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BOTSWANA TEAM SPORT PLAYERS' PERCEPTION OF COHESION AND IMAGERY USE IN SPORT

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ABSTRACT

Perception of cohesion and imagery use among 45 elite team sport players in Botswana were assessed with the Group Environment Questionnaire (Carron et al., 1985) and the Sport Imagery Questionnaire (Hall et al., 1998) to determine whether a relationship exists between the variables, and whether imagery use will significantly predict team cohesion. Results of the correlation analysis revealed a significant ($p<.05$) positive relationship between Attraction to Group-Social and Cognitive General Imagery. Significant positive relationships ($p<.05$) were also revealed between Individual Attraction to Group-Task and Cognitive Specific, Motivational Specific and Motivation General Arousal Imagery. The regression analysis revealed no significant ($p>.05$) composite effect of imagery use on cohesion, while a shared variance of 6.7% was recorded for both variables. Furthermore it was revealed that Motivational Specific and Cognitive General imagery use were significant ($p<.05$) predictors of cohesion as perceived by the team players. Findings further suggest that the cognitive and affective elements of perceived imagery and cohesion are reciprocally related on the basis of theories concerning the relationship between cognition and affect. The implications of these findings suggest that the team cohesion and imagery relationship could be used for team building and a team intervention tool with other cognitive variables.

Key words: Cohesion; Imagery; Perception; Team.

INTRODUCTION

Research on cohesion within the sport and exercise psychology context has been based on Carron's (1982) conceptual framework. Cohesion is defined as "a dynamic process which is reflected in the tendency for a group to stick together and remain united in the pursuit of its goals and objectives" (Carron, 1982:124). This conceptual framework remains widely influential to the contributions found in cohesion literature and has led to the development of a model by Carron *et al.* (1985) which assumes that each sport team develops perceptions of cohesiveness which are categorized as group integration (the perception of the team as a whole), and individual attractions to the group (the personal attractions to the group). Hardy *et al.* (2003) report that four dimensions accounted for the majority of the variance in team cohesion. These are Group-Integration-Task, Group-Integration-Social, Individual Attraction to Group-Task and Individual Attraction to Group-Social.

The two Group Integration dimensions reflect the individual's feelings about the closeness and bonding in the group as a whole in relation to the task or social perspective, while the two

individual attractions to group dimensions reflect the individual's feeling about involvement with the group from the task or social perspective. The four facets of cohesion according to Gill (2000), contribute to cohesiveness dynamically and collectively. As the cohesiveness of teams' changes over time, so do the members' perceptions of cohesiveness.

The facets of team cohesion were earlier operationalised by Carron *et al.* (1985) with the development of the Group Environment Questionnaire which has been used by researchers to assess the relationship between individual perception of team cohesion and athletes' self-reports of behaviour, as well as their actual behaviour.

Studies by Widmeyer and Martens (1978), Shangi and Carron (1987) and Widmeyer *et al.* (1990), have confirmed the positive relationship of players' perception of cohesiveness and success within basketball teams. Prapavessis and Carron (1997a) also reported that elite cricket players' perception of cohesion subscales of Group-Integration-Task, and Group-Integration-Social were positively associated with their self-reported conformity to group norms. It was also found that the subscale of Individual Attraction to Group-Task is a reliable predictor of the work output of elite athletes from different sports (Prapavessis & Carron, 1997b).

The quest by sport psychologists working with teams is to identify constructs that relate to performance in order to manipulate these constructs to improve performance (Lowther & Lane, 2002). However, one variable that has consistently influenced performance positively is imagery. As a cognitive process, imagery use is dynamic and state-like in nature and would be positively associated with perception of team cohesion which is a dynamic process (Munroe *et al.,* 1998). Imagery is seen as an experience that mimics real experience (White & Hardy, 1998).

Imagery is a psychological activity recreating the physical properties of an object, person or peace that is out of personal perception and is considered to be the most popular performance enhancement technique because of its versatility in effecting several different outcomes (Denis, 1985; Short *et al*., 2006). Paivio (1985) has proposed a conceptual framework which explains the mediating role of imagery through cognitive and motivational mechanisms which affect specific or general response systems. The Cognitive General (CG) dimension involves imaging any combination of movements, whereas the Cognitive Specific dimension (CS) involves imaging the execution of specific skills (Strachan & Munroe-Chandler, 2006). The Motivational Specific dimension (MS) involves imaging goals such as winning or receiving a medal while the Motivation General (MG) dimension is related to physiological arousal and affect stemming from various sport situations (Law *et al.,* 2006; Short *et al.,* 2006). Hall *et al.* (1998) have expanded upon Paivio's framework by further separating the Motivation General (MG) functions into Motivation General-Arousal (MGA) imagery, which involves feelings of being relaxed or psyched up and Motivation General-Mastery (MGM) imagery, which involves imaging feelings of confidence and mental toughness.

The Sport Imagery Questionnaire (SIQ) developed by Hall *et al.* (1998) based on Paivio's (1985) conceptual framework is used to assess the frequency with which athletes use images representative of different imagery types. The composite use of the SIQ has revolutionalised studies on imagery, especially with psychological constructs such as sport confidence and

self-efficacy (White & Hardy, 1998; Callow & Hardy, 2001; Abma *et al.*, 2002), anxiety (Monsma & Overby, 2004) and team cohesion (Hardy *et al.*, 2003).

An explanation can be proposed theoretically for the dynamic nature of imagery as it increases imagery vividness among athletes, similar to the dynamic nature of cohesiveness. Actions in a sport situation facilitate imagery through representational updating. Specifically, the use of a mental model helps people (i.e. team players) to imagine how one movement causes another movement within a physical situation (Baddeley & Andrade, 2000). It also helps the team players convert their bodily actions into updated images. As vividness of imagery use in sport reflects the richness of the representation displayed in the short-term memory, the dynamic process of imagery may aid the updating of the representation displayed in the memory, and thereby improve the vividness of imagery for improved team performance.

Hypothetically, imagery use in team sport according to Shearer *et al.* (2007), is perceived to be beneficial for imaging team strategies and plays, the same way it has been found to have a positive effect on individual perceptions of collective efficacy. Team players with very strong perceptions of team cohesion will devote a considerable time to imaging team techniques that will be significant to the success of the team. Hardy *et al.* (2003) has predicted that team players possessing higher perceptions of task cohesion would report greater use of both Cognitive Specific (CS) and Cognitive General (CG) types of imagery, while high task cohesion was expected to lead to greater use of Motivation Specific (MS) and Motivation General-Mastery (MG-M). Also, team players with a vivid perception of social cohesion utilize Motivation General-Arousal imagery (MGA) more, given the fact that it represents the player's affective feedback within their sport context. Attraction to the group task and social as expressed by the team players are apparently expected to have stronger relationships with the team players' imagery use than the group task and social as manifested with the cohesion of the team.

It is in the light of the above, that this study examines the relationships of the team sport players' perception of cohesion and imagery in sport. It further examines whether the five imagery subscales will significantly predict cohesion of team players.

METHODS

Participants

The sample for this study consists of 45 male elite players in volleyball, football and basketball (15 participants for each sport) from Botswana. They have participated in their sports both at the national and international levels. Their ages range from 19 to 26 years (M=22.50; SD=1.32). All the participants had gone through imagery training sessions in the past and have had at least a one year playing experience at the elite level.

Measures

The Group Environment Questionnaire (GEQ) is an 18-item questionnaire developed by Carron *et al.* (1985) which assess individual attraction to group task, individual attraction to

group social, group integration task as well as group integration social. The questionnaires were completed by the participants in order to measure team cohesion. Participants responded on a 9-point Likert Scale anchored at the extremes by "strongly disagree" (1) and "strongly agree" (9). Larger scores reflect stronger perceptions of cohesiveness. The task construct refers to a general orientation towards achieving the group's goals and objectives, whereas the social orientation is focused on developing and maintaining social relationships within the group. The group integration construct represents the closeness, similarity and bonding within the group as a whole. Conversely, the individual attractions to group represent the interaction of the motives working on the individual to remain in the group. The subscale of team cohesion assessed were (ATG-T; 4 items), (ATG-S, 5 items), (GI-T; 5 items) and (GI-S; 4 items). Previous studies by Carron *et al.* (1985) and Brawley *et al.* (1987) have demonstrated that the questionnaire has adequate internal consistency with alpha coefficients ranging from 0.64 to 0.76. The GEQ subscales in this study demonstrated adequate internal consistency with alpha coefficients ranging from 0.66 to 0.77.

The second questionnaire used for this study is the Sport Imagery Questionnaire (SIQ) developed by Hall *et al.* (1998) to measure imagery functions in sport. This questionnaire consists of 30 items with five subscales of Cognitive General (CG), Cognitive Specific (CS), Motivational Specific (MS), Motivation General-Mastery (MGM) and Motivation General-Arousal (MGA). Each imagery function consists of 6 items and the items are rated on a 7-point Likert Scale ranging from "rarely" (1) to "often" (7). The scores for the subscales are calculated as the sum of the item scores from that subscale. Previous research have shown acceptable internal consistency for the SIQ subscales ranging from 0.68 to 0.90 (Hall *et al.*, 1998; Abma *et al.*, 2002; Shearer *et al.*, 2007; Adegbesan, 2009). The Motivation General-Arousal subscale recorded the smallest alpha value of 0.68 in this study, but the instrument still demonstrated a sufficiently high degree of internal consistency with coefficient alphas ranging from 0.68 to 0.89.

Procedure

Permission was sought from the ethical committee and team officials to conduct the study. The consent of the participants was also obtained. The researcher and the research assistants explained the study to the participants. The Group Environment Questionnaire and the Sport Imagery Questionnaire were then administered to the participants during one of their training sessions in a group setting. They were assured of the confidentiality of their responses prior to data collection.

Analysis

The Statistical Package for the social sciences (SPSS) was used for the analysis of the data. The internal consistency for the GEQ and the SIQ was done using the Cronbach alpha coefficient. The descriptive statistics of mean and standard deviation were also utilized. The Pearson correlation coefficient was used to determine the relationships between the team sport player's perception of cohesion and imagery use in sport, while the multiple regression analysis was used to examine whether the five imagery subscales will significantly predict cohesion of team players.

RESULTS

Descriptive statistics of mean and standard deviation were calculated for the subscales of

team cohesion and imagery as presented in table 1. The mean values for cohesion ranged from 13.5 to 28.6, while the mean values for imagery ranged from 28.4 to 35.7. Internal consistency for the imagery and cohesion subscales were also calculated using the Cronbach alpha coefficient as presented in table 1. Alpha values ranging from 0.66 to 0.77 were reported for cohesion. Individual Attraction to the Group-Social recorded the smallest alpha value of 0.66. This value was considered to be moderate and was not deleted from the present study in comparison to the study by Hardy *et al.* (2003) in which an alpha value of 0.59 was recorded for Individual Attraction to the Group-Social and was subsequently deleted and did not form part of the final analysis. Pearson correlation was computed to show the relationships between the cohesion and imagery subscales as presented in the matrix in table 1. Attraction to Group-Social and Cognitive General (CG) revealed a significant relationship (r=0.69), while Individual Attraction to Group-Social also revealed a significant relationship (r=0.60) with cognitive Specific imagery (CS). The matrix table also shows significant perceptions of the relationships of Individual attraction to Group-Task and imagery types of Cognitive Specific (CS) (r=0.61), Motivational Specific (MS) (r=0.64) and Motivation General-Arousal (MGA), (r=0.59) respectively.

TABLE 1: **CORRELATION MATRIX, MEAN, STANDARD DEVIATION AND CRONBACH ALPHA COEFFICIENT OF THE GEQ AND THE SIQ**

Subscales	Cronbach alpha	M	SD	ATGT	ATGS	GIT	GIS	CS	CG	MS	MGM	MGA
ATGT	0.70	13.5	6.23	…	.58**	-.34*	.59**	.32*	-. 21	.61**	.51*	-.20
ATGS	0.66	22.5	5.73		…	.49*	.60**	.47*	.69**	.41*	.28*	.31**
GIT	0.72	28.6	5.68			…	.52*	.61**	.58**	.64**	.49*	.59**
GIS	0.77	17.6	5.66				…	.56*	.60**	.49*	.58**	.62**
CS	0.81	30.9	7.53					…	.55*	.46*	.63**	.51*
CG	0.74	28.4	9.92						…	.52*	.47*	.64**
MS	0.89	35.7	6.99							…	.66**	.62**
MGM	0.76	28.5	10.2								…	.57*
MGA	0.68	34.8	7.56									…

Note: Individual attraction to Group task=ATGT; Individual attraction to Group social=ATGS; Group Integration Task=GIT; Group Integration Social=GIS; Cognitive Specific=CS; Cognitive General=CG; Motivational Specific=MS; Motivation General Mastery=MGM; Motivation General Arousal=MGM.

** p<.01 = Significant

* p<.05 = Significant

TABLE 2: **COMPOSITE EFFECT OF IMAGERY ON COHESION SHOWING THE ANOVA SUMMARY OF THE REGRESSION ANALYSIS**

Model	Sum of Square	Mean	Df	F	Sig
Regression	909.796	181.959	5		
Residual	4350.204	111.544	39	1.63	0.175
Total	5260.000		44		

R=.416
R^2=.173
Adj R^2=.067
Standard Error=10.561

A shared variance of 6.7% was also recorded for the imagery and cohesion variables. The composite effect of the athletes' perception of imagery use was not statistically significant ($F(5, 44) = 1.63$; $p>.05$).

The results of regression analyses conducted for the cohesion and imagery subscales is shown

in table 3. The cohesion subscales served as the criterion variables, while the imagery subscales were the predictor variables. The use of Cognitive General (t=2.31; df=5.39; p<.05) and Motivational Specific (t=2.84; df=5, 39; p<.05) imagery functions could significantly predict changes in perceptions of team cohesion.

TABLE 3: **PARAMETER ESTIMATE OF THE RELATIVE CONTRIBUTION OF IMAGERY TYPES ON COHESION**

Subscales	Unstandardized Coefficient		Standardized Coefficient	t	Sig
	β	Standard Error	Beta		
(Constant)	59.570	8.763		6.798	.000
Cognitive Specific	.053	.293	.037	.181	.857
Cognitive General	.172	.210	.157	2.31	.041*
Motivational Specific	.634	.455	.406	2.84	.026*
Motivation General Mastery	.078	.223	.073	1.62	.066
Motivation General-Arousal	.027	.374	.019	.072	.943

* Significant at p<.05

DISCUSSION

This study examined, firstly, the relationship between team cohesion and imagery use in sport as perceived by the team sport players and secondly, whether imagery use can significantly predict cohesion in team sport. The relationship between cohesion and imagery subscales as reflected in this study is apparent because the cognitive process of imagery helps to enhance individual performances that are beneficial to the overall performance of a team.

The results suggest that Attraction to Group-Social and Individual Attraction to Group-Task have significant moderate relationships with Cognitive General (CG) and Cognitive Specific (CS) imagery respectively. The Individual Attraction to Group-Task was also shown to be significantly related to Cognitive Specific (CS), Motivational Specific (MS) and Motivation General- Arousal (MGA) imagery respectively.

The significant prediction reported for both Cognitive General (CG) and Motivational Specific (MS) imagery on cohesion is peculiar with the fact that performing basic skills in sports is always done in a coordinated form which is crucial for good team performance (Martin Ginis *et al*., 1999; Hall, 2001). Every member learns that the team must be united more often because of the fact that imagery is practiced in a team context. Furthermore, there

is always a mounting pressure as the competitive season progresses for every team member to practice both physically and mentally, as effectively as possible for the benefit of the whole team (Hardy *et al.,* 2003). As the team players' perception of their task increases, so does the probability of an increase in motivation for unity in the use of imagery to be rehearsed for the various skills needed for team success.

The appraisal of a team player's group belongingness takes place both cognitively and

affectively. The cognitive aspect relates to the information the player has accumulated concerning his sport experiences within the team and with the team members. The affective aspect concerns feelings about the sport experiences of the player. In other words, based on the theories concerning the relationship between cognition and affect, the cognitive and affective elements of both perceived imagery and cohesion are expected to be reciprocally related.

The positive association of both imagery and cohesion are not only vital for the closeness and bonding of the team members, but also for the realization of the cognitive and motivational functions of imagery which gives support to the teams' short-term and long-term goals.

CONCLUSION

Most experiences associated with sport occur in group settings including the use of imagery considering the fact that people will devote considerable cognitive processing to interpersonal interaction and relationships. This study examined the relationship between Botswana team sport athletes' perception of team cohesion and imagery use in sport. The examination of these relationships revealed that the athletes perceived the use of Motivational Specific and Cognitive General imagery functions as significant predictors of team cohesion. Also the positive relationships established between the elements of both team cohesion and imagery as revealed in this study, stresses the fact that perception of togetherness can influence cognitions which are beneficial to the sport teams. Sport Psychology is a discipline in which cohesion and imagery are unquestionably important. A theory driven approach to the study of these two dynamic psychological constructs has yielded meaningful findings in Sport Psychology literature. Therefore, social cognitive variables such as sport confidence, collective efficacy and cognitive anxiety in team sport setting should be examined in future studies along with imagery and cohesion using both the individual and team players as a unit of analysis.

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REFERENCES

ABMA, C.L.; FRY, M.D.; Li, Y. & RELYA, G. (2002). Differences in imagery context and imagery ability between high and low confident track and field athletes. *Journal of Applied Sport Psychology*, 14(2): 67-75.

ADEGBESAN, O.A. (2009). Use of imagery by athletes in Nigeria. *Perceptual and Motor Skills*, 108(1): 43-50.

BADDELEY, A.D. & ANDRADE, J. (2000). Working memory and vividness of imagery. *Journal of Experimental Psychology: General*, 129(1): 126-145.

BRAWLEY, L.R.; CARRON, A.V. & WIDMEYER, W.N. (1987). Assessing cohesion of teams: Validity of the group environment questionnaire. *Journal of Sport Psychology*, 9: 275-294.

CALLOW, N. & HARDY, L. (2001). Types of imagery associated with sport confidence in netball players of varying skill levels. *Journal of Applied Sport Psychology*, 13(1): 1-17.

CARRON, A.V. (1982). Cohesiveness in sport groups: Interpretation and considerations. *Journal of Sport Psychology*, 4: 123-128.

CARRON, A.V.; WIDMEYER, W.N. & BRAWLEY, L.R. (1985). The development of an instrument to assess cohesion in sport teams: The group environment questionnaire. *Journal of Sport Psychology*, 7: 244-266.

DENIS, M. (1985). Visual imagery and the use of mental practice in the development of *m*otor skills. *Canadian Journal of Applied Sport Sciences*, 10(4): 45-165.

GILL, D.L. (2000). *Psychological dynamics of sport and exercise* (2nd ed.). Champaign, IL: Human Kinetics.

HALL, C.R. (2001). Imagery in sport and exercise. In R.N. Singer; H.A. Hausenblas & M. Janelle (Eds). *Handbook of Sport Psychology* (529-549). New York, NY: Wiley.

HALL, C.R.; MARK, D.; PAIVIO, A. & HAUSENBLAS, H.A. (1998). Imagery use by athletes: Development of sport imagery questionnaire. *International Journal of Sport Psychology*, 29(1): 73-89.

HARDY, J.; HALL, C.R. & CARRON, A.V. (2003). Perceptions of team cohesion and athletes' use of imagery. *International Journal of Sport Psychology*, 34: 151-167.

LAW, B.; DRIEDIGER, M. & HALL, C.R. (2006). Imagery use, perceived pain, limb functioning and satisfaction in athletic injury rehabilitation. *New Zealand Journal of Physiotherapy*, 34(1): 10-16.

LOWTHER, J. & LANE, A. (2002). Relationships between mood, cohesion and satisfaction with performance among soccer players. *Athletic Insight*, 4(3): 57-69.

MARTIN GINIS, K.A.; MORITZ, S.E. & HALL, C.R. (1999). Imagery use in sport: A literature review and applied model. *The Sport Psychologist*, 13: 245-268.

MONSMA, E.V. & OVERBY, L.Y. (2004). The relationship between imagery and competitive anxiety. *Journal of Dance Medicine and Science*, 8: 11-18.

MUNROE, K.J.; HALL, C.R.; SIMMS, S. & WEINBERG, R.S. (1998). Athletes' use of imagery, early and late in their season. *The Sport Psychologist*, 12: 440-449.

PAIVIO, A. (1985). Cognitive and motivational functions of imagery in human performance. *Canadian Journal of Applied Sport Science*, 10(4): 22-28.

PRAPAVESSIS, H. & CARRON, A.V. (1997a). Cohesion and work output. *Small Group Research*, 28(2): 294-301.

PRAPAVESSIS, H. & CARRON, A.V. (1997b). Sacrifice, cohesion, and conformity to norms in sport teams. *Group Dynamics: Theory, Research and Practice*, 1(3): 231-240.

SHANGI, G. & CARRON, A.V. (1987). Group cohesion and its relationship with performance and satisfaction among high school basketball players. *Canadian Journal of Sport Sciences*, 12: 20-26.

SHEARER, D.A.; THOMPSON, R.; MELLALIEU, S.D. & SHEARER, C.R. (2007). The relationship between imagery type and collective efficacy in elite and non-elite athletes. *Journal of Sport Science and Medicine*, 6(2): 180-187.

SHORT, S.E.; ROSS-STEWART, L. & MONSMA, E.V. (2006). Onwards with the evolution of imagery research in sport psychology. *Athletic Insight*, 8(3): 1-14.

