provincial players with club players to establish whether differences in performance are reflected also in their differences in anthropometry and fitness levels.

METHODOLOGY

Sample

The sample was purposively selected and consisted of 15 provincial and 15 club male fast-pitch softball players. All participants were members of an accredited provincial softball federation. Match statistics, the numerical representations of team and individual playing performances, can be divided into offensive statistics (batting and base running), and defensive statistics (pitching, catching and fielding). These were obtained from the relevant provincial softball federation for the provincial players and from the club for the club

players.

Ethical clearance

The players and coaches were informed as to what the study entails and all signed informed consent forms. The players were also notified that all information would be kept strictly confidential. The players were made aware of the benefits of the tests, how they rate on these tests and their strengths and weaknesses. The players were assured that their participation was voluntary and that that they could withdraw from the study at any time. The aims and objectives, methodology employed and ethics of the research were presented to and approved by the Senate Research Committee of the University of the Western Cape (04/2/14).

Anthropometric measures

The postgraduate researcher, who had completed postgraduate courses in Kinanthropometry, administered 10 anthropometric measurements. The measurements were taken in accordance with the standard procedures of the International Society for the Advancement of Kinanthropometry (Marfell-Jones *et al*., 2006). Technical errors of measurement (TEM) were within acceptable standards (Norton & Olds, 1996). The measurements included height (cm), weight (kg) and skinfolds (mm) (triceps, sub-scapular, supra-iliac, abdominal, thigh, calf). Body density ($g.cm^{-3}$) was determined by means of the Durnin and Womersley (1974)

formula, which was converted to percentage body fat by means of the formula of Brozek *et al*. (1963).

Physical fitness tests

The battery of tests for physical fitness included the *vertical jump*, which was used to measure leg power. Johnson and Nelson (1986) reported a validity of 0.79 and a reliability coefficient of 0.93 for the test. The *standing broad jump* test was used to measure leg power in a horizontal rather than vertical direction. Johnson and Nelson (1986) reported a validity of
0.61 and reliability 0.96 for this test. Heights and distances were measured by means of a measuring tape. *Agility*, the ability to stop, start and change the direction of the body rapidly and in a controlled manner, was measured with the Illinois Agility Test (Tomchuck, 2011). The aim of the test is to complete a weaving course marked out with cones, in the shortest possible time. A whistle was used to start the test and times were taken with a hand held stopwatch. A reliability co-efficient of 0.95 and an SEM (variation in subjects‟ performance from measurement to measurement), of 0.19 were reported for this test (Hachana *et al*., 2013).

Skills tests

Skills were assessed by means of the „softball throw for distance test‟, the „two-base sprint test‟, the „batting test‟ and the „fielding test‟. The tests employed to assess the fundamental softball skills of the participants are similar to those employed in previous studies (Johnson & Nelson, 1986).

Softball throw for distance

Equipment used for the „softball throw for distance" included softballs, a tape measure, marking cones, a field measured in 5m intervals, and a 1.8m restraining area parallel to the 5m field markers. The best of 3 attempts was recorded as the test score.

Two-base sprint test

The speed and skill involved in running between 2 bases was measured. The testing area was the softball diamond. The test started with the player in the batter"s box, swinging with a bat as if at a pitched ball and releasing the bat under control and running. The timer started when the bat was released and stopped when the player crossed second base. There was 1 practice trial and then 2 timed trials, with the better of the 2 being recorded. For safety, the player had to run through second base. The time was recorded to the nearest 10^{th} of a second (Morrow *et al*., 2011). Safrit and Wood (1995) reported validity coefficients of 0.89 to 0.95 for the base running test.

Batting test

The batting test was administered on a softball diamond. The ball was set on a tee, the player then hit the ball as far as possible. Players were allowed 2 practice trials and 6 test trials (Morrow *et al*., 2011). The furthest distance achieved was recorded as the test score. Safrit and Wood (1995) reported validity coefficients ranging from 0.69 to 0.91 for the batting test.