STRACHAN, L. & MUNROE-CHANDLER, K. (2006) Using imagery to predict self-confidence and anxiety in young elite athletes. *Journal of Imagery Research in Sport and Physical Activity*, 1(3): 1-19.

WHITE, A. & HARDY, L. (1998). An in-depth analysis of the uses of imagery by high-level slalom canoeists and artistic gymnasts. *The Sport Psychologist*, 12: 387-403.

WIDMEYER, W.N. & MARTENS, R. (1978). When cohesion predicts performance outcome in sport. *Research Quarterly*, 49: 372-380.

WIDMEYER, W.N.; BRAWLEY, L.R. & CARRON, A.V. (1990). The effects of group size in sport. *Journal of Sport and Exercise Psychology*, 12(2): 177-190.

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DIE ANTROPOMETRIESE SPRONGITEM-PRESTASIEDETERMINANTE VAN JONG DOGTERGIMNASTE

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ABSTRACT

The purposes of this study were firstly to determine the anthropometric variables that differ significantly ($p \leq 0.05$) between successful and less successful young, South-African (SA), female gymnasts in the vault item and secondly, to determine the anthropometric variables that contribute to the performance of young SA female gymnasts in the vault item. Twelve young, female gymnasts (13.39 $\pm$ 2.14 years) from

a gymnastics club in the North-West Province of South Africa participated in this study. Only gymnasts who participated at level 6-9 and junior as well as at the senior Olympic level were selected to participate in this study. Sixty-one anthropometric variables were measured on the dominant side of the body according to the methods of Norton et al. (1996). Independent t-tests and effect sizes revealed that the gymnasts who obtained the highest points (top 5) during the execution of the vault item during the South African Gymnastics Championships had statistical and practical significantly larger relaxed and flexed upper arm, wrist and ankle circumferences as well as higher mesomorphy values than the less successful gymnasts. The cluster analysis-reduced variables were used to perform a forward, stepwise multiple regression analysis, which showed that flexed upper arm circumference (53.93%), midstillion dactillion length (12.38%), foot length (11.50%), fat percentage (8.93%), trochanterion-tibial lateral length (5.77%), chest circumference (3.69%), ectomorphy (1.96%), bideltoied breadth (1.54%), triceps skinfold (0.23%) and iliospinal box height (0.07%) contributed 100% to the variance in gymnasts' vault performances. Therefore the conclusion that can be drawn is that larger upper arm and upper body circumferences; hand, foot, upper leg and total leg lengths; triceps skinfold and fat percentage as well as a higher ectomorphy value are important anthropometric vaulting performance determinants for young, South African, female gymnasts and should be included in the sport-scientific testing protocols of gymnasts.

Key words: Gymnastics; Vault; Anthropometry; Performance; Female; Girls.

INLEIDING

Artistiese gimnastiek is 'n sport waaraan meer as 30 miljoen individue in meer as 80 lande deelneem (Bale & Goodway, 2004). Dit is 'n sportsoort wat uit 'n groot hoeveelheid items bestaan wat elk unieke eise aan die gimnas stel. Die items waaraan dogters deelneem, kan verdeel word in vloer-, sprong-, brug- en balkreekse (Bale & Goodway, 1990). Suksesvolle gimnaste toon 'n kenmerkende antropometriese profiel (Carter & Brallier, 1988), wat die belang van antropometriese samestelling as 'n prestasiedeterminant beklemtoon (Thorland *et al*., 1981; Norton *et al*., 1996; Claessens *et al*., 1999). Dit is slegs in baie uitsonderlike gevalle dat sekere gimnaste die vermoë toon om ten spyte van 'n minder gunstige antropometriese profiel gimnastiekprestasies te behaal (Claessens *et al*., 1999). Dit is met dié wete dat die literatuurbevindinge wat die verband tussen gimnastiekprestasie en die antropometriese samestelling van gimnaste opsommend weergegee word. Vanweë die besondere eise wat elk van die gimnastiekitems aan 'n gimnas stel, het die navorsers van hierdie studie besluit om slegs op die antropometriese komponente wat in verband staan met prestasies in die sprongitem te fokus.

Claessens *et al*. (1999) is egter die enigste navorsers wat die bydrae bepaal het wat verskillende antropometriese veranderlikes tot itemspesifieke gimnastiekprestasies lewer. In dié verband het hulle bevind dat velvoue (biseps, triseps, subskapulêre, crista iliaca en kuit) en endomorfie die hoogste betekenisvolle, negatiewe korrelasie met sprongitem-prestasie getoon het. Daar is ook in die studie gevind dat 'n laer endomorfie, groter kuitomtrek, ouer chronologiese ouderdom, korter sithoogte en groter voorarmomtrek 'n 43.25%-bydrae lewer tot die punte wat gimnaste in die sprongitem behaal. Ten spyte dus van die beskikbaarheid van literatuur wat verskillende antropometriese prestasiedeterminante onder internasionale

gimnaste uitwys, blyk dit daar geen navorsing bestaan wat die presiese bydrae van elk van die antropometriese prestasiedeterminante tot die sprongitemprestasies van Suid-Afrikaanse gimnaste bepaal het nie. Dit is teen dié agtergrond dat die volgende navorsingsvrae gestel is: Ten eerste, wat is die antropometriese veranderlikes wat betekenisvol tussen suksesvolle en minder suksesvolle SA-dogtergimnaste in die sprongitem verskil? Tweedens, wat is die antropometriese veranderlikes wat bydra tot die prestasies (puntetoekenning) wat SA-dogtergimnaste in die sprongitem behaal? Die beantwoording van hierdie vrae sal moontlik afrigters en sportwetenskaplikes in staat stel om meer talentvolle gimnaste te identifiseer en om vas te stel wat die mees bepalende antropometriese komponente is wat aandag tydens gimnastiekkondisioneringsprogramme moet geniet.

METODE VAN ONDERSOEK

Navorsingsontwerp

'n Eenmalige dwarsdeursnee-opname is vir die doel van die studie uitgevoer.

Die proefpersone

'n Groep van twaalf jong, provinsiale dogtergimnaste ($\overline{X}$ =13.39 $\pm$ 2.14 jaar) van 'n gimnastiekklub in die Noordwes-Provinsie (Suid-Afrika) is vir die studie gebruik. Slegs gimnaste wat op vlak 6-9 en op junior en senior Olimpiese vlak kompeteer, is vir die doel van die studie gebruik. Dié groep is onder andere saamgestel uit een gimnas wat aan die Olimpiese Spele van 2004 deelgeneem het.

Die toetsingsprosedure

Die studie (met die nommer 04M13) is deur die Noordwes-Universiteit se Etiekkomitee goedgekeur. Die gimnaste en hulle ouers is ingelig oor die toetsprosedures en ingeligtetoestemming-vorms is deur beide die genoemde partye onderteken voordat die toetsings 'n aanvang geneem het. Die gimnaste se demografiese en persoonlike inligting is deur middel van 'n demografiese en algemene inligtingsvraelys ingesamel. Inligting oor die gimnaste se oefengewoontes, beseringsinsidensie, aktiwiteitsdeelnamevlak en fisieke voorbereiding is ook deur middel van dié vraelys bepaal.

Elk van die proefpersone is gedurende die week van deelname aan hul primêre gimnastiekkompetisie (Suid-Afrikaanse Gimnastiekkampioenskap) aan die ondergenoemde metings onderwerp.

Die volgende antropometriese veranderlikes is volgens die metodes van Norton *et al*. (1996) aan die dominante kant van die liggaam gemeet:

Absolute liggaamsgrootte

Die volgende veranderlikes is onder hierdie kategorie bepaal: liggaamsmassa; liggaamslengte; sithoogte; armspan; kop-, nek-, ontspanne boarm-, gespanne boarm-, voorarm-, gewrig-, bors-, middel-, heup-, bo-dy-, mid-dy-, kuit- en enkelomtrek; biakromiale, transversale bors-, AP-bors-, bi-iliokristale, humerus-, gewrigs-, hand- en femurdeursnee; boonsteledemaat-, arm-, voorarm-, hand-, ondersteledemaat-, dy-, been- en voetlengte.

Somatotipering

Die somatotipering van gimnaste het gefokus op die beoordeling van hul endo-, meso- en ektomorfiewaardes. Aangesien somatotipe bereken word deur van ’n aantal antropometriese veranderlikes gebruik te maak, is laasgenoemde ook hier aangeraak: liggaamslengte; triseps-, subskapulêre, kuit- en supraspinale velvou; humerus- en femurdeursnee; gespanne boarm- en kuitomtrek; sowel as liggaamsmassa. Die laasgenoemde veranderlikes is in die formule van Carter en Heath (1990) ingesluit om somatotipering te bepaal.

Relatiewe liggaamsgroottes

Relatiewe liggaamsgrootte is bepaal deur ’n verskeidenheid metings, naamlik: armspan; sithoogte; arm-, vooram-, hand-, dy-, been- en voetlengte; biakromiale, transversale bors-, AP-bors-, bi-iliokristale, humerus- en femurdeursnee; kop-, nek-, ontspanne boarm-, gespanne boarm-, voorarm-, gewrig-, bors-, middel-, heup-, bo-dy-, mid-dy-, kuit- en enkelomtrek; triseps-, subskapulêre, biseps-, iliospinale, supraspinale, abdominale, frontale dy- en mediale kuitvelvou. Liggaamsmassa-indeks (LMI) is bepaal deur die liggaamsmassa (kg) van elke gimnas te deel deur die vierkantswortel van die liggaamslengte (m) van elke gimnas (Heyward & Stolarczyk, 1996).

Liggaamsamestelling

Vetmassa, spiermassa en skeletmassa is onder hierdie kategorie geanaliseer. Vir die bepaling van vetmassa is die triseps-, kuit- en subskapulêre velvou gebruik. Liggaamslengte, femur-, humerus-, gewrig- en enkeldeursnee is gebruik vir die bepaling van skeletmassapersentasie, terwyl liggaamsmassa, liggaamslengte, arm-, dy- en kuitomtrek, sowel as die triseps-, dy- en kuitvelvou, vir die bepaling van spiermassapersentasie gebruik is. Vetpersentasie, spiermassapersentasie en skeletmassapersentasie is bepaal volgens die formules van onderskeidelik Slaughter *et al*. (1988), Lee *et al*. (2000) en Martin *et al*. (soos aangehaal deur Drinkwater & Mazza, 1994).

Statistiese verwerking

Die Statistica-statistiekverwerkingspakket (StatSoft, 2005) wat op die Noordwes-Universiteit-netwerk beskikbaar is, is gebruik om die data te verwerk. Ten eerste is die beskrywende statistiek (gemiddeldes, minimum en maksimum waardes sowel as standaardafwykings) van die verskillende veranderlikes bereken. Dit is opgevolg met ’n analise wat die gimnaste in ’n rangorde geplaas het volgens die sprongitempunte wat hul tydens die Suid-Afrikaanse Gimnastiekkampioenskap behaal het. Ten einde te kompenseer vir die verskillende vlakke waarop die gimnaste deelgeneem het, is daar ’n ekstra 1.125 punte per vlak vir elke vlak hoër as vlak 6 toegeken. Die punte is gebruik om die gimnaste in ’n rangorde te plaas volgens die prestasies wat in die sprongitem behaal is. Die gimnas met die hoogste punt is eerste geplaas en die gimnas met laagste punt laaste. Dit is opgevolg met ’n onafhanklike t-toets wat gebruik is om te bepaal of daar wel betekenisvolle verskille tussen die vyf hoogste geplaaste gimnaste en die res van die gimnaste is. Praktiese betekenisvolheid van dié genoemde verskille is hierna deur middel van effekgroottes (EG) bepaal waar EG = $(M_1 – M_2)/s$ (Thomas & Nelson, 2001). M_1 is die gemiddeld van die eerste groep, M_2 is die gemiddeld van die tweede groep en s is die standaardafwyking. Thomas en Nelson (2001) het voorgestel dat die gepoelde standaardafwyking (Sp) gebruik word.

$$s_p = \sqrt{\frac{s_1^2(n_1-1) + s_2^2(n_2-1)}{n_1+n_2-2}}$$

Hier is $s1^2$ = die variansie van die eerste groep, $s2^2$ = die variansie van die tweede groep, n1 = die aantal gimnaste in die eerste groep en n2 = die aantal gimnaste in die tweede groep. Effekgroottes (uitgedruk as Cohen se d-waarde) kan as volg geinterpreteer word: 'n EG van min of meer 0.8 is groot, 'n EG van min of meer 0.5 is gemiddeld en 'n EG van min of meer 0.2 is klein. Effekgroottes is slegs bereken by die veranderlikes wat statisties betekenisvolheid verskille getoon het. Vervolgens is 'n trosontledinganalise op die verskillende antropometriese veranderlikes uitgevoer om daardeur die mees bepalende veranderlikes vir die sprongitem uit te sonder. Die trosontleding is opgevolg met 'n voorwaartse, stapsgewyse meervoudige regressie-analise wat gedoen is om die bydrae van elk van die trosontleding-geïdentifiseerde veranderlikes tot sprongitem-gimnastiekprestasie vas te stel. Die aangepaste punte wat elk van die gimnaste in die sprongitem behaal het, is as die afhanklike veranderlikes vir die meervoudige regressie-analise gestel. Die vlak van betekenisvolheid is op kleiner as en gelyk aan 0.05 gestel.

BESPREKING VAN DIE RESULTATE

Ten eerste word die beskrywende statistiek, die statisties (onafhanklike t-toets) sowel as prakties betekenisvolheid (effekgroottes) van verskille tussen die vyf hoogste geplaaste gimnaste en die res van die dogtergimnaste met betrekking tot ouderdom en liggaamsamestelling weergegee (tabel 1).

TABEL 1. **BESKRYWENDE STATISTIEK VIR OUDERDOM EN LIGGAAMSAMESTELLING VAN JONG DOGTERGIMNASTE (N=12)**

Veranderlikes	Suksesvol		Minder suksesvol		Verskille en betekenisvolheid van verskille	Effek-grootte
	$\overline{X}$	SA	$\overline{X}$	SA		
Ouderdom (jaar)	14.00	2.48	12.77	1.80	1.23	-
Massa (kg)	45.57	12.44	38.44	4.59	7.13	-
LMI (kg/m^2)	19.41	3.23	17.35	0.82	2.06	-
Skraalliggaamsmassa (kg)	38.12	9.48	32.70	3.44	5.42	-
Som van ses velvoue (mm)	56.61	14.73	48.91	8.54	7.70	-
Vetpersentasie (%)	15.94	2.76	14.82	1.85	0.84	-
Vetmassa (kg)	7.45	3.09	5.74	1.32	1.71	-
Endomorfie	2.59	0.62	2.29	0.36	0.31	-
Mesomorfie	4.84	0.64	3.69	0.99	1.15*	1.3^{+++}
Ektomorfie	2.87	1.35	3.69	0.66	-0.82	-
Spiermassa (kg)	19.98	3.92	17.84	1.37	2.14	-
Spiermassa (%)	44.56	3.35	46.62	2.91	-2.07	-
Skeletmassa (kg)	6.23	0.73	5.55	0.70	0.68	-
Skeletmassa (%)	14.13	2.16	14.45	0.83	-0.32	-

$\overline{X}$ = Gemiddeld SA = Standaardafwyking *$p \leq 0.05$ +++ = Groot effekgrootte

Die beskrywende statistiek sowel as die betekenisvolheid van verskille (onafhanklike t-toets)

tussen die vyf hoogs geplaaste gimnaste en die res van die dogtergimnaste met betrekking tot velvoue word in tabel 2 weergegee.

TABEL 2. **BESKRYWENDE STATISTIEK VIR DIE VELVOUE VAN JONG DOGTERGIMNASTE (N=12)**

Veranderlikes	Totale gimnastiek-groep		Suksesvol		Minder suksesvol		Verskille en betekenisvolheid van verskille
	$\overline{X}$	SA	$\overline{X}$	SA	$\overline{X}$	SA	
Trisepsvelvou (mm)	9.13	2.11	9.50	2.39	8.86	2.04	0.64
Bisepsvelvou (mm)	5.03	1.36	4.84	1.21	5.16	1.54	-0.32
Midaksilêre velvou (mm)	5.14	1.24	5.73	1.61	4.71	0.78	1.02
Subskapulêre velvou (mm)	6.28	1.22	6.81	1.70	5.89	0.62	0.92
Pektorale velvou (mm)	4.62	1.12	4.51	1.19	4.70	1.15	-0.19
Abdominale velvou (mm)	8.17	3.20	9.13	4.13	7.49	2.46	1.64
Crista illiaca-velvou (mm)	10.58	3.96	12.48	4.26	9.21	3.39	3.27
Supraspinale velvou (mm)	6.10	1.98	6.96	2.33	5.49	1.58	1.47
Frontale dyvelvou (mm)	14.60	4.22	15.53	5.11	13.93	3.74	1.60
Mediale kuitvelvou (mm)	8.36	1.50	8.82	1.59	8.03	1.46	0.79

$\overline{X}$ = Gemiddeld SA = Standaardafwyking

Die beskrywende statistiek, die statisties (onafhanklike t-toets) sowel as prakties betekenisvolheid (effekgroottes) van verskille tussen die vyf hoogste geplaaste vyf gimnaste en die res van die dogtergimnaste met betrekking tot omtrekke word in tabel 3 weergegee.

TABEL 3. **BESKRYWENDE STATISTIEK VIR OMTREKKE VAN JONG DOGTERGIMNASTE (N=12)**

Veranderlikes	Totale gimnastiekgroep		Suksesvol		Minder suksesvol		Verskille en betekenis-volheid van verskille	Effek-grootte
	$\overline{X}$	SA	$\overline{X}$	SA	$\overline{X}$	SA		
Kopomtrek (cm)	52.87	1.13	53.01	1.08	52.76	1.24	0.25	-
Nekomtrek (cm)	29.20	1.70	30.01	2.04	28.63	1.26	1.38	-
Ontspanne boarm-omtrek (cm)	22.94	2.69	24.73	3.28	21.66	1.25	3.07*	1.4^{+++}
Gespanne boarm-omtrek (cm)	24.86	2.51	26.69	2.88	23.56	1.10	3.13*	1.0^{+++}
Voorarmomtrek (cm)	22.10	1.92	23.21	2.00	21.31	1.53	1.90	-
Gewrigsomtrek (cm)	14.53	0.91	15.22	0.64	14.03	0.75	1.19*	0.8^{+++}
Mesosternale borsomtrek (cm)	71.06	18.83	79.33	7.69	65.15	22.65	14.18	-
Middelomtrek								

(cm)	60.90	4.24	62.79	5.70	59.54	2.48	3.25	-
Heupomtrek (cm)	77.54	6.54	80.48	8.41	75.44	4.36	5.04	-
Dyomtrek gluteaal (cm)	46.15	5.08	48.26	6.96	44.64	2.95	3.62	-
Dyomtrek (cm)	42.61	4.97	44.84	7.06	41.01	2.24	3.83	-
Kuitomtrek (cm)	30.58	3.40	32.26	4.78	29.37	1.39	2.89	-
Enkelomtrek (cm)	19.58	1.34	20.68	1.24	18.79	0.73	1.89*	0.8^{+++}

$\overline{X}$ = Gemiddeld SA = Standaardafwyking $*p \leq 0.05$ +++ = Groot effekgrootte

Die beskrywende statistiek sowel as die betekenisvolheid van verskille (onafhanklike t-toets) tussen die vyf hoogste geplaaste gimnaste en die res van die dogtergimnaste met betrekking tot lengtes en hoogtes word in tabel 4 weergegee.

TABEL 4. **BESKRYWENDE STATISTIEK VIR LENGTES EN HOOGTES VAN JONG DOGTERGIMNASTE (N=12)**

Veranderlikes	**Totale gimnastiekgroep**		**Suksesvol**		**Minder suksesvol**		**Verskille en betekenisvolheid van verskille**
	$\overline{X}$	SA	$\overline{X}$	SA	$\overline{X}$	SA	
Liggaamslengte (cm)	150.07	7.64	152.08	8.60	148.64	7.21	3.44
Sithoogte (cm)	116.26	4.46	118.30	5.29	114.80	3.44	3.50
Armspan (cm)	151.80	7.61	154.86	8.73	149.61	6.47	5.25
Akromiale-radiale lengte (cm)	27.23	2.12	27.30	1.50	27.19	2.59	0.11
Radiale stillion-lengte (cm)	21.95	1.43	22.10	1.58	21.85	1.43	0.25
Midstillion-daktillion-lengte (cm)	17.36	0.71	17.68	0.86	17.13	0.52	0.55
Iliospinale bokshoogte (cm)	47.80	4.99	50.00	6.50	46.24	3.24	3.76
Troganterion bokshoogte (cm)	41.53	3.81	41.96	4.79	41.21	3.32	0.75
Troganterion-tibiale laterale lengte (cm)	38.16	2.95	38.79	3.62	37.71	2.57	1.08
Tibiale laterale tot vloer-hoogte (cm)	40.66	3.04	40.07	3.00	41.09	3.22	-1.02
Tibiale med-sphy-lengte (cm)	33.78	1.90	33.50	2.50	33.98	1.54	-0.48
Voetlengte (cm)	22.61	1.04	23.07	1.39	22.29	0.63	0.78

X = Gemiddeld SA = Standaardafwyking

Die beskrywende statistiek sowel as die betekenisvolheid van verskille (onafhanklike t-toets) tussen die vyf hoogste geplaaste gimnaste en die res van die dogtergimnaste met betrekking tot breedtes word in tabel 5 weergegee.