Testing procedure

Testing was conducted during the competition phase of the season. The anthropometric measurements, starting with body weight in kilograms, height in centimetres and skinfolds, measured with a Harpenden skinfold calliper in millimetres, were taken prior to the physical training sessions. The fitness tests were conducted after warm-up and stretch sessions, which were conducted by the researcher. The 2 power tests were conducted first followed by the agility test. The vertical jump and standing broad jump tests were measured in centimetres while the results of the agility test were recorded in seconds. The „softball throw for distance" was measured in metres, the „two-base sprint test" in seconds, and the „batting test" (Morrow *et al*., 2011), and „fielding test" (Johnson & Nelson, 1986), were recorded as a score (pass/fail). The tests were conducted at different sessions to exclude the possibility of fatigue effects. Tests were administered over a 4-week period for provincial players and over a 2- week period for club players on separate occasions.

Data analysis

Since the data did not have a normal distribution, the Spearman"s Rank Correlation was used to assess possible relationships between variables (Estep, 2013). The provincial and club squads were compared on 16 measures using the non-parametric Wilcoxon Rank Sum test. A more stringent level of $p<0.01$ was set as so many tests were involved. An alternative approach was used to control the „False Discovery Rate" (FDR) with the significance level set at $p<0.05$ (Benjamini & Hochberg, 1995).

RESULTS

Table 1 illustrates the descriptive statistics of the morphological, fitness and performance characteristics of men"s fast-pitch softball players.

TABLE 1. **DESCRIPTIVE STATISTICS OF VARIABLES**

Variable	N	Mean±SD
Height (cm)	30	169.00±7.38
Weight (kg)	30	65.37±14.83
Body fat (%)	30	19.72±4.68
Agility (sec)	30	13.53±2.14
Base running (sec)	30	6.03±0.33
Distance throw (m)	30	50.87±5.31
Batting (pts)	30	20.33±8.33
Batting average (runs)	30	0.24±0.12
Fielding (pts)	30	17.33±3.63
Fielding average (pts)	30	0.92±0.04
Total hits (pts)	28	3.39±2.77
Stolen bases (pts)	8	1.25±0.46
Home runs (runs)	4	1.25±0.50

Table 2 depicts the relationships between morphological, fitness, skill and performance characteristics. Although different positions vary with regard to the demands of the above characteristics, the sample did not warrant an investigation into the positional variances and only body fat percentage and BMI (Body Mass Index) were analysed by position.

TABLE 2: **CORRELATIONS (Spearman's rho) BETWEEN VARIABLES**

Variable	Height	Weight	Body fat	BMI	Vert. jump	St Br. jump	Agility	Base Runs	Dist. Throw	Batting
Height	—	0.763 **	0.594 **	0.584 **	-0.428 *	-0.040	-0.610 **	0.229	0.335	0.618 **
Weight	0.763 **	—	0.775 **	0.950 **	-0.283	-0.024	-0.534 **	0.188	0.244	0.560 **
Body fat %	0.594 **	0.775 **	—	0.787 **	-0.427 *	-0.264	-0.356	0.402 *	-0.012	0.481 **
BMI	0.584 **	0.950 **	0.787 **	—	-0.201	-0.041	-0.454 **	0.143	0.187	0.404 *
Vertical Jump	-0.428 *	-0.283	-0.427 *	-0.201	—	0.414 *	0.394 *	-0.681 **	-0.279	-0.320
Stand Br. Jump	-0.040	-0.024	-0.264	-0.041	0.414 *	—	0.071	-0.256	0.035	0.140
Agility	-0.610 **	-0.534 **	-0.356	-0.454 **	0.394 *	0.071	—	-0.208	-0.269	-0.536 **
Base runs	0.229	0.188	0.402 *	0.143	-0.681 **	-0.256	-0.208	—	-0.023	0.326
Distance Throw	0.335	0.244	-0.012	0.187	-0.279	0.035	-0.269	-0.023	—	-0.022
Batting	0.618 **	0.560 **	0.481 **	0.404 *	-0.320	0.140	-0.536 **	0.326	-0.022	—
Fielding	0.008	0.329	0.292	0.406 *	0.201	0.000	-0.098	-0.214	-0.094	0.055
Fielding ave.	0.159	0.324	0.436 *	0.389 *	-0.225	-0.106	-0.153	0.245	-0.222	0.273