TABEL 5. **BESKRYWENDE STATISTIEK VIR BREEDTES VAN JONG DOGTERGIMNASTE (N=12)**

Veranderlikes	Totale gimnastiek-groep		Suksesvol		Minder suksesvol		Verskille en betekenisvolheid van verskille
	$\overline{X}$	SA	$\overline{X}$	SA	$\overline{X}$	SA	
Biakromiale breedte (cm)	33.43	2.18	34.12	3.15	32.94	1.19	1.18
Bi-iliokristale breedte (cm)	22.70	1.74	23.23	1.98	22.31	1.60	0.92
Transversale borsbreedte (cm)	25.67	9.80	30.19	14.77	22.44	1.26	7.75
A-P-borsdiepte (cm)	15.13	0.58	15.30	0.45	15.00	0.66	0.30
Humerusbreedte (cm)	5.98	0.27	6.15	0.17	5.86	0.27	0.29
Gewrigbreedte (cm)	4.88	0.27	5.04	0.20	4.76	0.26	0.28
Handbreedte (cm)	6.85	0.40	7.11	0.43	6.67	0.28	0.44
Femurbreedte (cm)	8.26	0.57	8.60	0.63	8.02	0.42	0.58
Enkelbreedte (cm)	6.31	0.27	6.38	0.21	6.26	0.31	0.12
Voetbreedte (cm)	7.12	0.88	7.48	1.17	6.86	0.57	0.62
Bideltoïed-breedte (cm)	36.25	2.89	37.75	3.67	35.19	1.77	2.56
Bitroganteriese breedte (cm)	26.28	2.56	27.70	2.88	25.26	1.89	2.44

$\overline{X}$ = Gemiddeld SA = Standaardafwyking

Vergelykings tussen die vyf hoogste geplaaste gimnaste in die sprongitem en die res van die gimnaste toon dat die suksesvolle gimnaste statisties en prakties betekenisvol hoër waardes in vyf uit die 61 (8.20%) antropometriese veranderlikes as die minder suksesvolle gimnaste behaal het. Dit het die volgende ingesluit: ontspanne en gespanne boarm-, gewrigs- en enkelomtrek, sowel as mesomorfie. Die uitwysing van die ontspanne en gespanne boarmomtrekwaardes sowel as mesomorfie as antropometriese veranderlikes wat betekenisvol verskil tussen die twee groepe gimnaste kan moontlik verklaar word aan die hand van die verband wat tussen borarmomtrek en bolyfkrag bestaan. Scanlan *et al*. (1999) het byvoorbeeld in hul studie getoon dat daar ’n direkte verband tussen gespanne boarmomtrek (r=0.45), gespanne boarm-dwarsdeursneeoppervlakte (r=0.45) sowel as mesomorfie (r=0.44) en maksimale bolyfkrag by dames bestaan.

In nog ’n studie is gevind dat gespanne boarmomtrek (r=0.53), borsomtrek (r=0.49) en skouerbreedte (r=0.36) betekenisvol met bolyfkrag korreleer (Mayhew *et al.*, 1989). Voorts dui Douda *et al*. (2002) daarop dat artistiese gimnaste oor die algemeen oor betekenisvol hoër boonsteledemaat-omtrekke ($p< 0.01$) beskik as dogters wat nie aan gimnastiek deelneem nie, en skryf dit toe aan die liggaamsgewig-ondersteunende oefeninge wat oor ’n lang tydperk uitgevoer word en tot spiermassaverhogings in die boonste ledemate lei. Die aard van aktiwiteite wat tydens die sprongitem uitgevoer word, vereis maksimale sowel as eksplosiewe krag. Ritzdorf (1999) dui in dié verband aan dat die uitvoeringstyd van verskillende bewegings in gimnastiek baie kort is omdat kleiner spiergroepe of meer ongunstige hefboomarms gebruik moet word en dat dit gevolglik die kraguitset tydens die uitvoering van bewegings verhoog. So byvoorbeeld maak baie bewegings tydens die sprongitem staat op afstootaksies vanaf die hande, wat die klem onder andere op bolyfkrag plaas.

Eksplosiewe beenspierkrag en spoed is volgens Pool *et al*. (1969), Sands *et al.* (2003) sowel

as Bradshaw en Rossignol (2004) van absolute belang vir sprongitemprestasies. Kukolj *et al.* (1999) het getoon dat daar ’n positiewe verband tussen eksplosiewe beenkrag en spoed is. Die sprongitem vereis ’n vinnige aanloop en ’n eksplosiewe vastrap, sodat hoër hoeksnelhede verkry kan word (Sharma, 1992). ’n Gimnas wat oor ’n hoër hoeksnelheid tydens die vastrap beskik, sal ’n meer effektiewe afstoot vanaf die sprongtafel verkry, wat die suksesvolle uitvoering van draai- en saltobewegings verseker (Sharma, 1992). Dié gimnaste sal dus hoër punte in die sprongitem behaal. Daar kan dus verwag word dat enkelomtrek betekenisvol groter waardes by die suksesvolle vergeleke met die minder suksesvolle gimnaste sal toon, in die lig van die navorsingsresultaat dat daar ’n positiewe korrelasie tussen die enkeldeursnee van junior dogtersportlui en hul been-eksplosiewe kragwaardes bestaan (Ray & Khanna, 1991).

Wat gewrigsomtrek betref, het Markou *et al*. (2004) getoon dat die aanvangsouderdom van gimnastiekdeelname tesame met liggaamslengte, LMI, liggaamsmassa, skraalliggaamsmassa en liggaamsvet ’n positiewe effek op dogtergimnaste se beenminerale digtheid (BMD) het. Aangesien gewrigsdeursnee (wat ’n bepaler van gewrigsomtrek is) in samehang met femur-, humerus- en enkeldeursnee gebruik word om skeletmassa indirek te bereken, kan verwag word dat die suksesvolle gimnaste betekenisvol groter gewrigsomtrekke as die minder suksesvolle gimnaste sal toon. Dié suksesvolle gimnaste toon ’n jonger aanvangsouderdom vir gimnastiekdeelname (5.06 ± 1.38 teenoor 5.91 ± 1.35 jaar), ’n langer gemiddelde liggaamslengte (152.08 ± 8.60 teenoor 148.64 ± 7.21 cm), ’n hoër LMI (19.41 ± 3.23 teenoor 17.35 ± 0.82 kg/m^2), ’n groter liggaamsmassa (45.52 ± 12.44 teenoor 38.44 ± 4.59 kg) en skraalliggaamsmassa (38.12 ± 9.48 teenoor 32.70 ± 3.44 kg), sowel as ’n groter gemiddelde liggaamsvetmassa (7.45 ± 3.09 teenoor 5.74 ± 1.32 kg) as hul minder suksesvolle eweknieë, wat dus hulle BMD en skeletdeursneë sal bevoordeel. Artistiese gimnastiek word voorts as ’n sportsoort beskou waarin die tipe oefeninge wat uitgevoer word, ’n hoë meganiese lading op die ledemate en romp plaas, wat ’n baie voordelige effek op die BMD van jong gimnaste het (Nickols-Richardson *et al*., 2000; Dowthwaite *et al*., 2006).

Volgens King en Yeadon (2004) speel die hande ’n baie belangrike rol tydens die sprongitem, aangesien die hande die gimnas in staat stel om langer in kontak met die sprongtafel te bly sodat ’n groter hoekmomentum gegenereer kan word. Die gevolg is dat die gewrig, wat die skakel tussen die hand en arm vorm, baie sterk ontwikkel moet wees. In dié verband het Koh *et al.* (2003) byvoorbeeld getoon dat die gewrigfleksore ’n piekkrag van ongeveer 100 Nm tydens handimpak met die sprongtafel gedurende die uitvoering van die Yurchenko-sprong moet genereer. Die voorarmfleksore is merendeels op die metakarpale en karpale bene van die hand ingeplant (Behnke, 2006), wat beteken dat verdikking in die spierstrukture vanweë hoë impakkragte moontlik tot hoër gewrigsomtrekke by suksesvolle gimnaste aanleiding kan gee. Die aanname kan ook gemaak word dat suksesvolle gimnaste oor die algemeen sal poog om spronge uit te voer waarvan die moeilikheidsgraad hoër is. Die kraggenerering wat deur middel van die hande en gewrig bewerkstelling word, sal dan verhoog word om meer hoogte vanaf die sprongtafel te verkry. Die gevolg is dat hoër impakkragte deur die gewrig geabsorbeer moet word, wat moontlik tot ’n verdere verdikking van die spierstrukture in die voorarm en gewrig kan lei.

TABEL 6. **RESULTATE VAN DIE VOORWAARTSE, STAPSGEWYSE, MEERVOUDIGE REGRESSIE-ANALISE OM AAN TE DUI WATTER ANTROPOMETRIESE VERANDERLIKES DIE MEESTE TOT SPRONGITEM-GIMNASTIEKPRESTASIE BY JONG DOGTER-**

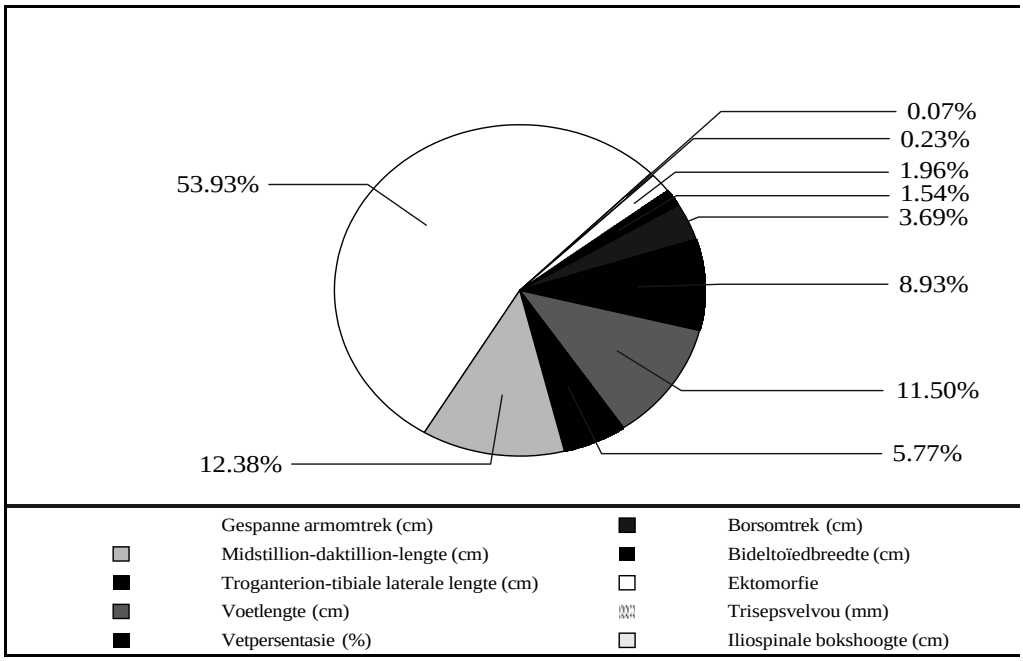
GIMNASTE BYDRA

Veranderlike	Beta in	Meervoudige R^2	R^2-verandering	p-vlak
Gespanne boarmomtrek (cm)	2.979	0.5393	0.5393	0.0065*
Midstillion-daktillion-lengte (cm)	-0.3173	0.6631	0.1238	0.1023
Troganterion-tibiale laterale lengte (cm)	1.179	0.7208	0.0577	0.2344
Voetlengte (cm)	-1.1799	0.8358	0.1150	0.0624
Vetpersentasie (%)	-0.3884	0.9252	0.0893	0.0367*
Borsomtrek (cm)	-0.3549	0.9620	0.0369	0.0788
Bideltoïedbreedte (cm)	0.6998	0.9774	0.0154	0.1745
Ektomorfie	-0.6405	0.9970	0.0196	0.0212*
Trisepsvelvou (mm)	-0.3856	0.9993	0.0023	0.1292
Iliospinale bokshoogte (cm)	0.0844	1.0000	0.0007	0.0326*

R = Korrelasie *$p \leq 0.05$

Vervolgens is die r^2-veranderingwaardes gebruik om die persentasie bydrae van elk van die antropometriese veranderlikes tot sprongitem-puntetelling grafies voor te stel (figuur 1). In ’n verdere ontleding is ’n trosontleding gedoen om die antropometriese veranderlikes wat met mekaar in verband staan, uit te sonder en te elimineer. Die antropometriese veranderlikes van die dogtergimnaste is deur middel van die trosonleding vanaf 61 na 26 veranderlikes verminder, wat die volgende ingesluit het: frontale dy- en triseps-velvou; gluteale dy-, mesosternale, bors-, gewrig-, gespanne boarm-, kuit-, middel-, mid-dy- en kopomtrek; troganterion-tibiale laterale, midstillion-daktillion-, voet- en akromiale-radiale lengte; transversale bors en bitroganteriese deursnee; bideltoïed- en femurbreedte; A-P-borsdiepte; sithoogte; troganterion- en iliospinale bokshoogte; spiermassa- en vetmassapersentasie; som van die ses velvoue, sowel as ektomorfie.

Die trosontleding is opgevolg met ’n voorwaartse, stapsgewyse, meervoudige regressie-analise om die bydrae van elk van die trosontleding-geïdentifiseerde veranderlikes tot sprongitem-gimnastiekprestasie vas te stel. Die resultate word in tabel 6 en figuur 1 weergegee:



FIGUUR 1. **PERSENTASIE BYDRAE VAN ELK VAN DIE VOORWAARTSE, STAPSGEWYSE, MEERVOUDIGE REGRESSIE-ANALISE-GEÏDENTIFISEERDE VERANDERLIKES TOT SPRONGITEMGIMNASTIEKPRESTASIE BY JONG DOGTERGIMNASTE**

Die bogenoemde resultate dui daarop dat gespanne boarmomtrek (53.93%), midstillion-daktillion- (12.38%) en voetlengte (11.50%) die mees bepalende antropometriese komponente is vir die behaling van hoë punte in die sprongitem (77.81%). Verder verklaar vetpersentasie (8.93%), troganterion-tibiale laterale lengte (5.77%), borsomtrek (3.69%), ektomorfie (1.96%), bideltoïedbreedte (1.54%), trisepsvelvou (0.23%) en iliospinale bokshoogte (0.07%) die res van die variansie (22.19%). Gespanne boarmomtrek, vetpersentasie, ektomorfie en iliospinale bokshoogte se bydra tot die variansie in sprongitempuntetelling was betekenisvol ($p \leq 0.05$).

Hierbo is reeds melding gemaak van die moontlike verband wat daar tussen gespanne boarmomtrek en maksimale bolyfkrag kan bestaan. Om dié verband tussen die laasgenoemde twee veranderlikes te staaf, is ’n verdere analise met addisionele data van die gimnastiekprojek gedoen. Die sprei-L-handstandopdruktoets is tydens dié projek gebruik om maksimale bolyfkrag te bepaal. Om dus die laasgenoemde aanname te staaf, is die korrelasie-koëffisiënt (r) tussen die uitslae van die laasgenoemde toetse en die gespanne boarm-omtrekwaardes van die gimnaste bereken. ’n Betekenisvolle r-waarde van 0.76 ($p = 0.04$) is gevind, wat beteken dat 57.76% ($r^2 \times 100$) van die variansie in maksimale bolyfkrag aan die hand van die gespanne boarm-omtrekwaardes van die gimnaste verklaar kan word. Die korrelasiekoëffisiënte tussen gespanne boarm-omtrek en spiermassa ($r = 0.87$, $p = 0.0002$), sowel as tussen gespanne boarm-omtrek en mesomorfie ($r = 0.69$, $p = 0.01$), dui ook daarop

dat gimnaste met hoër gespanne boarm-omtrekmates oor ’n hoër relatiewe muskuloskeletale robuustheid beskik. Volgens Heyward en Stolarczyk (1996) sal ’n hoë spiermassa bydra tot

beter eksplosiewe kragvertonings. Die meeste bewegings in gimnastiek, en veral ook in die sprongitem, maak staat op 'n kontaktyd van ongeveer 20 ms (Ritzdorf, 1999), wat die belang van eksplosiewe krag beklemtoon.

'n Moontlike verklaring vir die uitwysing van midstillion-daktillion-lengte (handlengte) as die tweede-grootste bydraer tot sprongitem-puntetelling is dat 'n direkte verband tussen handlengte en voorarmwringkrag bestaan (Crawford *et al*., 2002). Om die bevinding te staaf is die handgreepwaardes van die gimnaste met hul handlengtes gekorreleer. 'n Betekenisvolle r-waarde van 0.59 ($p = 0.04$) het aan die lig gekom. Soos reeds genoem, speel die hande 'n belangrike rol in die verlenging van kontaktyd op die sprongtafel en sal groter hande 'n langer kontaktyd tot gevolg hê, wat weer die generering van 'n hoër hoekmomentum sal ondersteun. Dit alles sal meebring dat die gimnas haar liggaam vir 'n langer tydperk in die lug kan verplaas sodat sy meer tyd het om rotasie- en tolbewegings uit te voer.

Voetlengte het as die derde-grootste sprongitem-verbandhoudende determinant in die studie na vore gekom. Die resultaat is moontlik toe te skryf aan die verband wat daar tussen voetlengte en beeneksplosiewe krag bestaan (Davis *et al.,* 2006). Weereens kan die laasgenoemde verband getoets word deur die r-waarde tussen die gimnaste se voetlengtes en tweebeen-vertikale sprongwaardes te bereken wat vanuit die gimnastiekprojek bepaal is. 'n Betekenisvolle r-waarde van 0.76 ($p = 0.004$) is tussen die laasgenoemde veranderlikes gevind. Dié verband kan moontlik toegeskryf word aan 'n langer hefboomarm en kontaktyd met die grond wat deur 'n langer voet teweeggebring word. Dit het alles tot gevolg dat 'n groter enkelwringkrag in die vertikale rigting gegenereer kan word.

'n Onverwagse bevinding van dié studie is dat die gimnaste se vetpersentasies positief en betekenivol met hul sprongitempuntetellings gekorreleer het. Daar word verwag dat gimnaste wat oor 'n hoër vetpersentasie beskik se liggaamsmassa uit meer "dooie" of metabolies onaktiewe weefsel opgemaak sal wees, wat 'n nadelige invloed op prestasies in die sprongitem behoort te hê. Die navorsingsbevinding van die studie is dus teenstrydig met dié van Richards (2006), wat byvoorbeeld gevind het dat daar 'n omgekeerde verband tussen die vetmassa en vaardigheidsvlak van gimnaste bestaan. Dié resultaat in die studie is moontlik te wyte aan die feit dat die suksesvolle gimnaste in hiérdie studie verder gevorder is wat hulle liggaamsontwikkeling en groei betref, vergeleke met die minder suksesvolle gimnaste. Soos reeds gemeld, is hulle ook die groep wat vanweë hul meer gevorderde ontwikkeling 'n hoër vetmassa toon.

Volgens Brown (2001) behaal meer volwasse en groter gimnaste dikwels meer sukses as hul minder volwasse en kleiner eweknieë vanweë hul beter ontwikkelde en afgeronde vaardigheidsvlakke. Hy stel dit ook dat internasionale afrigters nie meer so gesteld is op liggaamsgrootte nie, solank 'n gimnas haar liggaam in die regte posisie kan plaas en die korrekte uitvoering van bewegings kan doen. Dit sal egter beteken dat die laasgenoemde groep harder sal moet werk om hul krag:liggaamsmassa-verhoudings te verhoog.

Troganterion-tibiale laterale lengte, wat 'n aanduiding is van die gimnaste se femurlengtes, het ook positief met sprongitem-puntetelling gekorreleer en 'n klein bydrae (5.77%) tot

prestasies in die laasgenoemde item gelewer. Tydens die springplankfase van die sprongitem lê gimnaste ongeveer 30º terug vanaf die vertikale posisie (Prassas, 2002). 'n Moontlike rede vir dié teruglê-posisie is om meer vertikale krag te genereer deur 'n groter hoeveelheid

liggaamsmassa deur die steunpunt (wat die voete is) te laat gaan sodat meer aksiekrag teen die springplank gegenereer kan word. Die gevolg is dat 'n groter reaksiekrag in direkte verhouding tot die aksiekrag gegenereer kan word sodat die gimnas hoër in die lug verplaas kan word. Gimnaste wat oor 'n langer femurlengte beskik sal dus in staat wees om verder terug te lê in verhouding tot die vertikale posisie en sal vanweë 'n langer hefboomarm langer in kontak met die springplank kan bly sodat meer krag gegenereer kan word. Die uiteinde is dat die gimnas oor hoër hoekmomentum beskik, wat haar in staat sal stel om draai- en saltobewegings meer suksesvol uit te voer. Aangesien die gimnaste wat hoër punte in die sprongitem behaal het ook wat hulle fisieke ontwikkeling betref verder gevorder is, kan daar verwag word dat hulle langer beenlengtes sal toon.

Navorsing deur Reynolds *et al.* (2006) het daarop gewys dat die vermoë van dames om 20- ($r = 0.56$), 10- ($r = 0.57$), 5- ($r = 0.59$) en 1-repetisie-maksimum borsopdruk-oefeninge ($r = 0.60$) uit te voer, voorspel kan word op grond van hulle borsomtrekke. Daar kan verwag word dat borsomtrek wel 'n invloed op die laasgenoemde kragbepalingsoefeninge sal hê aangesien die borsomtrekmeting onder andere deur die grootte van die pectoralis major- en latissimus dorsi-spiergroepe bepaal word. Gimnaste wat oor groter borsomtrekmates beskik, behoort dus groter pectoralis major- en latissimus dorsi-spiergroepe te toon, wat moontlik tot verhoogde bolyfkrag sal aanleiding gee. Die gimnaste wat meer sukses in die sprongitem behaal, sal dus die gimnaste wees wat die grootste borsomtrekke toon, moontlik vanweë die kragvoordeel wat dit tot gevolg het.

Die laaste vier veranderlikes wat uit die voorwaartse, stapsgewyse meervoudige regressie-analise na vore gekom het se bydrae tot sprongprestasie is weglaatbaar klein. Bideltoïedbreedte, ektomorfie, trisepsvelvou en iliospinale bokshoogte dra gesamentlik maar 3.8% by tot die variansie in sprongitem-puntetelling. Vanweë dié klein bydrae sal dié antropometriese veranderlikes nie verdere aandag in die bespreking geniet nie.

GEVOLGTREKKING

Die algehele navorsingsresultate van dié studie dui daarop dat die antropometriese veranderlikes van jong dogtergimnaste wel as belangrike prestasiedeterminante van die sprongitem beskou kan word. Die onafhanklike t-toets- en effekgrootte-resultate het ten eerste getoon dat die jong, suksesvolle (vyf hoogste geplaaste) dogtergimnaste in die sprongitem betekenisvol hoër ($p \leq 0.05$; $d \geq 0.8$) waardes met betrekking tot ontspanne en gespanne armgewrigs- en enkelomtrek sowel as mesomorfie vergeleke met die minder suksesvolle gimnaste getoon het. 'n Verdere analise waarin 'n voorwaartse, stapsgewyse meervoudige regressie-analise uitgevoer is, het getoon dat gespanne boarmomtrek (53.93%), midstillion-daktillion- (12.38%) en voetlengte (11.50%), vetpersentasie (8.93%), troganterion-tibiale laterale lengte (5.77%), borsomtrek (3.69%), ektomorfie (1.96%), bideltoïedbreedte (1.54%), trisepsvelvou (0.23%) en iliospinale bokshoogte (0.07%) 'n 100%-bydrae gelewer het tot die prestasies (puntetoekenning) wat SA-dogtergimnaste in die sprongitem behaal. Gespanne boarmomtrek, vetpersentasie, ektomorfie en iliospinale bokshoogte se bydrae tot die variansie in sprongitempuntetelling was betekenisvol ($p \leq 0.05$).

Die moontlike redes wat aangevoer kan word vir die uitwysing van die laasgenoemde antropometriese veranderlikes as prestasiedeterminante van die gimnastiek-sprongitem is dat groter liggaamsomtrekke, -lengtes en -breedtes meestal in verband staan met 'n kapasiteit vir hoër krag- en eksplosiewekrag-generering. Hiermee tesame toon die data van dié studie dat

gimnaste wat meer suksesvol is in die sprongitem oor die algemeen 'n langer gimnastiekdeelnametyd toon en wat hul liggaamlike ontwikkeling betref, meer volwasse is as die minder suksesvolle gimnaste. Dié gimnastiekdeelnametyd- en rypwordingsverskille tussen die twee genoemde populasies het alles tot gevolg dat die suksesvolle gimnaste groter antropometriese liggaamsmetings toon as hul minder suksesvolle eweknieë.

Die bevinding van die studie is dus dat daar wel meriete daarin is om dogtergimnaste se antropometriese samestelling in ag te neem tydens die opstelling en uitvoering van sportwetenskaplike toetsprotokolle. Die resultate dui voorts daarop dat groter boarm- en bolyfomtrekke; langer hand-, voet-, bobeen- en algehele beenlengtes; groter trisepsvelvoue en vetpersentasies sowel as ektomorfiewaardes veral van belang is vir prestasies in die gimnastieksprongitem. Dié genoemde antropometriese veranderlikes moet dus veral aandag geniet in toetsprotokolle wat gebruik word om jong dogtergimnaste te evalueer.

Dit is in die lig van laasgenoemde resultate en bespreking dat tekortkominge van die studie onder die soeklig geplaas word. Ten eerste kan aanbeveel word dat 'n groter aantal gimnaste gebruik word in studies van hierdie aard. Die relatief klein groepgroottes kan moontlik daartoe lei dat uitskieters die gemiddelde waardes van die antropometriese veranderlikes beïnvloed het. Voorts kon die klein groepgroottes die statistiese betekenisvolheid van resultate beïnvloed het. Tweedens kan aanbeveel word dat gimnaste van dieselfde ouderdomsgroepe eerder saam gegroepeer word om sodoende die effek van ouderdom op die verband tussen die onderskeie antropometriese veranderlikes en gimnastiekprestasie te bepaal. Laastens sal dit raadsaam wees om 'n uitgebreide studie te onderneem waarin die invloed van verskillende antropometriese veranderlikes op elk van die oorblywende gimnastiekitems (balk, brug en vloer) sowel as algehele gimnastiekprestasie te bepaal.

SUMMARY

The anthropometric vault item performance determinants of young female gymnasts

The number of participants in artistic gymnastics is more than 30 million individuals in more than 80 countries. It is in view of the latter fact that the need has developed for the identification and determination of gymnastics-specific performance determinants for girls. The identification of performance determinants will enable coaches and sports scientists to identify gymnasts at a young age and to guide them to top performances. In spite of this, no investigation has until now made an attempt to determine the performance determinants of young, South African (SA), female gymnasts. Owing to the comprehensiveness of a multi-factorial investigation, the aim of this study was only to focus on the anthropometric performance determinants of one item in artistic gymnastics, namely the vault. The purposes of this study were therefore firstly to determine the anthropometric variables that differ significantly ($p \leq 0.05$) between successful and less successful young, SA, female gymnasts

in the vault item, and secondly to determine the anthropometric variables that contribute to the performance of young SA, female gymnasts in the vault item.

Twelve young, female gymnasts (13.39 ± 2.14 years) from a gymnastics club in the North-West Province of South Africa participated in the study. Only gymnasts who participated at level 6-9 and junior as well as senior Olympics level were selected to participate in this study.

Sixty-one anthropometric variables were measured on the dominant side of the body according to the methods of Norton *et al.* (1996). Firstly, the descriptive statistics (means and standard deviations) of the gymnastics population were calculated. This was followed by an analysis which intended to arrange the gymnasts in ranking order according to their vault performances (marks) that were achieved during the South African Gymnastics Championships. Due to differences in the participation levels, data was normalised by making use of correction factors. The analysis was followed by an independent t-test in which the gymnasts who achieved the top five positions in the ranking were compared with the rest of the gymnasts. The practical significance of differences was determined by calculating effect sizes. Thereafter, a cluster analysis of the different anthropometric variables was done to detect clusters of measures that appear to tap similar abilities. In the next step, a forward stepwise multiple regression analysis was performed to determine the contribution of each of the reduced anthropometric variables of the cluster analysis to the performances (points) that each gymnast achieved during the South African Gymnastics Championships. The level of significance was set at $p \leq 0.05$.

The results of the study firstly showed that the successful gymnasts in the vault item had statistical and practical significantly larger relaxed and flexed upper arm, wrist and ankle circumferences as well as mesomorphy values compared to the less successful gymnasts. The forward stepwise multiple regression analysis indicated that flexed upper arm circumference (53.93%), midstillion dactillion length (12.38%), foot length (11.50%), fat percentage (8.93%), trochanterion-tibial lateral length (5.77%), chest circumference (3.69%), ectomorphy (1.96%), bideltoid breadth (1.54%), triceps skinfold (0.23%) and iliospinal box height (0.07%) contributed 100% to the variance in gymnasts' vault performances. Flexed upper arm circumference, fat percentage, ectomorphy and iliospinal box height was the anthropometric variables which contributed significantly to gymnasts' vault performances.

The conclusion that can therefore be drawn is that larger upper arm and upper body circumferences; hand, foot, upper and total leg lengths; triceps skinfold and fat percentage as well as ectomorphy are important anthropometric vaulting performance determinants for young, South African, female gymnasts and should be included in the sport-scientific testing protocols of gymnasts.

VERWYSINGS

BALE, P. & GOODWAY, J.D. (1990). Performance variables associated with the competitive gymnast. *Sports Medicine*, 10(3): 139-145.

BALE, P. & GOODWAY, J.D. (2004). "Gymnastics: performance, physique, injury and training." *Sport Science.* Hyperlink [http://www.sportsci.org/encyc/drafts/Gymnastics.doc]. Datum van aflaai 27 Februarie 2004.

BEHNKE, R.S. (2006). *Kinetic Anatomy* (2nd ed.). Champaign, IL: Human Kinetics.

BRADSHAW, E.J. & ROSSIGNOL, P.L.E. (2004). Anthropometric and biomechanical field measures of floor and vault ability in 8-14 year old talent-selected gymnast. *Sports Biomechanis*, 3(2): 249-262.

BROWN, J. (2001). *Sports talent*. Champaign, IL: Human Kinetics.

CARTER, J.E.L. & BRALLIER, R.M. (1988). Physiques of specially selected young female gymnasts. In R.M. Malina (Ed.), *Young athletes: Biological, psychological, and educational perspectives* (167-175). Champaign, IL: Human Kinetics.

CARTER, J.E.L. & HEATH, B.H. (1990). *Somatotyping – development and applications*. Cambridge:

Cambridge University Press.

CLAESSENS, A.L.; LEFEVRE, J. & MALINA, R.M. (1999). The contribution of anthropometric characteristics to performance scores in elite female gymnasts. *The Journal of Sports Medicine and Physical Fitness*, 39(4): 355-360.

CRAWFORD, J.O.; WANIBE, E. & NAYAK, L. (2002). The interaction between lid diameter, height and shape on wrist torque exertion in younger and older adults. *Ergonomics*, 45(13): 922-933.

DAVIS, D.S.; BOSLEY, E.E.; GRONELL, L.C.; KEENEY, S.A.; ROSSETTI, A.M.; MANCINELLI, C.A. & PETRONIS, J.J. (2006). The relationship of body segment length and vertical jump displacement in recreational athletes. *Journal of Strength and Conditioning Research*, 20(1): 136-140.

DOUDA, H.; LAPARIDIS, K. & SAVVAS, P. (2002). Long-term training induces specific adaptations on the physique of rhythmic sports and female artistic gymnasts. *European Journal of Sport Science*, 2(3): 1-13.

DOWTHWAITE, J.N.; DISTEFANO, J.G.; PLOUTZ-SNYDER, R.J.; KANALEY, J.A. & SCERPELLA, T.A. (2006). Maturity and activity-related differences in bone mineral density: Tanner I vs. II and gymnasts vs. non-gymnasts. *Bone*, 39: 896-900.

DRINKWATER, D.T. & MAZZA, J.C. (1994). Body composition. In J.E.L. Carter; T.R. Ackland; J.C. Mazza & W.D. Ross (Eds.), *Kinanthropometry in aquatic sports: A study of world class athletes* (102-137). Champaign, IL: Human Kinetics.

HEYWARD, V.H. & STOLARCZYK, L.M. (1996). *Applied body composition assessment* (2nd ed.). Champaign, IL: Human Kinetics.

KING, M.A. & YEADON, M.R. (2004). Factors influencing performance in the Hecht vault and implications for modelling. *Journal of Biomechanics*, 38: 145-151.

KOH, M.; JENNINGS, L.; ELLIOT, B. & LLOYD, D. (2003) A predicted optimal performance of the Yurchenko layout vault in women's artistic gymnastics. *Journal of Applied Biomechanics*, 19(3): 187-204.

KUKOLJ, M.; ROPRET, R.; UGARKOVIC, D. & JARIC, S. (1999). Anthropometric, strength, and power predictors of sprinting performance. *Journal of Sports Medicine and Physical Fitness*, 39(2): 120-122.

LEE, R.D.; WANG, Z.; HEO, M.; ROSS, R.; JANSSEN, I. & HEYMSFIELD, S.B. (2000). Total-body skeletal muscle mass: development and cross-validation of anthropometric prediction models. *American Journal of Clinical Nutrition*, 72(3): 796-803.

MARKOU, K.B.; PANANGIOTIS, J.; THEODOROPOULOU, A.; KONTOGIANNIS, A.; LEGLISE, M.; VAGENAKIS, A.G. & GEORGOPOULOS, N.A. (2004). The influence of intensive physical exercise on bone acquisition in adolescent elite female and male artistic gymnasts. *The Journal of Clinical Endocrinology and Metabolism*, 89(9): 4383-4387.

MAYHEW, J.L.; BALL, T.E.; BOWEN, J.C & PRUDHOMME-LIZOTTE, J. (1989). Relationship between anthropometric dimensions and bench press strength in females. *Journal of Osteopathic Sports Medicine*, 3(3): 9-14.

NICKOLS-RICHARDSON, S.M.; MODLESKY, C.M.; O'CONNOR, P.J. & LEWIS, R.D. (2000). Premenarcheal gymnasts possess higher bone mineral density than controls. *Medicine and Science in Sports and Exercise*, 32(1): 63-69.

NORTON, K.; OLDS, T.; OLIVE, S. & CRAIG, N. (1996). Anthropometry and sports performance. In K. Norton & T. Olds (Eds.), *Anthropometrica* (287-352). Sydney: University of New South Wales Press.

POOL, J.; BINKHORST, R.A. & VOS, J.A. (1969). Some antrhopometric and physiological data in relation to performance of top female gymnasts. *European Journal of Applied Physiology*, 27(4): 329-338.

PRASSAS, S. (2002). "Vaulting mechanics." *Coaches' info service*. Hyperlink

[http://www.coachesinfo.com/category/gymnastics/315/]. Datum afgelaai 5 Desember 2006.

RAY, D. & KHANNA, S.N. (1991). A Kinanthropometric study of leg explosive strength of female junior national kho-kho players. *Research Bi-annual for Movement*, 8(1): 24-33.

REYNOLDS, J.M.; TORYANNO, J.G. & ROBERGS, R.A. (2006). Prediction of one repetition maximum strength from multiple repetition maximum testing and anthropometry. *Journal of Strength and Conditioning Research*, 20(3): 584-592.

RICHARDS, J. (2006). "Talent identification in elite gymnasts: Why body size is so important?." *Coaches info service.* Hyperlink [http://coachesinfo.com/category/gymnastics/70/]. Datum afgelaai 30 Oktober 2006.

RITZDORF, W. (1999). Strength and power training in sport. In B. Elliott (Ed.), *Training in sport: applying sport science* (189-236). New York, NY: Wiley.

SANDS, W.A.; McNEAL, J.R.; BORMS, J. & JEMNI, M. (2003). **"**Sprint characteristics of talent-selected female gymnasts age 9-11 years." *USA Gymnastics.* Hyperlink [http://www.usa-gymnastics.org/safety-and-education/congress/2003/sss-sprintTOPs2.pdf]. Datum afgelaai 27 Februarie 2004.

SCANLAN, J.M.; BALLMANN, K.L.; MAYHEW, J.L. & LANTZ, C.D. (1999). Anthropometric dimensions to predict 1-RM bench press in untrained females. *Journal of Sports Medicine and Physical Fitness*, 39(1): 54-60.

SHARMA, R.C. (1992). Speed, take-off, and hand push-off abilities in gymnastics vaulting. A biomechanical study. *NIS Scientific Journal*, 15(3): 104-109.

SLAUGHTER, M.H.; LOHMAN, T.G.; BOILEAU, R.A.; HORSWILL, C.A.; STILLMAN, R.J.; VAN LOAN, M.D. & BEMBEN, D.A. (1988). Skinfold equations for estimation of body fatness in children and youths. *Human Biology*, 60: 709-737.

STATSOFT, INC. (2005). "Statistica (data analysis software system), version 6." Hyperlink [www.statsoft.com].

THORLAND, G.W.; JOHNSON, G.O.; FAGOT, T.G.; THARP, G.D. & HAMMER, R.W. (1981). Body composition and somatotype characteristics of junior Olympic athletes. *Medicine and Science in Sports and Exercise*, 13(5): 332-338.

THOMAS, J.R. & NELSON, J.K. (2001). *Research methods in physical activity* (4th ed.). Champaign, IL: Human Kinetics.

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SPORT-FOR-DEVELOPMENT APPROACHES IN THE SOUTH AFRICAN CONTEXT: A CASE STUDY ANALYSIS

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ABSTRACT

The politics of development ideology and global leadership set the scene for sport (for) development in South Africa. Diverse research agendas and donor requirements informed research whereby indigenous knowledge systems could be accessed in a collaborative venture of knowledge production. A discussion of three distinct and interrelated models, based on the rationale of Mintzberg (2006), affords insights within a social capital framework of a top-down, bottom-up and outside-in approach in the field of sport-for-development. Each approach as evidenced in three diverse case studies set the scene for social impact and networking around strategic alliance formation and development agenda of major stakeholders. The different approaches, either in isolation and/or in an interrelated fashion shed light on the evolving dynamics in the field of sport and development.

Key words: Sport-for-development; Development approaches; Sport programmes; Community development.

INTRODUCTION

The adoption of resolution 58/5 by the General Assembly of the United Nations in November 2003 (United Nations, 2003a), entitled "Sport as a means to promote education, health, development and peace", provided the impetus for propelling sport into the realm of universal development strategies of global donors and development agencies (Levine *et al*., 2008). By declaring 2005 the International Year of Sport and Physical Education, sport programmes and initiatives were designed, piloted and implemented by a myriad of stakeholders, operating at all levels of society to meaningfully contribute towards Achieving the Millennium Development Goals. Not only did governments invested millions in sport for development programmes, but a company such as Nike invested $100 million in the last two years and pledging another $315 million to community-based sport initiatives world-wide, aiming at changing the lives of individuals trough sport participation, building a healthy community and leverage change (Nike CR Report, 2008).

International stakeholder clusters such as the Commonwealth, IOC (International Olympic Committee), FIFA (Football for Hope), UNICEF in partnership with UK Sport and the British Council (International Inspirations) and a myriad of Foundations (e.g. Laureus Sport for Good Foundation) capitalized on the „sportification of social investment" sparking a post-modern figuration. This also set the scene for the formation of strategic partnerships, social engineering, entrepreneurship to collectively deliver on a sport-for-development agenda within an ever changing landscape. International events for global networks such as StreetfootballWorld (2006 in Germany) and the Homeless World Cup (2007 in Copenhagen) attracted worldwide media attention and showcased partners as caring and altruistic (Commonwealth Advisory Body of Sport, 2008).

Major initiatives and the mass mobilization to „Making Poverty History" are reflected in the historical pathway of the Sport for Development and Peace (SDP) movement, which has grown in a very uncoordinated and donor-infused way (Kidd, 2008). Substantial resourcing and innovative schemes and initiatives flooded development work in third world economies. Most first world governments and global corporations invested billions of foreign currency in community-based sport initiatives worldwide (Nike CR Report, 2008).

It is inevitable that African countries where populations are subjected to severe poverty (living on less that $1 per day), gender inequality, a high prevalence of HIV/Aids, environmental erosion and neglect, conflict zones, high mortality rates and relatively low levels of literacy would be targeted for delivering on the Millennium Development Goals by 2015 (United Nations, 2003b). As South Africa will be the host nation for the FIFA World Cup in 2010, the first in Africa to do so, the country increasingly serves as a gateway for international agencies to explore and export their sport development initiatives into other African countries. This new wave of development work attracted academic engagement, but most often yield isolated bodies of knowledge due to uncoordinated studies, not encapsulating the complexity of development dynamics, methodological limitations, diverse contextual realities and the lack of guiding theoretical frameworks. This paper will thus address some theoretical approaches with anticipated consequences within the development work of sport, or where it serves as a vehicle for development in different spheres of society.

SPORT-FOR-DEVELOPMENT

Hylton *et al.* (2007) argue that social change is inherent in the in-field application of sports development, where sport is instrumental to the change in whatever form or focus it might have. Change represents a process that could have positive or negative consequences for the implementing agency and/or for the recipients earmarked for „development". The latter is reflected in the notion of progress by a multiplicity of agencies seeking accountability for their „development work" in the form of tangible evidence (Powell, 1995). Different approaches of delivering sport-for-development would inevitably influence the process and results of development work.

Conceptual frameworks

The sport-for-development discourse is mostly directed towards disenfranchised collectives within the wider population such as girls and women (gender), people with disabilities (ability), ethnic minorities (race), senior citizens or children (age), people suffering from diseases of stigma (HIV/Aids) and/or class distinction (socio-economic vulnerability). Broad theories of change (Scott Porter Research and Marketing, 2000), generic theories of attitudinal and behaviour change and social learning theories underpin a critical mass of development studies (Blinde & Taub, 1999; Coalter, 2008).

Cultural dynamics, in-group values and sport subculture formation are informed by the cultural resource theory (Miller *et al.*, 1999) and social constructionist frameworks (Glover, 2004), whereas intergroup conflict separatist ideologies are explained by the conflict model of social theory (Shuttleworth & Wan-Ka, 1998). The latter work reflected on the conflict of competitive sport with the world-view of participants who subscribed to a value system of altruism, inclusion and appreciation for collective effort. Multi-dimensional models are utilized for exploring the conditions and dynamics of influencing pro- and anti-social behaviour and the impact of sport participation in addressing different forms of delinquency in schools (Langbein & Bess, 2002). The findings of the study suggest that, in respect of fostering pro-social behaviour in high schools, the status quo of big schools with relatively small extracurricular programmes is less than optimal compared to schools where more and smaller groups are participating regularly in sport activities.