Batting ave.	0.439 *	0.330	0.140	0.217	0.161	-0.158	-0.459 *	-0.130	-0.054	0.541 **

*p<0.05 (2-tailed) **p<0.01 (2-tailed)

Body fat exhibited a significant (p<0.01) positive relationship with weight (r=0.775) and height (r=0.594). Height and vertical jump had a moderate negative relationship, r=-0.428 (p<0.05). Weight also negatively correlated with jumping ability. However, this relationship was not significant. The relationship between body fat percentage and vertical jump was also found to be moderately negative (r=-0.427; p<0.05).

The relationship between the distance achieved in the batting test and height was high with a correlation coefficient of 0.618 (p<0.01). There was a strong negative relationship between base running and vertical jumping (r=-0.681; p<0.01). The relationship between the standing broad jump and base running was small, negative and not significant (r= -0.256). A negative, moderate and significant relationship was found between body weight and agility (r=-0.534; p<0.01).

Comparison of per cent body fat and BMI of players in different positions

The players in the infield had the lowest percentage body fat and BMI‟s (Table 3). This is in line with the demands of their individual positions, which require quick agile players capable of quick lateral movements. However, even though the pitcher and catcher also form part of the infield, their fielding and positional requirements are different to other infielder demands.

TABLE 3. **BODY FAT PERCENTAGE AND BMI BY PLAYING POSITION**

Position	Variable	N	Mean±SD	Median
Pitcher	BF	6	21.06±4.95	19.12
	BMI	6	22.37±2.63	22.97
Catcher	BF	4	21.05±5.52	20.37
	BMI	4	24.08±6.07	23.13
First base fielder	BF	5	20.73±5.65	18.21
	BMI	5	23.80±4.50	22.30
Other infield fielders	BF	7	17.08±4.49	15.55
	BMI	7	20.84±2.57	21.38
Outfield fielders	BF	8	19.74±3.77	19.21
	BMI	8	22.82±4.35	21.17

BF= Body fat % BMI= Body Mass Index SD= Standard Deviation

Comparison between club and provincial players

Descriptive statistics for club and provincial players are shown in Table 4. Table 5 orders the results by p-value and provides the False Discovery Rate (FDR) adjusted values. The results show that the club players were younger, shorter, lighter, and they were more agile and performed a better vertical jump than the provincial players. However, the provincial squad performed better on the batting test and had a better batting average. There were no significant differences in the fielding tests or the fielding average.

The provincial players were taller (173cm vs. 164cm) and heavier (74.2kg vs. 56.5kg) than the club players. The weight advantage of the provincial players was not only because of their greater height but they also demonstrated a higher lean body mass of 58kg compared to the 46kg of the club players. The provincial players had a higher body fat percentage (21%) compared to the club players (17%). This higher body fat percentage was also reflected in a higher BMI in the provincial players (24.4 vs. 20.7)