Interpersonal relationships, friendships and the development of the social self are addressed

by Hills (2007) reflecting on how physical education represents a dynamic social space where students experience and interpret physicality in a context with accentuated peer relationships and privileges particular forms of embodiment. Some authors discuss self-presentational processes (Smith, 2003), the socialization influences of significant other as social agents and role models (Green, 2008) by focusing on social interaction and the socialization process. More holistic approaches tap into the social cognitive theory, self-efficacy theory and social context frameworks (Fraser-Thomas *et al*., 2005) by exploring social exclusion, isolation and potential inter-group conflict inherent in socialization processes. In this regard, Lawson (2005) also reflects on the development of human capital and of developing collective identities through empowering experiences inherent in participation in sport, exercise and physical education programmes. A critical mass of research focus on meso-level analysis of social institutions and collectives (e.g. volunteers) as „focal practices" (e.g. sport festivals and volunteering) (Arai & Pedlar, 2003) or the impact of programmes on community well-being. Pedlar (1996) considers the ideas behind communitarianism and community development in relation to recreation and leisure by arguing that in times of economic and social distress recreation has a vital role to play in enhancing the quality of community life. Offering recreation at community level through the a practice of reflexivity contributes to a particular kind or praxis and agency, rather than communities only being engaged in recreation as a mere product or set of activities. However, in the work of Hylton and Totten (2007), the very concept of community is contested, as it may be imagined or realized in terms of locality.

Community development is closely associated with concepts of „social transformation", „community regeneration", the development of citizenship through sport-based volunteering (Eley & Kirk, 2002), multi-stakeholder involvement and networking (Misener & Mason, 2006). Building bridges and forging relationships of care and „peaceful coexistence" are particularly challenging in conflict areas where hatred is entrenched in national values such as in the case of the Football for Peace initiative in Israel and Palestine (Misener & Mason, 2006). Reflecting on the Football for Peace (F4P) as a school-based co-existence project for Jewish and Arab children, John Sugden (2006: 221) is critical about major changes and stated that "if such programmes are locally grounded, carefully thought out, and professionally managed they can make a modest contribution to wider efforts to promote conflict resolution and peaceful co-existence." Academia increasingly tapped into the neo-classical capital theory of Bourdieu (Coalter, 2007), Coleman"s rational choice theory, network theory,

Putnam"s framework of civil engagement and Verveel"s multilevel analysis of different types of social capital (Burnett, 2006). The formation of social capital identified as bonding, bridging and/or linking is discussed in terms of how social ties are formed and trust developed among disparate cultural groups in the Netherlands (Verveel) and/or community-based clubs in South Africa where the focus is on „community regeneration and cohesion" through diverse community-based programmes (Burnett, 2006).

The formation of strategic partnerships for the delivery of sport development (identifying and nurturing athletic talent) and promoting the development agenda in developing countries can be traced in the spheres of government and within the NGO fraternity (Green, 2008). As „social entrepreneurs" that are making a living through tapping into global and national funding, NGOs often advocate an „evangelist" approach of sport offerings as antidote for many illnesses of society. It is within this context of network formation that Mintzberg (2006) critically reflected on three distinct development approaches, namely i) the top-down government planning approach, ii) the inside-up indigenous development approach and the

iii) outside-in „globalisation" approach. In his observation of development work in Ghana, he argues that development work should be about people and the development of leaders. This should be an indigenous process whereby leadership will develop more or less spontaneously given an enabling environment and not through programmes that purport to create leaders. He criticized the overt claims of development work by „first world developers" by stating: "We have had enough of hubris in the name of heroic leadership, much as we have had enough of foreign experts pretending to develop the „developing" countries" (Mintzberg, 2006: 4). For this indigenous process to flourish, some elements of the bottom-up approach should be part and parcel of development work.

The three case studies have been chosen to illustrate the development dynamics of such models in the South African context of poverty where individuals (developing athletes), collectives (schools, clusters and organizations) and communities have been targeted for sports-related development. A critical standpoint will be explored as posed by Mintzberg, yet will reflect on the nature of intervention and ideological underpinnings. Social impact will inevitably relate to the approach, foci of investigations and developing agendas. Given the context of chronic poverty and unequal socio-economic conditions, the research was participatory and an „empowering" experience focus towards the building of capacity (human capital) as an asset to „leave behind" once a programme has matured beyond the „delivery phase (Burnett, 2006). This implicates a „left behind" effect of self-reliance in terms of programme management and delivery where the latter may have taken on a distinct community life of its own

THE SOUTH AFRICAN CONTEXT

Poverty is multidimensional and has unique manifestations at all levels of human existence. It represents a dynamic and complex process whereby vulnerable populations such as women and children are exposed through interlocking factors that deny them relative access to available resources (Narayan *et al*., 2000). Poverty thus manifests in recognizable lack of income and assets at the individual and community level (Kane-Berman, 2007), displays specific disease profiles such as malnutrition, HIV/Aids and Tuberculoses and is synonymous with fragmented family lives (May, 1998). Low literacy levels, high incidences of violence,

high school drop-out rates, teenage pregnancies, gang formation, physical neglect, psychological scars and a „live-for-the-moment" mentality exemplify a life of chronic poverty. The poor mostly have low skill and literacy levels, and are often denied access to stable employment and turn to low-paid self-employment (Dimant *et al*., 2007).

South Africa ranks among the highest crime ridden countries in the world, with the crime rate estimated to be about 2.17 million in 2005/6, and the highest rape rate in the world per 1000 000 of the population in 2000 (Lebone, 2007). Most frequent criminal acts reported in 2008/9 are property-related crimes such as housebreaking (506.5 ratio per 1 000 000 of the population) and soft fabric crimes such as common assault (396.1 ratio per 1 000 000 of the population) (Lebone, 2008/2009: 633).

Government-sponsored feeding schemes only provide the bare minimum of subsistence needs, and parents or guardians are unable to carry any additional cost of sport participation, despite the fact that „free education" (introduced by the Education Laws Amendment Act of 2005), has been delivered to about 5 million learners in 13 856 schools across South Africa

(Botsis *et al*., 2007). The lack of school and community sport facilities restricts sport participation and soccer is often the only sport offered at community level (Burnett & Hollander, 2006). Limited access to resources fostered a culture of interdependency, however extreme poverty eroded networks of cooperation at all levels of the South African society.

The lack of resources fostered a mutual dependency and culture of interdependency, however extreme poverty eroded networks of cooperation, undermining the social fabric, and in 2008 flared up as zenophobic-inspired violence as immigrant minorities from other African countries (e.g. Zimbabwe) swept through major townships (Naidoo, 2008). It is against this background of poverty that Sport and Recreation South Africa (SRSA) funded and implemented mass participation programmes and external developing agencies became involved, each with its own approach and product.

On the basis of overall national government policies, priorities and strategies, the White Paper developed by SRSA, represent the vision of how sport and recreation activities contribute to the general welfare of all South Africans, emphasizing the „building of communities" through active and structured participation. Following the „getting the nation to play" theme, SRSA has set four main objectives which include: i) increasing the level of participation in sport and recreation activities, ii) raising sport"s profile in the face of conflicting priorities, iii) maximizing the probability of success in major events, and iv) placing sport at the forefront of efforts to educate the public about HIV/Aids, and to reduce the level of crime (SRSA, 2008). At a recent National Sports Indaba, all key stakeholders reflected on „legacy of exclusion" of women, impoverished rural communities and townships schools, whilst the Minister (Makhenkesi Stofile) pledged to form strategic partnerships and provide opportunities for „all" to actively participate in sport and recreation within their own communities and schools (Ministry: Sport and Recreation, 2008).

SPORT-FOR-DEVELOPMENT: CASE STUDIES

The Participatory Action Research (PAR) approach was followed for all programmes, focusing on building various degrees of empowerment in monitoring and evaluation. All agencies were interested in the deliverables, but equally committed to have process information revealing intended and unintended consequences by tracking change according to a pre-post comparative design (Burnett & Hollander, 2003). The S·DIAT (Sport Development Impact Assessment Tool) was utilized, ensuring a synthesis and the triangulation of quantitative and qualitative data according to, and directed by two main indicator bands (Programme Management and Delivery, as well as Human and Social Development) and the related indicator fields (Burnett & Hollander, 2006). The Tool (S·DIAT) was specifically developed to „measure social impact" at different levels, namely the macro-, meso- and micro-level as manifested consequences of a particular programme or intervention according to a pre-post research design (Burnett & Uys, 2000). A mixed-method approach was implemented for all case studies which includes interviews with decision-makers and key stakeholders at various levels of intervention, questionnaires for implementers and participants, as well as focus group sessions for contextual and consensus information.

School sport mass participation

The School Sport Mass Participation Programme was introduced in all nine provinces of

South Africa in 2006, following the community-based Siyadlala Programme (Burnett & Hollander, 2006). SRSA signed a Memorandum of Understanding with the Minister of Education for the delivery of the Programme at schools within a cluster context in impoverished areas of the country. Prior to the baseline study that was conducted in 2008, 76 fieldworkers were trained in the collection of data according pre-designed methods of the S·DIAT. Data from 161 schools in 18 clusters selected for the baseline study, provided in-context pre-impact data on different indicator fields for post-impact comparisons (Burnett & Hollander, 2008).

Local stakeholders and recipients participated in identifying contextual priorities to be addressed by the Programme against such social realities as a high teenage pregnancy rate of an average of 9.4 per annum for secondary school girls, and 1.2 for primary school girls. Unpacking the manifestations of poverty such as poor health, criminality, deviant behaviour, low literacy levels and economic dependency of school sport assistants on the stipend of R1 200 per month became evident. A large percentage (48.4%) of them is breadwinners and 30.3% are essential contributors towards the survival of households (Burnett & Hollander, 2008).

The baseline study identified increased opportunities in „new" sports such as rugby, cricket and volleyball, in addition to more traditional sports such as athletics, netball and soccer. Other benefits included participations, in festivals, inter-school and inter-class competitions that stimulated sustained participation and the development of a „sporting culture" among the majority of participants and in their schools.

Despite „start up" equipment and contracted school sport assistants, main challenges remain the lack of physical resources, replacement of damaged equipment, non-credit bearing and skill-appropriate training. The decline of participation over time (from 63% to 10% in the secondary school, and from 71% to 31% in the primary school, with an average of 3.5% of girls" participation at grade 12), can partially be contributed to the top-down delivery of traditionally male sports (as decided upon by SRSA), the lack of ID documents (about a third

of the learners in rural schools did not have the relevant documents that were required for them to participate in competitive sport) , budget constraints and lack of a reporting system that would enhanced the monitoring, evaluation and follow-up actions (Burnett & Hollander, 2008).

Active community clubs

The Active Community Clubs" Initiative is funded by the Australian Agency for International Development (AusAID) and delivered by the Australian Sports Commission. An impact assessment was conducted in 2003 on two clubs in the Eastern Cape Province, another one in 2006 in Keiskammahoek (also in the Eastern Cape Province), followed by baseline studies in 2008 in KwaZulu-Natal (a province in South Africa), Swaziland and Botswana under an outreach programme (ASOP) where partnerships were established between researchers from South Africa, Swaziland and Botswana. This Programme is based on recruitment, training and seeking of partnerships with local stakeholders through inclusive community consultation and the needs-based, community-driven structuring of a club.

The impact study of 2003 illustrated this outside-in and bottom-up approach where a central component of the ACC (Active Community Club) was the delivery of a sport programme

(rugby, netball and cricket) to local schools (Burnett & Hollander, 2003). Other activities that were developed under club leadership included a gardening project (in Tshabo) and a health programme (HIV/Aids education and training) (Burnett, 2006). Some of these programmes experienced a decline in participation as community leadership changed and new priorities emerged. The gardening project of 2003 in which about 12 individuals participated, is now operated by a teacher and her husband who just produce enough vegetables for the pre-school where she is the teacher, and for their own use. On the other hand, the more institutionalized sport programme is still being delivered to the local schools, and some volunteers have been involved in the programme for more than eight years. There is an overwhelming belief that volunteering will enhance unemployed youths‟ opportunities to obtain employment by gaining relevant experience, and learning job-related skills and values. The following continuum illustrates a belief system of relative helplessness of avoiding the poverty trap and as such offering a way „out of the streets‟.

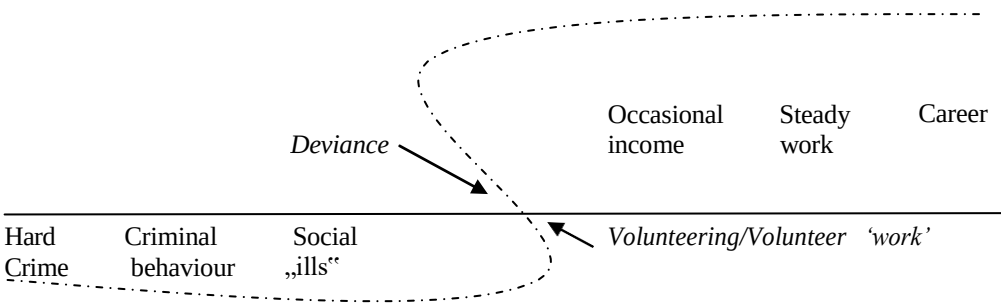

FIGURE 1. **THE PERCEIVED ROLE OF VOLUNTEERING TOWARDS RESPONSIBLE CITIZENSHIP AND EMPLOYMENT**

The initial social value of the increase in social trust between coaches and participants, reduction of social distance between children and parents, increased self-esteem and a sense of self-worth for the unemployed volunteers are highly valued consequences within the context of extreme poverty and psycho-social destitution and neglect (Burnett, 2006). The dependency on the „external‟ provision of resources for programme implementation and events, timely education and training, dependency on leadership for strengthening institutional capacity and a competitive environment to forge meaningful relationships beyond the social realm of the community, are indicative of the relative delicateness of sustaining, bridging and linking ties. However, widely acclaimed exposure and the flagship status of this programme opened up opportunities for a possible partnership with Siyadlala (the national community mass participation programme of SRSA), as the top-down model has been met with mixed success after the initial few years of implementation due to the fact that it lacks the community uptake and shared ownership.

Youth development through football (YDF)

Youth Development through Football (YDF) is an initiative that was established in July 2007 by the GTZ that envisaged involvement in development work in Africa until March 2011. The European Union joined this initiative as a major co-funder and partner in March 2009. By utilizing the popularity of football, youth and community development will be promoted in economically disadvantaged communities to afford boys and girls the opportunity to receive education and capacity building. The programme has established a working

relationship with SRSA with a representative to drive a „Legacy Programme" in commemoration of the FIFA World Cup that will be presented in South Africa in 2010 (Burnett, 2008). An outside-in approach is utilized, as partnerships are forged with different NGOs and the government sector, with whom they will collaborate to ensure sustainable social development through sport, and particularly football-for-development initiatives. Their focus is on building a conceptual framework on football-for-development work. There is also a drive to provide leadership, develop material and build capacity through education, training and consultancy within their network of partners. NGOs, the sports fraternity and government departments are their major partners for supporting programmes and delivering services whereby a „development philosophy" will be spread, and their partnerships strengthened and showcased.

The following diagram is reflective of their framework of operation and directive in forming a network and collaborative service delivery that will ensure a lasting footprint for football for development work.

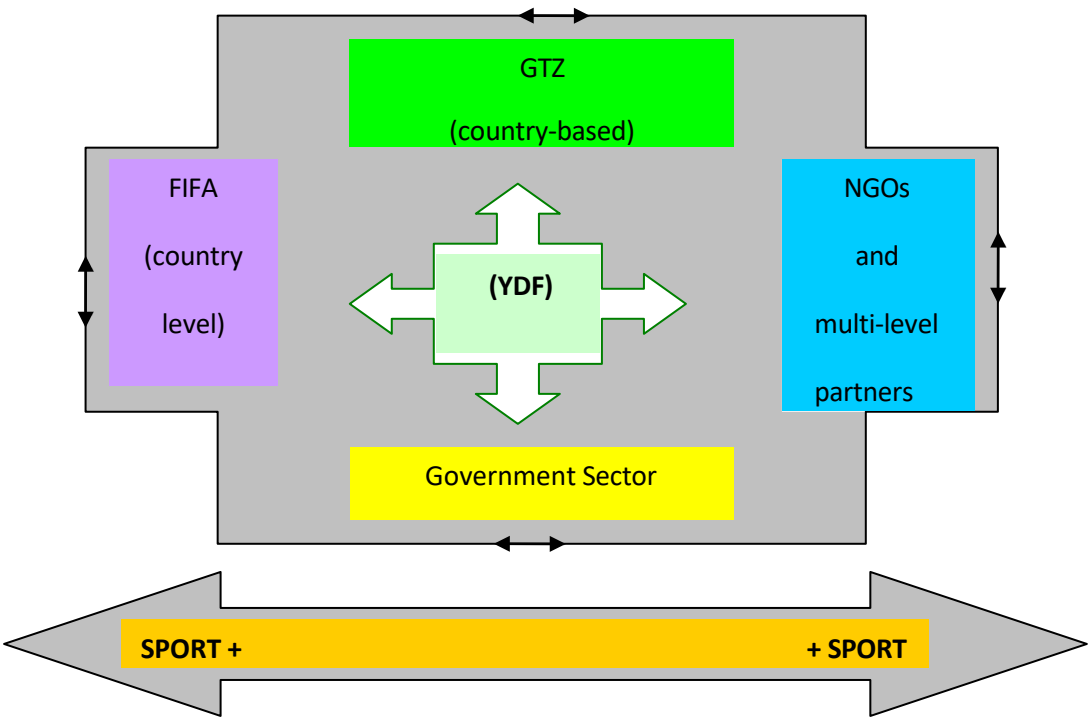

FIGURE 2. **YOUTH-DEVELOPMENT-THROUGH-FOOTBALL FRAMEWORK**

In the first instance, the GTZ"s (Gesellschaft für Technische Zusammenarbeit) Youth Development through Football initiative is focused on identifying main country-based stakeholders and partners within the youth and sport development domains, taking cognizance of existing programmes, government and existing GTZ operatives, operations and priorities. Often, country-operations are structured according to local and multi-stakeholder needs, and aligned with strategic objectives without necessarily focusing on establishing a network and creating a synthesis between a myriad of service providers. This represents an

outside-in approach with a top-down dynamics when a partnership with government programmes such as the School Sport Mass Participation Programme is forged, yet a bottom-up approach prevailing when a partnership with the Active Community Clubs‟ Initiative is formed. Both partners have been recruited for collaborative ventures with the most recent including the placement of German volunteers in the Eastern Cape with the Active Community Clubs‟ Initiative is in the beginning stages. In figure 3, the South African-based parents‟ organization, for driving a compatible development agenda has initially been identified as a baseline.

FIGURE 3: **MULTILEVEL SPORT-FOR-DEVELOPMENT PROGRAMMES IN SOUTH AFRICA**

In such multilevel and diversity in stakeholder collaboration, the ties will be relatively weak and in need of seeking to deliver on mutual outcomes. The delivery and success of the corporation will largely be met by the partnerships, and within the diversity of partnerships, GTZ brand and donor-inspired expectations will transpire. The success of collaborative work will inevitably lie within the collective association and goal achievement within a particular network of partners.

CONCLUSION

The top-down approach of the School Sport Mass Participation Programme allowed for the introduction and resourcing of sport activities and structured programmes that are to provide a broad base of participation to deliver on national priorities of sporting excellence and a framework of development aligned with the Millennium Development Goals (Burnett, 2008).

The emphasis of traditional male sports such as rugby, cricket and football, inevitably limited the opportunities for equitable gender participation. Inter-departmental collaboration was challenging, especially at the level of implementation where the relatively „uneducated" school sport assistants and teachers experienced a strained relationship. Possibly due to the fact that the Programme was funded and „delivered" by SRSA and „accepted" by the national, provincial and local Departments of Education, without real buy-in at the local level of implementation. This top-down approach and unequal power relations at all levels of

implementation, had direct implications for creating mass participation at the school level and afforded many rural learners the opportunity to participate in a variety of sports. There was less focus on addressing contextual priorities and appropriate needs-based education and training to address the expectations of the (current and potentially future) unemployed by creating career pathways or enhancing the employability status (with reference to the school sport assistants and contract workers) of vulnerable populations.

Initiated by outside agencies such as the Australian Sports Commission, the Active Community Clubs" Initiative was implemented in the Eastern Cape and KwaZulu-Natal provinces to address issues of community development and regeneration in selected rural and urban areas. The „outside-in factor" is minimized as communities structure their own clubs – first by introduction and later by request, around community needs where sport participation at primary school level is a „given". Strategies and structures follow an „Australian model" interwoven with local dynamics for uptake and ownership. Linking and bridging ties remain fragile (Coalter, 2007), and needs-based sustainable development seems feasible through the collaboration, mutual reflection and reflective learning (Cunningham & Beneforti, 2005). The mobilizing of local networks and strategic partners may counter the external influence to be absorbed and given „life" in the local vernacular. Volunteering provided the context for social learning (Green, 2008) and active citizenship in the need to seek mutual ground for delivery and collective impact. This reflect on a programme taking on community life and being shaped by local needs and existing opportunities. Such an approach enhanced local ownership and buy-in with local leaders taking responsibility for addressing local development priorities and social issues.