TABLE 4. **DESCRIPTIVE STATISTICS OF VARIABLES FOR CLUB AND PROVINCIAL TEAM PLAYERS**

	CLUB TEAM PLAYERS			PROVINCIAL TEAM PLAYERS		
Variable	**N**	**Mean±SD**	**Median**	**N**	**Mean±SD**	**Median**
Age (yrs)	15	15.67±2.50	15.00	15	24.60±5.42	25.00
Height (cm)	15	164.00±4.04	164.00	15	173.00±5.50	174.00
Weight (kg)	15	56.53±11.31	58.20	15	74.20±12.66	72.00
Body Fat (%)	15	17.76±3.70	16.83	15	16.54±5.95	18.40
Body Fat (kg)	15	10.34±4.14	9.02	15	16.54±5.95	18.40
LB Mass (kg)	15	46.18±7.53	46.45	15	57.65±7.41	57.81
BMI (kg/m^2)	15	20.73±3.14	19.47	15	24.46±3.73	23.46
Vert. Jump (cm)	15	55.53±7.44	52.00	15	48.60±4.61	49.00
Std. Br. Jump (cm)	15	244.67±15.73	241.00	15	239.39±17.49	240.00
Agility (sec.)	15	15.05±1.77	15.57	15	12.02±1.21	11.82
Base run (sec)	14	5.91±0.39	5.91	15	6.14±0.23	6.15
Throw Dist. (m)	15	50.22±5.74	51.20	15	51.52±4.94	52.00
Batting (pts)	15	15.00±7.50	14.00	15	25.67±5.13	25.00
Fielding (pts)	15	17.00±4.05	18.00	15	17.67±3.27	18.00
Fielding ave. (pts)	15	0.91±0.04	0.91	14	0.93±0.03	0.92
Batting ave. (runs)	15	0.18±0.08	0.17	14	0.30±0.14	0.29

LB Mass= Lean Body Mass BMI= Body Mass Index SD= Standard Deviation

The club team‟s agility scores were weaker than the provincial team‟s scores and ranged from 11.5 seconds to almost 18 seconds with players averaging 15.05 seconds. The provincial team had a narrower range starting from almost 12 seconds to over 17 seconds and an average of 12.92 seconds. The provincial team scored much better on the batting test (25.67) compared to the club team (15.0). The lowest score of 15 was the same as the club team‟s average.

The club team lacked consistency in their performance as reflected in their wide range of

batting ability (SD=7.5), while the provincial team was more consistent and scored in the middle to upper range of the test (SD=5.1). The provincial team outperformed the club team on batting averages, which is an important performance measure as it gives an indication of a team‟s ability to score runs and therefore win games.

TABLE 5. **SAS SYSTEM: P-VALUES AND FALSE DISCOVERY (FD) RATE**

Order	Variable	p-Value	Raw p-value	Bon p-value	FD rate
1	Age	0.0004	0.000439	0.01055	0.00850
2	Agility	0.0008	0.000821	0.01970	0.00850
3	Height	0.0016	0.001565	0.03756	0.00850
4	Batting	0.0017	0.001717	0.04121	0.00850
5	Lean Body Mass	0.0018	0.001772	0.04252	0.00850
6	Weight	0.0030	0.003012	0.07230	0.01205
7	Sub-scapular	0.0041	0.004130	0.09911	0.01416
8	Supra-iliac	0.0059	0.005916	0.14199	0.01758
9	Body Fat kg	0.0070	0.006986	0.16768	0.01758
10	Triceps	0.0073	0.007323	0.17576	0.01758
11	Batting ave.	0.0146	0.014595	0.35028	0.02953
12	Batting	0.0148	0.014767	0.35440	0.02953
13	Vertical Jump	0.0268	0.026813	0.64350	0.04650
14	Body Fat %	0.0361	0.036057	0.86536	0.06181
15	Base Run	0.0678	0.067758	1.00000	0.10841
16	Biceps	0.0873	0.087255	1.00000	0.13088
17	Abdominal	0.1662	0.166243	1.00000	0.23470
18	Fielding ave.	0.2845	0.284476	1.00000	0.37930
19	Total	0.3161	0.316061	1.00000	0.39924
20	Stand. Br. Jump	0.4486	0.448630	1.00000	0.53836
21	Distance Throw	0.6365	0.636452	1.00000	0.72737
22	Calf	0.6838	0.683812	1.00000	0.73519
23	Thigh	0.7046	0.704556	1.00000	0.73519
24	Fielding	0.7050	0.705015	1.00000	0.73519

DISCUSSION

Successful performance in any sport, including men‟s fast-pitch softball, is dependent on a multitude of factors, which include, among others, fitness, skill, performance and anthropometric characteristics. Match statistics alone do not define a player, especially if based on a single event, such as a tournament, which only lasts for a few days.

Anthropometry

Anthropometry is considered a very important distinguishing characteristic in fast-pitch softball players. Carjaval *et al.* (2009) found a strong correlation between pitching speed,

height, body weight, mesomorphy and muscle mass of Cuban baseball players. The relationship between weight and body fat in the current study was found to be high and significant. Fat is non-contractile tissue and is a burden in activities, which require explosive

power or sudden change of direction. The inhibiting impact of body fat, as a contributor to body weight, is reflected in the significant negative relationship ($r = -0.534$; $p<0.05$) that was found between weight and agility. Weight appears to be an advantage to batting as measured by the batting skills test. For this reason, it could be that fat, as a contributor to weight, also positively correlated with batting performance. Spaniol (2009) also identified body composition as an important factor in baseball performance especially for fielding and base running, and further highlighted the high positive correlation found between lean mass and bat speed and batted-ball velocity.

Weight was also found to relate strongly with height ($r=0.763$). Weight, as a proxy for height, and height, strongly correlated with batting as tested by the batting test ($r=0.618$). Increased height provides a mechanical advantage in batting. Height also had a significant correlation with batting as a performance measure (based on match statistics).

Body fat interacted negatively with most fitness variables. However, this relationship was only significant for leg power, as measured by the vertical jump test ($r=-0.427$; $p<0.05$). Body fat not only impacted on fitness variables but also on softball skills. It was found to have a significant impact on base running ($r=0.402$; $p<0.05$) (note lower running scores denote faster running speeds – hence the positive statistical relationship).

Physical fitness and performance measures

The vertical jump, as a measure of leg power, showed an average significant correlation with the standing broad jump ($r=0.414$; $p<0.05$) and the agility test ($r=0.394$; $p<0.05$). Agility, speed and explosive power are key fitness components of fast-pitch softball. The vertical jump also strongly correlated with base running. This is expected, as leg power is a component of running speed. Base runs showed a strong correlation with "stolen basis" as a performance measure. Spaniol (2009) identified leg power as important for hitting, running and throwing, as they all require forceful movements, which are generated from the ground up.

Agility was found to have average negative correlations with batting performances as reflected by the batting test ($r=-0.536$; $p<0.05$) and the "batting average" (as a performance measure) ($r=-0.459$; $p<0.05$). Agility was also found to have strong negative correlations with weight ($r=-0.534$; $p<0.01$) and height ($r=-0.610$; $p<0.01$). Batting was shown to be favoured by heavier weights while agility had strong negative correlations with weight. One needs to weigh up the importance of each of these qualities in achieving success in softball. As indicated earlier, team selections are mainly based on match statistics and therefore batting ability appears to be rated higher than being agile on the field, despite the fact that "stolen bases" and "homeruns" are also strongly related to agility.

Carjaval *et al*. (2009) found the infielders of Cuban baseball players weighed the least and had the lowest levels of body fat and this corresponded with agile, speedy, quick players. Kohmura *et al*. (2008) reported significant correlations between strength and batting, and between the standing broad jump and base running. The significant relationships found by Kohmura *et al*. (2008) are in concert with current research, which also reported significant

correlations between certain fitness parameters and performance.

Comparisons between club players and provincial players

Anthropometry

The club players were found to be significantly shorter and lighter than the provincial players ($p<0.01$). According to the correlations found in this study, taller heavier bodies favour batting performances although they compromise on agility, which is negatively correlated with height and weight. The shorter and lighter club players out performed the provincial players in the agility test.