The „outside-in" approach of the GTZ is demonstrated by the building of partnerships and co-delivering on a sport-for-development agenda through existing delivery channels, yet focusing on alignment and inclusion of partners that would support the YDF philosophy and targets. In such multilevel and diversity in stakeholder collaboration, the delivery and success of the corporation will largely be determined by the partnerships, and within the diversity of partnerships will run a donor-inspired process and product – a post-2010 legacy. The success of collaborative work will inevitably lie within the collective association and goal achievement within a particular network of partners. This approach would thus require a particular focus and sensitivity that should enable and shape the development of leaders (as suggested by Mintzberg) within the communities where the programmes are being delivered.

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REFERENCES

ARAI, S. & PEDLAR, A. (2003). Moving beyond individualism in leisure theory: a critical analysis of concepts of community and social engagement. *Leisure Studies,* 22: 185-202.

BLINDE, E.M. & TAUB, D.E. (1999). Personal empowerment through sport and physical fitness activity: perspectives from male college students with physical and sensory disabilities. *Journal of Sport Behavior,* 22(1): 181-202.

BOTSIS, H.; CRONJE, F. & MACFARLANE, M. (2007). „Education‟. In J. Kane-Berman (Ed.), *South Africa Survey 2006/2007* (141-258). Johannesburg: South African Institute of Race Relations.

BURNETT, C. & UYS, T. (2000). Sport Development Impact Assessment: towards a rationale and tool. *South African Journal for Research in Sport, Physical Education and Recreation*, 22(1): 27-40.

BURNETT, C. & HOLLANDER, W.J. (2003). An impact study on Australia Africa AA 2006. Sport Development Programme‟s Active Community Clubs‟ Initiative. Report prepared for the Australian Sports Commission, Department of Sport and Movement Studies, Rand Afrikaans University, Johannesburg.

BURNETT, C. & HOLLANDER, W.J. (2006). Post-impact report of the Mass Participation Projects of Sport and Recreation South Africa. Report prepared for SRSA, Department of Sport and Movement Studies, University of Johannesburg.

BURNETT, C. (2006). Building social capital through an Active Community Club. *International Review for the Sociology of Sport*, 41(3): 283-294.

BURNETT, C. (2008). Baseline study of YDF (Youth Development through Football) networks in South Africa. Report prepared for GTZ (Gesellschaft für Technische Zusammenarbeit), Department of Sport and Movement Studies, University of Johannesburg.

BURNETT, C. & HOLLANDER, W.J. (2008). Baseline study of the School Sport Mass Participation Programme. Report prepared for SRSA, Department of Sport and Movement Studies, University of Johannesburg.

COALTER, F. (2007). Sports clubs, social capital and social regeneration: „ill-defined interventions with hard to follow outcomes‟? *Sport in Society,* 10(4): 537-559.

COALTER, F. (2008). The role of theory in researching sport development. Paper presented at the Conference on Studying Sports Development. London: Brunel University, 24-25 April.

COMMONWEATH ADVISORY BODY OF SPORT (2008). Harnessing the power of sport. Unpublished document. Representative presented an introductory paper at the 2nd Commonwealth Sports Development Conference. Glasgow, 12-13 June.

CUNNINGHAM, J. & BENEFORTI, M. (2005). Investigating indicators for measuring the health and social impact of sport and recreation programs in Australian Indigenous communities. *International Review for the Sociology of Sport,* 40(1): 89-98.

DIMANT, T.; LEBONE, K. & MACFARLANE, M. (2007). Business and employment. In J. Kane-Berman (Ed.), *South African Survey 2006/2007* (141-258). Johannesburg: South African Institute of Race Relations.

ELEY, D. & KIRK, D. (2002). Developing citizenship through sport: the impact of a sport-based volunteer programme on young leaders. *Sport, Education and Society*, 7(2): 151-166.

FRASER-THOMAS, J.L.; CôTé, J. & DEAKIN, J. (2005). Youth sport programs: an avenue to foster positive youth development. *Physical Education and Sport Pedagogy*, 10(1): 19-40.

GIRGINOV, V. (Ed.) (2008). *Management of sports development*. Oxford: Elsevier.

GLOVER, T.D. (2004). The „community" center and the social construction of citizenship. *Leisure Sciences*, 26: 63-83.

GREEN, C. (2008). Sport as an agent for social and personal change. In V. Girginov (Ed.), *Management of Sports Development* (129-145). Oxford: Elsevier.

HARTMANN, D. & MASSOGLIA, M. (2007). Reassessing the relationship between high school sports participation and deviance: Evidence of enduring, bifurcated effects. [http://www.sportengland.org/vosm/document_159]. Retrieved 20 February 2007.

HILLS, L. (2007). Friendship, physicality and physical education: an exploration of the social and embodied dynamics of girls" physical education experiences. *Sport, Education & Society* 12(3): 335. Abstract.

HYLTON, K.; BRAMHAM, P.; JACKSON, D. & NESTI, M. (2007). *Sports development: policy, process and practice*. London: Routledge.

HYLTON, K. & TOTTEN, M. (2007). Community sports development. In Kevyn Hylton & Peter Bramham (Eds.), *Sports development: policy, process and practice* (77-117). London: Routledge.

KANE-BERMAN, J. (Ed.) (2007). *South Africa Survey 2006/2007*. Johannesburg: South African Institute of Race Relations.

KIDD, B. (2008). A new social movement: Sport for development and peace. *Sport in Society* 11(4): 370-380.

LANGBEIN, L. & BESS, R. (2002). Sports in school: source of amity or antipathy? *Social Science Quarterly*, 83(2): 436-454.

LAWSON, H.A. (2005). Empowering people, facilitating community development and contributing to sustainable development: The social work of sport, exercise, and physical education programmes. *Education & Society*, 1(1): 135-160.

LEBONE, K. (2007). Living conditions and communications. In J. Kane-Berman (Ed.), *South Africa Survey 2006/2007* (367-430). Johannesburg: South African Institute of Race Relations.

LEBONE, K. (2008/2009). Crime and security. In J. Kane-Berman (Ed.), South Africa Survey 2008/2009 (623-698). Johannesburg: South African Institute of Race Relations.

LEVINE, R.; LLOYD, C.; GREENE, M. & GROWN, C. (2008). *Girls count. a global investment & action agenda*. Washington, DC: Center for Global Development.

MAY, J. (1998). *Experience and perceptions of poverty in South Africa*. Durban: Proxis Publishing.

MILLER, K.E.; SABO, D.F.; FARRELL, M.P.; BARNES, G.M. & MELNICK, M.J. (1999). Sports, sexual behavior, contraceptive use, and pregnancy among female and male high school students: testing cultural resource theory. *Sociology of Sport Journal*, 16: 366-387.

MINISTRY: SPORT AND RECREATION (2008). National sports indaba, "from mass participation to integrated development of excellence", 9-10 October 2008, Durban.

MINTZBERG, H. (2006). Developing leaders? Developing countries? *Development in Practice* 16(1): 4-14.

MISENER, L. & MASON, D.S. (2006). Creating community networks: can sporting events offer meaningful sources of social capital? *Managing Leisure*, 11: 39-56.

NAIDOO, J. (2008). Our nations in up the creek and we need to find a paddle. *Sunday Times*, 15 June, p. 21.

NARAYAN, D.R.; SCHAFFT, P.K., RADEMACHER, A. & KOCH-SHULLE, S. (2000). *Voices from the poor. Can anyone hear us?* New York, NY: Oxford University Press.

NIKE CR REPORT (2008). Let me play. [http://www.nikeresponsibility.com]. Retrieved 20 November 2008.

PEDLAR, A. (1996). Community development: what does it mean for recreation and leisure? *Journal of Applied Recreation Research*, 21: 5-24.

POWELL, M. (1995). Culture: Intervention or solidarity. *Development in Practice,* 5(3): 196-206.

SCOTT PORTER RESEARCH AND MARKETING (2000). Sport and minority ethnic communities: aiming at social inclusion. Summary. *Research Digest,* 58:1-15.

SHUTTLEWORTH, J. & WAN-KA, C. (1998). Youth sport education and development in Hong Kong: a conflict model social impact assessment. *Sport, Education and Society,* 3(1): 37-58.

SMITH, A.L. (2003). Peer relationships in physical activity contexts: a road less traveled in youth sport and exercise psychology research. [http://www.sportengland.org/vosm/document_57]. Retrieved 2 March 2009.

SRSA (2008). *White Paper. Getting the nation to play.* Pretoria: Sport and Recreation South Africa.

SUGDEN, J. (2006). Teaching and playing sport for conflict resolution and co-existence in Israel. *International Review for the Sociology of Sport,* 41(2): 221-240.

UNITED NATIONS (2003a). Sport as a means to promote education, health, development and peace. *General Assembly Resolution 58/5*. New York, NY: United Nations.

UNITED NATIONS (2003b). *Sport for development and peace: Towards achieving the millennium development goals.* Report from the United Nations inter-agency task force on sport for development and peace. New York, NY: United Nations.

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ANTHROPOMETRIC, MOTOR ABILITY AND PHYSIOLOGICAL PROFILES OF INDIAN NATIONAL CLUB FOOTBALLERS: A COMPARATIVE STUDY

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ABSTRACT

Football is probably the most popular game worldwide but there is still limited scientific information available concerning the physique and performance qualities of elite Indian footballers. Team games are sports where size, shape, body composition and fitness all play an important part in providing distinct advantages for specific playing positions. Hence an attempt has been made to study the various anthropometric parameters, motor ability and physiological profiles of the different Indian national club footballers and also to compare the above parameters with their international counterparts. The present study was carried out on one hundred fifty (150) male Indian footballers of six different national clubs of India including three from Kolkata (East Bengal, Mohan Bagan & Mohammedan Sporting) and other three from Goanese clubs (Salgaokar, Vasco & Dempo). The players were also sub-divided according to their specific field positions. Physical and physiological profiles including height, weight, percentage body fat (%BF), flexibility, agility, explosive power, and VO_2 max were measured by standard procedures. It was noted that the mean values of age, height, weight and %BF were significantly different among footballers of different national clubs. Among the motor ability and physiological qualities only flexibility, agility and VO_2 max were significantly different among the footballers of different national clubs ($p<0.01$). It was also observed that the mean values of height, weight, vertical jump and VO_2 max of Indian national club players were found to be inferior to those of European, American and Australian footballers. However, the %body fat of Indian footballers according to their specific field positions was found to be comparable with their international counterparts. The defender, midfielder and striker of the present study were inferior in endurance (VO_2 max) as compared to their international counterparts. Genetic factors may be the cause of smaller body size of the subject of the present study as compare to their international counterparts. So, it can be concluded that the differences among the footballers of present study with their international counterparts and specific playing position is probably the cause of hereditary factors and differences in activity in the game.

Key words: Indian national club footballers; Speed ability; Agility; Explosive power; VO_2 max; Footballers.

INTRODUCTION

Football is probably the most popular game worldwide but there is still limited scientific information available concerning the physique and performance qualities of elite Indian footballers. Not many sports physiologist have been attracted to examine the footballer in details because of the lack of adequate experimental models to study the games in the laboratory (Reilly *et al*, 1990). The game comprises activities like sprint and jumps in attack and defense. It also requires aerobic capacity as the game lasts one and half hour, sometimes even longer than the official time. These short and long lasting activities are performed over the entire game, so, both aerobic and anaerobic capacities are very important to exhibit better performance (Malcovic *et al.*, 1994).

Football is a team game. Team games are sports where body size, shape, body composition and level of fitness, all play an important part in providing distinct advantages for specific playing positions particularly at the highest levels of performance where there is a high degree of player specialization (Bale, 1986). Specific positional roles within each code may demand unique physiological attributes (Reilly *et al*., 1990). These are reflected in the physical and physiological fitness of the soccer players (Reeves *et al.*, 1999).

The database of physique and performance qualities of the players of the renowned clubs throughout the country is very important to make a National Team. It is a fact that in India there is still limited information of club footballers regarding physique, physiological profiles and performance except a study on Indian University Footballers (Kansal *et al.*, 1980a) in this regard. Hence an attempt has been made to study the physique and physiological qualities of the Indian national club footballers. The aims of the present study are i) to evaluate the various anthropometric and physiological profiles of Indian national club footballers and also to evaluate the above parameters according to their playing positions and, ii) to compare these parameters with Indian national players and also their international counterparts.

MATERIALS AND METHODS

Subjects

The present study was carried out on one hundred fifty (150) male Indian national league club footballers of mean age 23.3±3.50 years. All the footballers were chosen from the six different national league clubs of India including three from Kolkata (East Bengal, Mohan Bagan & Mohammedan Sporting) and three from Goanese clubs (Salgaokar, Vasco & Dempo). The players of East Bengal, Mohan Bagan and Mohammedan Sporting were tested at Sports Authority of India (SAI), Eastern Center, Kolkata and the players of three Goanese clubs were investigated at Nehru Stadium, Margaon, Goa. The players consisted of 23 goalkeepers, 44 defenders, 48 midfielders and 35 strikers. Another 43 Indian national footballers were also investigated for their various physical and physiological profiles (parameters were tested as tested on national league club footballers) at Sports Authority of India (SAI), Eastern Center, Kolkata. Before the tests all the players were clinically examined by Doctors, specialized in Sports Medicine of Sports Authority of India. Prior to initial testing a complete explanation of the purposes, procedures and potential risks and benefits of the tests were explained to all footballers and consent was obtained from all the players. The

player who was found clinically fit, healthy and no history of any heart and lung diseases was

finally selected for the following tests.

The various anthropometric parameters of the players including height (cm) and weight (kg) were recorded by following the standard procedures (Sodhi, 1991). The decimal age of the footballers were calculated from their date of birth recorded at the time of testing. Skinfold thickness was recorded by Harpenden Skinfold caliper at the site of biceps, triceps, subscapular and suprailliac (Eston *et al*., 1995). Body density was calculated using the equation of Siri (1961) and %Body Fat (%BF) was calculated by the formula of Durnin & Womersley (1974**)**. Body Mass Index (BMI) was calculated from body height and weight (WHO, 1995).

The hip and back flexion as well as extension of the hamstring muscles of the leg was evaluated by modified Sit-and-Reach Test (Johnson & Nelson, 1988). Explosive power of lower limbs i.e., the power of the legs in jumping vertically upwards was measured by using the standard method of Verduci (Verduci, 1980). The speed ability of the subjects was assessed by 20-meter sprint by adopting the standard procedure (Rösch *et al*, 2000). Agility of the body (measurement of coordination and speed) maneuvering in forward, backward and sideward directions was evaluated by the Semo Agility test, which was adopted by Kirby (1971).

Maximum aerobic power (VO_2 max) was assessed to use an indirect method of multistage fitness test (Beep test) (Leger *et al*., 1988) from where VO_2 max was predicted. It is a progressive shuttle run test for the prediction of aerobic fitness as well as to estimate a person's maximum oxygen uptake capacity (VO_2 max) from the standard chart. The procedures and purpose of the above test were elaborately instructed to all the players. Briefly, players ran back and forth between two lines, spaced 20-m apart, in time with the "beep" sounds from a compact disc (20-m Shuttle Run test CD). Each successful run of the 20-m distance was a completion of a shuttle. The "beep" sounded at a progressively increasing pace with every minute of the test and correspondingly the player must increase his running speed accordingly. The player was warned if he did not reach the end line in time once. The test was terminated when he i) could not follow the set pace of the "beeps" for two successfully shuttles and/or ii) stopped voluntarily. Typically the scores in the test are expressed as levels and shuttles, which estimate a person's maximum oxygen uptake capacity (VO_2 max) from the standard chart. The laboratory tests were performed at a room temperature varying from 23℃ to 25℃ with the relative humidity varying between 50 and 60%. The field test was performed at temperature about 30°C with relative humidity of maximum about 70-80%.

Statistical analysis

Software, SPSS (Ver. 9.0) was used to analyze the collected data. Mean, standard deviation and one-way ANOVA were performed to see whether any significant differences among footballers and also according to their playing positions. After completion of the one-way ANOVA, Scheffe's *F* test was also used for multiple comparisons between clubs.

RESULTS

The various anthropometric, motor ability and physiological parameters of Indian National League club footballers were presented in table 1 and table 2a respectively. The mean age, height, weight, BMI and %BF were significantly different among footballers of different

national clubs (table 1). Regarding motor qualities, flexibility, agility and VO_2 max were also found to be significantly different among the footballers of different clubs ($P<0.01$). No such significant difference was observed in case of Standing Vertical Jump (SVJ) and 20 m sprint.

TABLE 1. **COMPARISON OF PHYSICAL CHARACTERISTICS AND BODY FAT% OF INDIAN NATIONAL LEAGUE CLUB FOOTBALLERS**

Variables	East Bengal (n=23)	Mohan Bagan (n=23)	Mohammedan Sporting (n=31)	Salgaokar (n=25)	Vasco (n=23)	Dempo (n=25)	F value with level of significance
Age (yrs)	24.6 ±3. 61	22.5 ±2.76	22.7 ±3.02	21.6 ±3.42	23.3 ±3.51	24.7 ±3.90	3.18**
Height (cm)	171.9 ±5.60	170.9 ±5.47	170.5 ±5.07	174.2 ±5.12	172.8 ±5.21	169.0 ±5.53	2.65*
Weight (kg)	67.3 ±5.48	66.4 ±5.40	64.5 ±5.53	63.9 ±5.46	63.4 ±5.47	61.0 ±5.75	2.64*
BMI	22.8 ±1.82	22.5 ±1.46	21.9 ±1.54	20.9 ±1.43	21.2 ±1.81	21.2 ±1.80	4.82**
% Body fat	13.5 ±2.75	12.2 ±2.76	11.6 ±2.28	14.3 ±1.27	14.2 ±2.02	15.1 ±1.93	9.62**

Values are (mean ±sd); **, $P<0.01$; *, $P<0.05$

TABLE 2a. **COMPARISON OF SELECTED MOTOR ABILITY PARAMETERS AND PHYSIOLOGICAL PROFILES OF INDIAN NATIONAL LEAGUE CLUB FOOTBALLERS**

Variables	East Bengal	Mohan Bagan	Mohammedan Sporting	Salgaokar	Vasco	Dempo	*F* value with level of significance
Flexibility (cm)	35.4 ±6.88	38.9 ±4.05	35.3 ±5.62	37.8 ±4.98	36.1 ±7.26	36.3 ±7.77	3.94^{**}
Standing vertical jump (cm)	44.1 ±4.34	42.6 ±4.91	43.8 ±4.74	42.2 ±4.63	43.1 ±4.73	45.6 ±4.72	1.11^{ns}
Speed ability-20m sprint (sec)	3.0 ±0.12	3.0 ±0.10	2.9 ±0.15	3.0 ±0.11	2.9 ±0.12	3.1 ±0.16	0.90^{ns}
Semo agility (sec)	12.2 ±0.61	11.9 ±0.51	12.3 ±0.55	11.6 ±0.34	11.6 ±0.43	12.2 ±0.67	9.49^{**}
VO_2 max ($ml.kg^{-1}.min^{-1}$)	52.3 ±4.27	52.6 ±4.90	51.4 ±4.04	55.2 ±4.18	55.0 ±4.10	54.4 ±3.89	3.36^{**}

Values are (mean ±sd); **, $P<0.01$; ns, not significant

TABLE 2b. **SCHEFFE'S *F* TEST FOR MULTIPLE COMPARISONS OF SELECTED ANTHROPOMETRIC, MOTOR ABILITY AND PHYSIOLOGICAL PARAMETERS OF INDIAN NATIONAL LEAGUE CLUB FOOTBALLERS**

Variables	EB *VS* MB	EB *VS* MS	EB *VS* SAL	EB *VS* VAS	EB *VS* DEM	MB *VS* MS	MB *VS* SAL	MB *VS* VAS	MB *VS* DEM	MS *VS* SAL	MS *VS* VAS	MS *VS* DEM	SAL *VS* VAS	SAL *VS* DEM	VAS *VS* DEM
Height	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*
Weight	ns	ns	ns	ns	*	ns	ns	ns	*	ns	ns	ns	ns	ns	ns
BMI	ns	ns	*	ns	ns	ns	*	ns	ns	ns	ns	ns	ns	ns	ns
%Body fat	ns	*	ns	ns	ns	ns	*	ns	*	*	*	*	ns	ns	ns
Flexibility	*	ns	ns	ns	ns	*	ns	*	*	*	*	ns	ns	ns	ns
Agility	ns	ns	*	*	ns	ns	ns	ns	ns	*	*	ns	ns	*	*
VO_2 max	ns	ns	*	*	ns	ns	ns	*	ns	*	*	*	ns	ns	ns

EB, East Bengal; MB, Mohan Bagan; MS, Mohammedan Sporting; SAL, Salgaokar; VAS, Vasco; DEM, Dempo *, P<0.05; ns, not significant; Scheffe's *F* values for significance at 0.05 level is 11.45

Table 2b represents Scheffe's *F* test for multiple comparisons of selected anthropometric, motor ability and physiological parameters of national league club footballers. The table depicted that the height was only found to be statistically significant when Dempo was compared with Salgaokar and Vasco respectively. On the other hand, body weight was significantly different when Dempo was compared with East Bangal and Mohan Bagan players. Like height and weight BMI also found to be significantly different when Salgaokar was compared with East Bengal and Mohan Bagan respectively. Percentage body fat was also significantly different between East Bengal vs Mohammedan Sporting, Mohan Bagan vs Salgaokar, Mohan Bagan vs Dempo, Mohammedan Sporting vs Salgaokar, Mohammedan Sporting vs Vasco and Mohammedan Sporting vs Dempo respectively. Almost similar observations were made in case of flexibility when Mohan Bagan compared with East Bangal and Mohammedan Sporting and significant differences were also observed in this regard. The VO_2 max and agility was found to be significantly different when East Bengal and Mohammedan Sporting compared with Salgaokar and Vasco respectively.

TABLE 3a. **COMPARISONS OF PHYSICAL CHARACTERISTICS, SELECTED MOTOR ABILITY PARAMETERS AND PHYSIOLOGICAL PROFILES OF INDIAN NATIONAL LEAGUE CLUB FOOTBALLERS (COMBINED, N=150) ACCORDING TO SPECIFIC FIELD POSITIONS**

Variables	Goalkeeper (n=23)	Defender (n=44)	Midfielder (n=48)	Striker (n=35)	*F* value with level of significance
Age (yrs)	23.3 ± 3.95	23.1 ± 3.26	23.3 ± 3.62	23.2 ± 3.46	0.03^{ns}
Height (cm)	173.8± 5.33	170.8 ± 5.78	171.9 ± 5.98	170.9 ± 5.76	1.52^{ns}
	±	±	±	±	
	±	±	±	±	

Weight (wt)	66.7	5.56	63.2	8.07	64.9	6.52	63.5	6.38	1.55^{ns}
% Body fat	14.0	2.61	13.8	2.05	13.3	2.41	13.6	2.15	0.76^{ns}
BMI	22.1	1.66	21.6	2.06	22.0	1.62	21.7	1.75	0.49^{ns}
Flexibility (cm)	43.8± 7.79		40.6± 6.18		36.1± 4.94		39.7± 5.84		8.45**
Standing Vertical Jump (cm)	43.7 ± 5.42		44.4 ± 5.93		43.3 ± 4.94		43.7 ± 5.31		0.34^{ns}
20m sprint (sec)	2.96 ± 0.13		2.97 ± 0.13		2.96 ± 0.13		2.99 ± 0.17		0.48^{ns}
Semo agility (sec)	12.0 ± 0.61		12.1 ± 0.63		11.8 ± 0.51		12.0 ± 0.67		1.62^{ns}
VO_2 max ($ml.kg^{-1}.min^{-1}$)	53.1± 3.60		53.7± 4.72		55.2± 5.02		53.8± 4.43		3.14*

Values are (mean ±sd); overall difference is made in one-way ANOVA, s^{*}, $P<0.05$; ^{ns}, not significant

The various anthropometric, motor ability and physiological parameters according to their specific field positions of Indian National League club footballers were presented in table 3a. It is evident from the table that goalkeepers were the tallest and heaviest among the players of different playing positions although the differences were found to be statistically insignificant. Percentage body fat was also found to be higher in goalkeeper as compared to their other counterparts and the value was found to be statistically insignificant like height and weight. Trunk flexibility and VO_2 max were found to be significantly different among the players of different playing positions. However, the mean flexibility was found to be higher in goalkeeper and VO_2 max was found to be higher in midfielders respectively as compared to the players of other field positions. Scheffe's-*F* test for multiple comparisons among the Indian national club footballers according to their specific field positions were presented in table 3b. It is evident from the table that the flexibility of goalkeepers and defenders were found to be significantly different when compared with midfielders. On the other hand VO_2 max was found to be significantly different between midfielder and striker. No such significant differences were observed among the players of other field positions.

TABLE 3b. **SCHEFFE'S *F* TEST FOR MULTIPLE COMPARISONS OF SELECTED MORPHOLOGICAL, MOTOR ABILITY PARAMETERS AND PHYSIOLOGICAL PROFILES**

Variables	GK *VS* DEF	GK *VS MF*	GK *VS* ST	DEF *VS* MF	DEF *VS* ST	MF *VS* ST
Flexibility	ns	*	ns	*	ns	ns
VO_2 max	ns	ns	ns	ns	ns	*

GK, Goalkeeper; DEF, Defender; MF, Midfielder; ST, Striker *, $P<0.05$; ns, not significant; Scheffe's *F* values for significance at 0.05 level is 8.04

TABLE 4. **COMPARISON OF PHYSICAL CHARACTERISTICS AND PHYSIOLOGICAL PROFILES OF THE INDIAN NATIONAL CLUB FOOTBALLERS WITH THEIR INTERNATIONAL COUNTERPARTS**

Teams & Authors	Age (yrs)	Height (cm)	Weight (kg)	%Body fat	Vertical Jump (cm)	VO_2 max ($ml.kg^{-1}min^{-1}$)

English League, First Division (White *et al.*, 1988), n=17	23.3	180.4	76.7	19.3	59.8	49.6
Aberdeen F.C. (Williams *et al.*, 1973), n=9	--	174.6	69.4	14.9	--	--
Dallas Tornado (Raven *et al.*, 1976), n=18	26.0	176.0	75.5	9.6	--	58.4
Italian Professionals (Faina *et al.*, 1988), n=27	26.0	177.2	74.4	--	--	63.2
Ujpesti Dozja, Budapest (Apor, 1988)	22.9	176.5	70.5	--	52.5	66.6
American National Team (Wilmore & Haskel, 1972; Douge, 1988), n=44	22.2	178.0	77.0	14.4	56.0	59.2
Indian National Team (2003), n=43	23.2	173.5	66.9	13.9	45.2	54.2
Present study of Indian national club footballers, n=150	23.3	171.6	64.4	13.6	43.7	53.6

Table 4 represents the comparison of various anthropometric, motor ability and physiological parameters of the Indian national club footballers with the players of Indian national team and their international counterparts. The mean values of height, weight, %BF, vertical jump and VO_2 max of the Indian national team (2003) and Indian national club footballers (present study) were found to be well comparable. But the above parameters were found to be higher in their International Counterparts except English First Division League footballers who were found to be less in VO_2 max than the present study.

TABLE 5. **COMPARISON OF CERTAIN PHYSICAL AND PHYSIOLOGICAL PARAMETERS OF INDIAN NATIONAL LEAGUE FOOTBALLERS WITH THEIR INTERNATIONAL COUNTERPARTS ACCORDING TO THEIR SPECIFIC PLAYING POSITIONS**

Teams & Authors	Position	Age (yrs)	Height (cm)	Weight (kg)	%Body fat	VO_2 max ($ml.kg^{-1}min^{-1}$)
Association football players college level (Bell & Rhodes, 1975)	Goalkeeper (n,7)	20.8	180.3	80.8	16.9	
	Defender (n,20)	20.8	176.8	72.5	14.7	-
	Midfielder (n,18)	20.8	173.4	68.1	14.6	
	Striker (n,16)	20.8	177.2	69.2	14.7	
South Australian Republic (Withers *et al*., 1977)	Defender (n,1)	-	188.6	83.5	14.0	61.6
	Midfielder (n, 3)		175.1	72.6	17.0	61.7
	Striker (n,1)		176.6	74.8	13.6	63.4
Indian national (Kansal *et al.*, 1980a)	Defenders (n,22)	-	173.1	59.4	10.2	-
	Midfielders & Strikers (n,24)	-	165.3	52.4	9.4	-
Indian University Champions (Kansal	Goalkeeper (n, 6)	-	-	60.3	14.3	39.7
	Defender (n,6)			59.8	13.2	42.9

et al., 1980b)	Midfielder (n, 5)			58.2	12.4	43.2
	Striker (n, 12)			55.0	10.4	47.6
Indian national footballers (2003)	Goal Keeper (n,5)	23.2	178.9	69.7	12.3	51.9
	Defender (n,12)	23.8	174.2	66.1	12.0	54.3
	Midfielder (n,17)	23.2	173.2	66.9	12.8	55.2
	Striker (n,9)	22.6	170.8	66.3	12.7	53.1
Present study of Indian national club footballers	Goal Keeper (n,23)	23.3	173.8	66.7	14.0	53.1
	Defender (n,44)	23.1	170.8	63.2	13.8	53.7
	Midfielder (n,48)	23.3	171.9	64.9	13.3	55.2
	Striker (n,35)	23.2	170.9	63.5	13.6	53.8

A comparison of physical and physiological parameters of the Indian national club footballers were also been made with their international counterparts according to their specific playing positions (table 5). However, mean values of height, weight, vertical jump and VO_2 max were found to be higher in European, American and Australian footballers as compare to Indian footballers. The mean values of height, weight and %BF of goalkeeper, defender, midfielder and striker of Indian national club footballers (present study) were well comparable with Indian University Players (Kansal *et al*., 1980a and Kansal *et al*., 1980b), but body height and weight are lower than Indian national team. However, %BF of Indian footballers (according to their specific field positions) is well comparable with their international counterparts (table 5). But defender, midfielder and striker of the present study were found to be inferior in VO_2 max than their international counterparts but well comparable with Indian national players.

DISCUSSION

The present study reveals that the mean values of height and weight were less than their International counterparts (table 4). Generally Asians are smaller in size than Non-Asians (Ekblom, 1994). The small sizes of Indians are probably due to genetic cause. It is well established that ethnic and racial factors which affects the average body size (Hirata, 1966). However, morphological factors are not a bar to success in soccer though it might determine a positional role most appropriate for the players (Ekblom, 1994).

It was also found that there were differences in the anthropometric characteristics and body composition associated with playing positions. This was supported by Reeves *et al.* (1999) who found that there were differences in the anthropometric characteristics and body composition associated with playing position. In the past a study of English Players at College Level confirmed that goalkeepers (mean 180 cm) were the tallest than other team members (Bell & Rhodes, 1980). This trend was supported by observations of Professional English League Players, the centre-backs being taller than the full backs with midfield players being the smallest of those playing outfield Reilly (1979). So, height does bestow an advantage to the goalkeeper, the centre-backs and to the forward used as the "target man" for winning the possession of the ball with his head (Reilly *et al*., 1990). Thus a particular stature may orient players towards specific positional or tactical roles. A particular body size may encourage the acquisition of certain skills and force of gravitation towards a specific playing position.

Body composition is an important aspect of fitness for soccer players. An excess body fat acts as dead mass in activities when body mass is lifted repeatedly against gravity in running and jumping during play (Ekblom, 1994). Percentage body fat of the present subjects was found

to be lower than Indian sedentary male population of same age (Uppal, 1992). The mean values of %BF of Indian national club footballers and Indian national footballers were less than European and Australian footballers although it is comparable with American footballers. In fact, authors could not explain the probable cause of this result due to lack of information about socioeconomic life style, food habit and methods of %BF measurement of European, American and Australian footballers. So, these are the very important factors while making any conclusions about %BF variations of an individual. However, goalkeeper posses more fat (14.0 2.61) than the players of other field positions although the differences were found to be statistically insignificant. De Rose (1975) also recorded higher %BF in goalkeeper than in outfield players and concluded that the difference was probably because of the lighter metabolic loading improved by match play and training of goalkeeper. Such difference may also be due to less activity of the goalkeeper in the game. However, habitual physical activity, diet and stage of competitive seasons were not systematically considered when the %Body fat was evaluated in the present subjects, as those are also important factors in this context.

The flexibility is another important factor in soccer. Strength imbalance between the limbs increases the occurrence of injury. The average range of trunk flexibility of Indian national club footballers varies between 36.1- 43.8 cm. However, mean value of flexibility was noted higher in goalkeeper than the player of other field positions. Due to less number of literatures, investigators could not compare flexibility of Indian players with their International

counterparts. However, Douge (1988) has reported that the American footballers tend to have greater flexibility as compared to their International counterparts.

Standing vertical jump is commonly used to measure the explosive power of lower limbs. The mean vertical jump of Indian national players and Indian national club footballers were found to be much lower than English, Australian and American footballers (table 4). The probable reason of the lower value in vertical jump of Indian footballers may be due to smaller body structure than English, Australian and American footballers (Ekblom, 1994). However, the higher vertical jump was found among defender as compared to their counterparts of other field positions. Reilly (1979) has also reported that defender had relatively high mean scores in vertical jump than midfielder. The result of the present study was also corroborated with the study of above authors.

Speed ability is the performance pre-requisite to perform motor actions under given conditions (movement task, external factor, individual pre-requisites) in minimum of time (Thiess & Schnabel, 1987). Like other qualities the speed ability also plays an important role in soccer. An accelerated pace of the game calls for rapid execution of typical movements by every member in a team. In many instances, successful implementation of certain technical or tactical maneuvers by different team members is tied up with the degree of velocity deployed. In this connection the experimental analysis of the sprint capacity of football players such as split times and mean velocities of the total running distance are indicative of individual strong and weak points in sprinting performance (Kollath & Quade, 1990). The mean values of speed ability of Indian national team and Indian national club footballers were found to be 2.95 and 3.2 seconds respectively. Due to lack of literature, the investigators also could not compare speed ability of Indian players with their other counter parts.

Agility is the physical ability, which enables an individual to rapidly change the body

position and direction in precise manner (Johnson & Nelson, 1988). It is not a single ability but a complex of several abilities (Mattausch, 1973; Meinel & Schnabel, 1976; Blume, 1978). These abilities are primarily dependent upon the coordinative processes of the central nervous system, which are important in sports. The average value of agility of Indian national team and Indian national club footballers were found to be 12.0 second. However, the midfielders were more agile as compare to the players of other positions and which may be due to their nature of activity in the game. Agility also could not be compared with their international counterparts as in the case of flexibility.

The upper limit of the body's ability to consume oxygen is indicated by the maximal oxygen consumption (VO_2 max). This is the maximum rate at which energy can be released from the oxidative process exclusively (Bouchard *et al*., 1994). For this reasons it is an essential measurement in the study of footballers. Aerobic power of present study was found to be higher than those of the average Indian male population (Chatterjee & Chakroborty, 1986). Maximum oxygen uptake capacity(VO_2 max) is the highest rate at which an individual can consume oxygen during exercise, limits the capacity to perform aerobic exercise and therefore, serves as the most popular index of aerobic fitness (Armstrong & Weisman, 1994). The average values of VO_2 max for top-level soccer players tend to be higher (Ekblom, 1994). On the other hand, the mean values of VO_2 max of Indian national club footballers and Indian national footballers were comparatively less than European and Australian footballers

and well comparable with Croatian footballers. However, the maximal oxygen consumption of the present study was found to be higher in midfielders and significantly different among the players of different playing positions. Maximum oxygen uptake capacity does vary with specific field position, when such positional roles can be clearly differentiated. However, it was evident that when English League players were subdivided as per playing positions, the midfield players had significantly higher aerobic power than those of other positions. The defenders had lower value while the strikers had intermediate value (Reilly, 1975). Indeed the significant correlation between VO_2 max and distance covered in a game (r=0.67) demonstrates the need for a high work-rate in midfield players as they act as a link between defense and attack. The goalkeeper was found to have lower values even than the defenders. Four goalkeepers in the German National squad had average values of 56.2 (± 1.2) ml kg^{-1} min^{-1} as compared to 62.0 (±4.5) ml kg^{-1} min^{-1} for the squad as a whole (Hollmann *et al*., 1981). A study of 95 young non-professional soccer players found that goalkeeper had significantly lower VO_2 max values than the outfield players (Caru *et al*., 1970). The present study was also corroborated with the study of above authors that midfielder showed higher value and lowest value in goalkeeper.

It is clear from the above discussions not only the anthropometric measures but also the various motor abilities and physiological parameters were less in case of Indian national club footballers and as well as Indian national players. Genetic factors determine body size and also to some extent physiological qualities. Body size does bestow and advantage to the goalkeeper, center back and the forward. Usually strength, stamina, power and skills are important factors for success in football. However, the motor abilities and aerobic power are found to be poor in Indian footballers as compare their International counterparts. Although in this study the specific football skills are not performed but on the basis of specific motor qualities and maximum aerobic power it can be said that Indian footballers are lagging behind as compare to European, American and Australian footballers not only in success in wining the medal but also physical fitness.

So, it may be concluded that the less physical and physiological qualities of Indian soccer players as compare to their International counterparts may be due to genetic influence and also the difference among the players of various playing positions may be due to their activity in the game and difference in training regimen.

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REFERENCES

APOR, P. (1988). Successful formulae for fitness training. In T. Reilly; A. Lees; K. Davids & W.J. Murphy (Eds.), *Science and Football* (95-107). London: E & FN Spon.

ARMSTRONG, N. & WEISMAN, J.R. (1994). Assessment and interpretation of aerobic fitness in children and adolescents. In J.E. Holloszy (Ed.), *Exercise and Sport Science Review* (435-476). Philadelphia, PA: Williams & Wilkins Publications.

BALE, P. (1986). A review of the physique and performance qualities, characteristics of game players in specific positions on the field of play. *Journal of Sports Medicine and Physical Fitness*, 20: 109-121.

BELL, W. & RHODES, G. (1975). The morphological characteristics of the association football player. *Journal of Sports Medicine & Physical Fitness*, 20: 196-200.

BLUME, D.D. (1978). Zu einigen wesentlichen theoretischen Grundlagen für die Untersuchung der koordinativen Fahigkeiten. *Theorie und Praxis der Korperkultur*, 1: 29-36.

BOUCHARD, C.; SHEPHARD, R.J. & STEPHENS, T. (1994). *Physical activity, fitness, and health*. Champaign, IL: Human Kinetics.

CARU, B.; LECOULTRE, L.; AGHEMO, P. & PINERA, L.F. (1970). Maximal aerobic and anaerobic muscular power in football players. *Journal of Sports Medicine & Physical Fitness*, 10: 100-103.

CHATTERJEE, S. & CHAKROBORTY, B. (1986). Comparative study of maximal aerobic capacity by three ergometrics in untrained college women. *Japanese Journal of Physiology*, 36: 151-162.

DE ROSE, E.H. (1975). Determination of the ideal body weight and corporal composition of 16 professional soccer players. *Questions of athletes nutrition*: Abstract of the reports of the international symposium. Leningrad: Leningrad Institute of Physical Culture.

DOUGE, B. (1988). Football: the common threads between the games. In T. Reilly; A. Lees; K. Davids & W.J. Murphy (Eds.), *Science and Football* (3-19). London: E & FN Spon.

DURNIN, J.V.G.A. & WOMERSLEY, J. (1974). Body fat assessed from the total body density and its estimation from skinfold thickness measurements on 481 men and women aged 16-72 years. *British Journal of Nutrition*, 32: 77-97.

EKBLOM, B. (1994). Physiological profiles of the players. In B. Ekblom (Ed.), *Football soccer* (78-93). London: Blackwell Scientific Publications.

ESTON, R.G.; FU, F. & FUNG, L. (1995). Validity of conventional anthropometric techniques for predicting body composition in healthy Chinese adults. *British Journal of Sports Medicine*, 29(1): 52-56.

FAINA, M.; GALLOZZI, C.; LUPO, S.; COLI, R.; SASSI, R. & MARINI, C. (1988). Definition of the physiological profile of the soccer player. In T. Reilly; A. Lees; K. Davids & W.J. Murphy (Eds.), *Science and Football* (158-163). London: E & FN Spon.

HIRATA, K. (1966). Physique and age of Tokyo Olympic champions. *Journal of Sports Medicine & Physical Fitness*, 6: 207-222.

HOLLMANN, W.; LIESEN, H. & MADER, A. (1981). Zur Hochstund Dauerleistungsfahigkeit der Deutschen Fussball-Spitzenspieler (High endurance performance of German elite football players). *Deutsche Zeitschrift für Sportsmedizine*, 32: 113-120.

JOHNSON, B.L. & NELSON, J.K. (1988). *In practical measurements for evaluation in physical education* (3rd ed.) (2nd Indian reprint). New Delhi, India: Surjeet Publications.

KANSAL, D.K.; VERMA, S.K. & SIDHU, L.S. (1980a). Anthropometric characteristics of Indian university football players. *Journal of Sports Medicine & Physical Fitness*, 20(3): 275-284.

KANSAL, D.K.; VERMA, S.K. & SIDHU, L.S. (1980b). Introspective differences in maximum oxygen uptake and body composition of Indian players in hockey and football. *Journal of Sports Medicine & Physical Fitness*, 20(3): 309-316.

KIRBY, R.F. (1971). A simple test of agility. *Coach and athlete*, 25(6): 30-31.

KOLLATH, E. & QUADE, K. (1990). Measurement of sprinting speed of professional and amateur soccer players. In T. Reilly; J. Clayers & A. Stibbe (Eds.), *Science in football II* (31-36) (1st ed.). London: E & FN Spon.

LEGER, L.A.; MERCIER, D.; GADOURY, C. & LAMBERL, J. (1988). The multistage 20-meter shuttle run test for aerobic fitness. *Journal of Sports Science,* 6: 93-101.

MALKOVIC, B.R.; JANKOVIC, S. & HEIMER, S. (1994). Physiological profiles of top Croatian soccer players. In T. Reilly; J. Clayers & A. Stibbe (Eds.), *Science in football II* (37) (1st ed.). London: E & FN Spon.

MATTAUSCH, W.D. (1973). Zu einigen Problemen der begrifflichen Fixierung der konditionellen und koordinativen Fahigkeiten. *Theorie und Praxis der Körperkultur,* 22 (9): 849-856.

MEINEL, K. & SCHNABEL, G. (1976). *Bewegungelehre.* Berlin: Volk und Wissen Volkseigner Publications.

RAVEN, P.; GETTMAN, L.; POLLOCK, M. & COPPER, K. (1976). A physiological evaluation of professional soccer players. *British Journal of Sports Medicine,* 109: 209-216.

REEVES, S.L.; POH, B.K.; BROWN, M.; TIZZARD, N.H. & ISMAIL, M.N. (1999). Anthropometric measurements and body composition of English and Malaysian footballers. *Malaysian Journal of Nutrition*, 5: 79-86.

REID, R.M. & WILLIAMS, C. (1974). A concept of fitness and its measurement in relation to rugby football. *British Journal of Sports Medicine*, 8: 96-99.