It is usually accepted that fast-pitch softball players participating at the elite level would have a lower percentage body fat in general than average males, regardless of their individual playing positions. In the present study, the mean percentage body fat was found to be 19.7 %, which is outside the norms of 6 to 13 % for elite sportspersons, and more in line with the range of 18 to 24% for normal or average males (Gleeson, 2013). The club team‟s average of 17% also fell outside the norms but was significantly lower than that of the provincial players. The impact of these higher fat percentages is reflected in the agility test of the two groups where the club team exhibited a superior performance.

Physical fitness and performance measures

To be effective in softball, all players, regardless of their individual fielding positions, must possess the common fitness characteristics of power for batting, sprinting speed and agility for base running and chasing the ball when hit by the opposition, as well as leg power to jump when catching high balls (Spaniol, 2009). Speed and agility are necessary to be effective defensively in fielding and offensively for base running. Although the club players were found to be faster and more agile than the provincial players were, these are only two of a myriad of factors that determine success in softball and do not necessarily translate into better overall performers.

The physical fitness requirements of the game demand that all players be fast, agile and good base runners. In addition, an explosive first step generates the speed needed to get to balls hit farther away (Spaniol, 2009). The provincial team performed better on the batting test and had a better batting average. Being taller with more muscle weight, the provincial team players could have generated more force during their swing when batting (Schoenfeld, 2010).

Games are won by scoring runs. Players can only score runs by getting onto bases, and players get on base by batting. In the case of the provincial team players, the less agile players were able to get on base more frequently by being stronger, more powerful batters with better batting technique. There was a very weak correlation coefficient of 0.021 between the batting test and total hits and this can be explained in terms of the way in which the batting test was administered. When doing the batting test, the batter hits a ball off a tee, whereas in the game situation the batter faces a ball pitched at various speeds and in different places within the strike zone.

CONCLUSIONS AND RECOMMENDATIONS

A number of interacting physiological, morphological and skill variables determine success in any sport, including men‟s fast-pitch softball. It is, therefore, imperative that the training and selection of fast-pitch softball players be based on scientific evidence, which links

science to practice. Softball is a complex game with many facets, which requires many specialised functions.

From an anthropometric perspective, height is an advantage as longer limbs means longer levers, which can generate greater force. This study also found a significant and strong correlation between height and batting performance. The importance of height is further emphasised by the difference in height between the elite provincial players and the club players.

Excess fat has no practical role to play in activities, such as sprinting between bases, jumping to catch high flying balls or fielding. It is regarded as dead weight that negatively affects acceleration. The prescribed fat percentage should at least be in line with the general guidelines for sport persons and could be position specific. The negative relationship between body fat and agility is clearly demonstrated in the current study.

Softball entails situations in which the athlete must exhibit high levels of agility, which involves sudden changes of direction and acceleration. These instances are evident in actions, such as fielding, when a player must move suddenly and quickly to cover a base drive, or in actions like base running, when a player must recover quickly or return to base. Stockton (1984) indicate that catchers in softball must be exceptionally agile and coordinated to be effective fielders also highlights the importance of agility.

Pitching, batting, throwing and base running are all actions of fast-pitch softball, which involve explosive and dynamic actions. These explosive actions require high levels of power. Based on the relationships established in the current study, it is recommended that speed, leg power and agility be included when compiling a test battery for fast-pitch softball. The importance of these relationships were emphasised by the differences found between provincial and club players. The results further suggest that, although a certain level of fielding proficiency is required, the main indicators of success are the performances on the batting test and the batting average as recorded in the match statistics.

Based on the relationships established in this research, it is strongly recommended that coaches include fitness, morphological and skills tests in their coaching and fitness programmes. Furthermore, the results of these tests should be used in team selection processes, as they are strong indicators of success and would make the selection process more objective.

REFERENCES

BENJAMINI, Y. & HOCHBERG, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society (Series B [Methodological])*, 57(1): 289-300.

BROWN, J. (2001). *Sports talent: How to identify and develop outstanding athletes*. Champaign, IL: Human Kinetics.

BROZEK, J.; GRANDE, F.; ANDERSON, J.T. & KEYS, A. (1963). Densitometry analysis of body composition: Revision of some quantitative assumptions. *Annals of the New York Academy of Sciences*, 110: 113-140, September.

CARVAJAL, W.; RIOS, A.; ECHEVARRIA, I.; MARTINEZ, M.; MINOSO, J. & RODRIGUES, D. (2009). Body type and performance of elite Cuban baseball players. *MEDICC Review*, 11(2): 15-20.

DURNIN, J.V.G.A. & WOMERSLEY, J. (1974). Body fat assessed from total body density and its estimation from skinfold thickness: Measurements on 481 men and women aged from 16-72 years. *British Journal of Nutrition*, 32: 77-97.

ESTEP, J.R. (2013). *Statistics, not sadistics! A practical guide to statistics for non-statisticians.* Louisville, KY: Lincoln Christian Seminary.

GLEESON, M. (2013). "Normal ranges of body weight and body fat." Hyperlink [humankinetics. com/excerpts/excerpts/normal-ranges-of-body-weight-and-body-fat]. Retrieved on 15 April 2013.

HACHANA, Y.; CHAABÈNE, H.; NABLI, M.A.; ATTIA, A.; MOUALHI, J.; FARHAT, N. & ELLOUMI, M. (2013). Test-retest reliability, criterion related validity and minimal detectable change of the Illinois agility test in male team sport athletes. *Journal of Strength Conditioning Research*, 27(10): 2752-2759.

INTERNATIONAL SOFTBALL FEDERATION (2003). "The history of softball." Hyperlink [http://www.isfsoftball.org/english/the_isf/history_of_softball.asp]. Retrieved on 12 May 2014.

JOHNSON, B.L. & NELSON, J.K. (1986). *Practical measurements for evaluation in Physical Education* (4th ed.). Minneapolis, MN: Burgess Publishing.

KOHMURA, Y.; AOKI, K.; YOSHIGI, H.; SAKURABA, K. & YANAGIYA, T. (2008). Development of a baseball-specific battery of tests and a testing protocol for college baseball players. *Journal of Strength and Conditioning Research*, 22(4): 1051-1058.

MARFELL-JONES, M.; OLDS, T.; STEW, A. & CARTER, L. (2006). *International standards for anthropometric assessment.* Sydney (Australia): International Society for the Advancement of Kinanthropometry.

MORROW, J.R. Jnr.; JACKSON, A.W.; DISCH, J.G. & MOOD, D.P. (2011). *Measurement and evaluation in human performance* (4th ed.). Champaign, IL: Human Kinetics.

NORTON, K.I. & OLDS, T. (1996). *Anthropometrica: A textbook of body measurement for sport and health courses*. Sydney (Australia): UNSW Press.

SAFRIT, M.J. & WOOD, T.M. (1995). *Introduction to measurement in Physical Education and exercise science*. Philadelphia, PA: Mosby.

SCHOENFELD, B.J. (2010). The mechanisms of muscle hypertrophy and their application to resistance training. *Journal of Strength and Conditioning Research*, 24(10): 2857-2872.

SPANIOL, J. (2009). Baseball athletic test: A baseball specific test battery. *Strength and Conditioning Journal*, 31(2): 26-29.

STOCKTON, B.A. (1984). *Coaching baseball: Skills and drills*. Champaign, IL: Human Kinetics.

TOMCHUCK, D. (2011). *Companion guide to measurement and evaluation for kinesiology*. Mississauga, Ontario (Canada): Jones & Bartlett Learning.

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