REILLY, T. (1975). An ergonomic evaluation of occupational stress in professional football. Unpublished PhD dissertation. Liverpool: Liverpool Polytechnic.

REILLY, T. & THOMAS, V. (1976). A motion analysis of work-rate in different positional roles in professional football match play. *Journal of Human Movement Studies*, 2: 87-97.

REILLY, T. (1979). *What research tells the coach about soccer*. Washington, DC: AAHPERD.

REILLY, T.; SECHEI, N.; SNELL, P. & WILLIAMS, C. (1990). *Physiology of sports*. London: E & FN Spon.

REILLY, T. (1996). *Science and soccer*. London: E & FN Spon.

RÖSCH D.; HODGSON, R.; PETERSON, L.; GRAF-BAUMANN, T.; JUNGE, A.; CHOMIAK, J. & DVORAK, J. (2000). Assessment and evaluation of football performance. *American Journal of Sports Medicine*, 28: 29-39.

SIRI, W.E. (1961). Body composition from fluid spaces and density: analysis of methods. In J.A. Brojak (Ed.). *Technique for measuring body composition* (223-244). Washington, DC: National Academy of Science Nation Research Council.

SODHI, H.S. (1991). *Sports anthropometry (a kinanthropometric approach)*. Mohali, Chandigarh, India: ANOVA Publications.

THIESS, G. & SCHNABEL, G. (1987). *Leistungsfaktoren in Training und Wettkampf*. Berlin: Sportsverlag.

UPPAL, A.K. (1992). *Physical fitness - how to develop*. Delhi: Friends Publications.

VERDUCI, F.M. (1980). Measuring the health related physical fitness domain. In C.V. St Lowis (Ed.). *Measurement concept in Physical Education* (247-287.). St. Louis, IL: Mosby.

WHITE, J.E.; EMERY, T.M.; KANE, J.L.; GROVES, R. & RISHMAN, A.B. (1988). Pre-season fitness profiles of professional soccer players. In T. Reilly; A. Lecs; K. Davids & W.J. Murphy (Eds.). *Science and Football* (164-171). London: E & F.N. Spon.

WILLIAMS, G.; REID, R.M. & COUTTS, R. (1973). Observations on the aerobic power of university rugby players and professional soccer players. *Brittish Journal of Sports Medicine*, 7: 390.

WILMORE, J.H. & HASKEL, W.L. (1972). Body composition and endurance capacity of professional football players. *Journal of Applied Physiology*, 33: 564-567.

WITHERS, R.T.; ROBERTS, R.G.D. & DAVIS, G.J. (1977). The maximal aerobic power, anaerobic power and body compositions of South Australian male representatives in athletics, basketball, field hockey and soccer. *Journal of Sports Medicine & Physical Fitness*, 17(4): 391-400.

WORLD HEALTH ORGANIZATION (WHO) (1995). *The use and interpretation of anthropometry*. Geneva, Switzerland: WHO Technical Report Series Publications.

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BIOMECHANICAL, ANTHROPOMETRICAL AND PHYSICAL PROFILE OF ELITE UNIVERSITY NETBALL PLAYERS AND THE RELATIONSHIP TO MUSCULOSKELETAL INJURIES

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ABSTRACT

Literature indicates that deficiencies of certain parameters such as biomechanics, anthropometry, physical and motor abilities, may influence a netball players susceptibility to injury, as well as the players physical performance during a game. The primary aim of this study was to determine the physical profile of elite netball players from the North-West University club, between 18 and 25 years old, with reference to the biomechanical, anthropometrical, physical and motor abilities (balance, agility and explosive power). The secondary aim was to identify shortcomings in the physical profile of netball payers that could contribute to musculoskeletal injuries among players. The results reveal numerous biomechanical deviations among the netball payers during the first and second testing procedures. With regard to anthropometry, the group presented an ideal body mass index, but with an above-average fat percentage. A comparison of the incidences of injury among the players indicated that players with more biomechanical stressors showed more injuries during the season.

Key Words: Elite Netball Players; Biomechanical; Anthropometric; Physical; Profile; Musculoskeletal Injuries.

INTRODUCTION

Netball is a physically demanding game and is associated with traumatic and overuse injuries, and therefore associated with high injury incidences (Eggar, 1990; Hopper, 1986: 231-239). Literature indicates that deficiencies of certain parameters such as biomechanics, anthropometry and physical/motor abilities (agility, balance and explosive power) could influence a netball player's susceptibility to injury, as well as the player's physical performance during a game (Fuller & Drawer, 2004: 349-356; Rossouw & Rossouw, 2003: 52-54; Trojian & McKeag, 2006: 610-613). For the purpose of this study the definition by (Neely, 1998: 395-413) for biomechanics will be used, i.e. "good biomechanics as near symmetry, good dynamic mobility and core stability of the human body". It is therefore essential to identify these shortcomings prior to the start of the netball season by means of assessment procedures. Netball is played in South Africa on a regular basis in schools, clubs and at regional level. There are half a million netball players at school level in South Africa and 9700 adult players (Venter *et al.*, 2005: 3-7). Upon re-admission of South Africa in

international sport in 1994 it became apparent that South African sports teams lacked specialised coaching, sport-specific skills, essential physique (i.e. body composition) and

fitness skills that characterise elite sport (Venter *et al.*, 2005: 3-7). Optimal performance in netball relies on the interaction of several factors, including physical conditioning and technique. Venter *et al.* (2005: 3-7) emphasise that more comprehensive studies must be conducted to obtain normative data. Further research is not only essential to develop the game of netball at all levels in South Africa, but also to gain information in terms of injury rates and injury costs or financial implications. The primary aim of this study was to determine the physical profiles of elite netball players from the North-West University (NWU) Netball Club, aged between 18 and 23 years, with reference to the biomechanics, anthropometric measurements and physical/motor abilities (balance, agility and explosive power). The secondary aim was to identify shortcomings in the physical profiles (biomechanical variables, anthropometrical components and physical/motor abilities) of the netball players that could contribute to musculoskeletal injuries among these players. This study was the first attempt to provide normative data on provincial-level netball players at the North-West University.

METHOD

Elite female netball players from the first, second, third, fourth and the u/19 A and B teams of the North-West University Netball Club participated in this study. Elite players in this study refer to first team players at the different age groups at the North-West University. Forty players were tested during testing occasion one and twenty five players were tested during testing occasion two. A shortcoming in the method of this study was the fact that only 25 players were available for the testing occasion two. This was due to injuries and other dropout factors. The players were tested pre-season in March 2007 and post-season during August 2007. The biomechanical tests were conducted by applying an approach that measures a combination of symmetry, dynamic mobility and local stability of the body for the biomechanical assessment (Hattingh, 2003). This biomechanical assessment protocol evaluated different zones, namely limb-pelvic region, hip girdle, lower limb (knee and foot) and neurodynamics. Since literature reveals that these areas are the most susceptible to injury in Netball, the researchers decided to focus on these areas (Hass *et al.*, 2005: 100-107; Hattingh, 2003). Range of movement was graded as 1, 2 or 3. In most cases 1 means ideal, 2 non-ideal and 3 highly unsatisfactory. Detail for biomechanical analysis or deviations can be found in Ferreira (2007). For the anthropometric measurements, three standardised variables were used: body fat percentage by means of 6 skin fold measurements, stature by means of a tape measure, and body mass by means of a calibrated scale (Ross & Marfell-Jones, 1991: 223-308). Physical/motor abilities, including agility, balance and explosive power, were determined. The battery of tests used are: the Illinois agility run test (Kirby, 1991) for agility; the computerised balance test (Techno Therapy, 1992) for balance, and the vertical jump for explosive power, measured by means of a tape-switch sensory mat connected to a Psion organiser (Boscosystem Ergojump, 2007). A clinic, performed by physiotherapists, was held for injured players every Monday and this made it possible to monitor the injuries during the season. The clinic offered a diagnostic evaluation and advice, as well as a referral to a doctor or physiotherapist for treatment, when necessary. The definition for injuries, as described by Garraway and Macleod (1995: 1485-1487) was used in this study, i.e. an injury sustained on the field during a competitive match or during training, or during other active training directly playing or training from the time of injury or from the end of the match on training session in which the injury sustained. The injury report form that was completed include: mechanism of

injury, diagnoses of injury, severity of injury, type of injury, time off from training,

recommended treatment, revisit of player, etc. The training programme that was followed between test procedures 1 and 2, and that was conducted by an ex-national coach, concentrated on agility, balance, explosive power, pliometrics and speed endurance. Detail of the programme is available from the authors. A statistical analysis was done on all the data collected from the test batteries and injury clinics. Descriptive statistics (means, standard deviations, minimum and maximum values) were used as well as practically significant differences (d-values and p-values) (Ellis & Steyn, 2003: 51-53).

RESULTS AND DISCUSSION

TABLE 1: **CHANGES IN BIOMECHANICAL DATA FROM TEST ONE TO TEST TWO FOR THE TOTAL GROUP FOR SIGNIFICANT DIFFERENCES IN PERFORMANCE (N = 25)**

TEST VARIABLES	$\overline{X}_1$	$\overline{X}_2$	$\overline{X}_2 -$	Sd	p	d
BIOMECHANICS						
LOWER LIMB REGION:						
Achilles tendon suppleness test	1.2173	1.1304	-0.0869	-0.1689	0.4264	0.2061
Iliotibial band mobility test (ITB)	1.6251	1.8260	0.1739	0.3018	0.1618	0.3036
Quadriceps mobility	1.4347	1.7391	0.3043	0.5446	0.0159*	0.6004
Iliopsoas mobility	1.7826	1.7391	-0.0434	-0.0566	0.7883	0.0590
Gluteus maximus mobility test	1.4782	1.4347	-0.0434	-0.0773	0.7143	0.0733
Adductor mobility test	1.1304	1.0434	-0.0869	-0.3018	0.1618	0.2525
Internal rotation mobility test	1.0000	1.0000	0.0000	0.0000	-	0.0000
External rotation mobility test	1.5652	1.3043	-0.2608	-0.4823	0.0304*	0.4423
Q-angle test	1.1428	1.1428	0.0000	0.0000	-	0.0000
Patella squint test	1.1428	1.1428	0.0000	0.0000	-	0.0000
Patella tilt test	1.6666	1.6666	0.0000	0.0000	-	0.0000
Patella height test	1.9047	1.9047	0.0000	0.0000	-	0.0000
VMO – L comparison test	1.2380	1.2380	0.0000	0.0000	-	0.0000
Longitudinal arch status test	1.7619	1.7619	0.0000	0.0000	-	0.0000
Fore foot positional test	1.1904	1.1904	0.0000	0.0000	-	0.0000
Rear foot positional standing test	1.2857	1.2857	0.0000	0.0000	-	0.0000
Rear foot lying test	1.3333	1.3333	0.0000	0.0000	-	0.0000
Transverse arch area comparison test	2.0000	2.0000	0.0000	0.0000	-	0.0000
Foot mobility test	1.8095	1.8095	0.0000	0.0000	-	0.0000
Toe positional test	1.9047	1.9047	0.0000	0.0000	-	0.0000
PELVIC GIRDLE REGION:						
Leg length discrepancy test	1.7619	1.8095	0.0476	0.2182	0.3292	0.1091
ASIS comparison test	1.7619	1.8095	0.0476	0.2182	0.3292	1.1091*

PSIS comparison test	1.7619	1.8095	0.0476	0.2182	0.3292	1.1091*
Pelvic rami positional test	1.7619	1.8095	0.0476	0.2182	0.3292	1.1091*
Sacroiliac cleft test	1.0476	1.0476	0.0000	0.0000	-	0.0000
Bilateral pelvis positional test	1.8571	1.8571	0.0000	0.0000	-	0.0000
SPINAL REGION:						
Thoraco-lumbar fascia	1.2857	1.2380	-0.0476	-0.2182	0.3292	0.1028
Sacral rhythm test	1.0000	1.0000	0.0000	0.0000	-	0.0000
Functional extension mobility test	1.4285	1.2380	0.0952	0.1524	0.4929	0.2656
Functional flexion test	1.3333	1.4285	0.0952	0.1767	0.4275	0.1971
Rotational mobility test	1.4285	1.1428	0.0476	0.0956	0.6657	0.1583
Side flexion mobility test	1.0476	1.0000	-0.0476	-0.2182	0.3292	0.2182
Head positional	1.0000	1.0000	0.0000	0.0000	-	0.0000
Cervical	1.0000	1.0000	0.0000	0.0000	-	0.0000
Thoracic	1.1904	1.1904	0.0000	0.0000	-	0.0000
Lumbar	2.0000	1.9523	-0.0476	-0.1239	0.5763	0.1505
NEURODYNAMICS						
Straight leg raise (SLR)	1.2380	1.8095	0.5714	0.9561	0.0002*	1.3093*
Prone knee bend test (PKB)	1.2380	1.2380	0.0000	0.0000	-	0.0000

$$d = \frac{\left|\bar{X}_1 - \bar{X}_2\right|}{s}$$

max

= effect size for difference between means; a measurement of practical significance

$p \leq 0.05$	$d \geq 0.2$ (small effect)
$d \geq 0.5$ (medium effect)	$d \geq 0.8$ (large effect)
$\overline{x}_1$ = mean value (test 1)	* = Large significant *intra-group*
$\overline{x}_2$ = mean value (test 2)	difference between testing episodes

Table 1 presents the comparison of the biomechanical results of the pre- (test one) and post-season testing occasion (test two) for the total group of elite NWU netball players. The reason for the comparison is to determine whether biomechanical changes occurred during the netball season. In the *lower limb region* only two practical significant differences ($p \leq 0.05$; $d \geq 0.8$) were identified. The first one was with the quadriceps mobility test ($p = 0.0159$), which indicated that the flexibility of the quadriceps for the total group decreased significantly during the season, with a medium effect size ($d = 0.6004$). The second practical significant difference ($p \leq 0.05$; $d \geq 0.8$) occurred with the external rotation mobility test ($p=0.0304$), which identified that the external rotation mobility improved during the course of the netball season, but the difference was small compared to the d-value of 0.4423.

In the *pelvic girdle region* high practically significant differences ($p \leq 0.05$; $d \geq 0.8$) were found in the ASIS comparison, PSIS comparison, and the pelvic rami positional tests. All three tests rendered the same value ($d = 1.1091$), which means that the asymmetries at the ASIS, PSIS and the pelvic ramis increased during the season. These pelvic asymmetries place more strain on the pelvic girdle of the players. No significant differences were identified in the *spinal region*. In the neurodynamics category, the SLR test found significant differences ($p = 0.0002$; $d = 1.3093$), which means that the *neurodynamics* of the players deteriorated

during the season. In conclusion, only five significant biomechanical differences among the total group occurred during the season. The reason for this could be the fact that every netball player has a unique mechanical make-up due to structural characteristics, and in the absence of a specific conditioning programme concentrating to maintain the player's joint symmetry, flexibility, core stability and biomechanics will not alter during a season (Brukner & Khan, 2007). No other literature offered an explanation for these few biomechanical changes during the season. The practical significant differences which did occur were with regard to the quadriceps mobility; external mobility; ASIS comparison; PSIS comparison; and the pelvic rami positional tests.

TABLE 2: **CHANGES IN ANTHROPOMETRY AND PHYSICAL/MOTOR DATA FROM TEST ONE TO TEST TWO FOR THE TOTAL GROUP FOR SIGNIFICANT DIFFERENCES IN PERFORMANCE (N = 25)**

TEST VARIABLES	$\overline{x}_1$	$\overline{x}_2$	$\overline{x}_2 -$	Sd	p	d
ANTHROPOMETRY:						
Weight (kg)	68.2000	70.7200	2.5200	1.0209	0.00003*	0.2293
Height (m)	1.7460	1.7456	-0.0004	-0.0331	0.8697	0.0045
Body mass index (BMI)	22.3720	23.0720	0.7000	0.6052	0.0058*	0.3033
Fat percentage (%)	26.6172	27.5568	0.9396	0.4345	0.0399*	0.4372
SKINFOLDS:						

Tricep	16.9760	17.0120	0.0360	0.0102	0.9594	0.0104
Subscapular	11.6240	12.9560	1.3320	0.4261	0.0435*	0.5093
Supraspinal	14.1160	14.8640	0.7480	0.2303	0.2608	0.2191
Abdominal	20.8120	20.8560	0.0440	0.0110	0.9563	0.0143
Thigh	22.9920	29.0120	6.0200	1.0644	0.00001*	1.0644*
Calf	17.0240	15.7160	-1.3080	-0.4977	0.0201*	0.3973
PHYSICAL/MOTOR ABILITIES:						
Agility (sec)	19.4428	18.9476	-0.4952	-1.1890	0.00002*	0.7181
Balance (%)	69.3136	81.8681	12.5545	1.3027	0.000005*	1.0936*
Explosive power	33.7391	28.6087	-5.1304	-1.2851	0.000003*	1.0693*

$$d = \frac{|\bar{X}_1 - \bar{X}_2|}{s}$$

max

= effect size for difference between means; a measurement of practical significance

$p \leq 0.05$	$d \geq 0.2$ (small effect)
$d \geq 0.5$ (medium effect)	$d \geq 0.8$ (large effect)
$\overline{x}_1$ = mean value (test 1)	* = Large significant *intra-group*
$\overline{x}_2$ = mean value (test 2)	difference between testing episodes

The *anthropometry* results are summarised in table 2. Significant differences occurred with regard to the weight, BMI, fat percentage, and subscapular, thigh and calf skinfold measurements. The weight of the total group ($p = 0.00003$) as well as the BMI ($p = 0.0058$) and fat percentage ($p = 0.0399$) increased significantly, although practical significant differences only indicated small effects ($d \geq 0.2$). Their subcutaneous fat increased practically significant especially in the subscapular ($p = 0.0435$), thigh ($p = 0.00001$; $d = 1.0644$) and calf ($p = 0.0201$) areas. Literature do not explain the increases in weight, BMI, fat percentage and skinfold measurements, but possible reasons for these increases could be, firstly, that the conditioning programme did not include adequate exercise routines during the season to increase their muscle mass and reduce their fat percentages, and secondly, that the second tests occurred three weeks into the players' off-season, meaning that for three weeks prior to the tests they did not train. Thus, significant increases occurred with regard to the weight, BMI, fat percentage, and the subscapular, thigh and calf skinfold measurements among the total group of netball players. No explanations for these increases could be found in literature. This occurrence could be an indication that the training program did not include adequate exercises during the season to improve muscle tissue and decrease body fat. Diet could also play a role; however, diet was not monitored as a parameter in this particular study.

The data of the *physical/motor abilities* for the total group is provided in table 2. Significant differences ($p \leq 0.05$; $d \geq 0.8$) were identified with all three motor tests (agility, balance and explosive power). The agility ($p = 0.00002$) and the balancing abilities ($p = 0.000005$; $d=1.0936$) of the total group improved significantly. However, a significant decrease in performance was identified with the explosive power test ($p = 0.000003$, $d = 1.0693$).

According to literature, the physical/motor abilities (agility, balance and explosive power) of a netball player could be enhanced during the netball season with the correct exercises (Baltaci & Kohl, 2003: 5-16; Clark & Burden, 2005: 181-187; Swanik & Swanik, 1999: 16-22; Verhagen *et al.*, 2004: 1385-1393). However, literature did not explain the decrease in performance with explosive power. One possible reason for the decrease in explosive power could be that the conditioning programme did not include adequate plyometric exercises to improve the netball players' explosive power.

TABLE 3: **DESCRIPTIVE STATISTICS OF INJURY EPIDEMIOLOGY AMONG THE TOTAL GROUP OF NETBALL PLAYERS (N = 25)**

Injury incidence	**%**
1. Severity of injury:	
Grade I	34.78
Grade II	56.52
Grade III	8.69

2. Body part:	
Ankle	39.13
Knee	28.26
Cervical	8.69
3. Mechanism of injury:	
Incorrect landing	52.17
No incident	34.78
Fall incident	4.34

The secondary aim of this study was to identify the shortcomings of the physical profiles (biomechanical variables, anthropometrical components and motor abilities) of the netball players that could contribute to musculoskeletal injuries. The study also explored the occurrence of injuries, the mostly affected body parts, as well as the mechanisms of injuries.

The statistics on injuries are discussed under three sections, namely the severity of the injury (grade of injury); the body part mostly affected; and the mechanism of injury (see table 3). Of the 46 injuries that occurred during the season, 34.78% were classified as Grade I (minor) injuries, while 56.52% were categorised as Grade II (moderately serious) and 8.69% as Grade III (serious) injuries (Van Mechelen *et al.*, 1992: 82-99). The majority of these injuries were classified as moderately serious, meaning that the injured players were unable to return to netball (training and games) for 8-21 days.

The body parts mostly affected by injuries were the ankle joint (39.13%), followed by the knee joint (28.26%) and thirdly the cervical region (8.69%). Similar findings were found in literature, i.e. the joints mostly affected by traumatic injuries in netball are the ankle and knee joint. In a study conducted by Hopper (1986: 231-239) on Australian netball players, the incidence of injury revealed that 58.2% of injuries occurred at the ankle; 15.2% at the knee; 13.3% at the hand and 13.3% at other parts of the body. A study conducted by Steele (1990: 88-102) on lower limb and back injury patterns of elite netball players reported 30.2% ankle injuries, followed by 15.9% shin/calf injuries. These findings were similar to the results of a one day veterans' netball tournament, where 29.6% of players presented with ankle injuries and 13.6% complained of leg/calf problems (Steele, 1990: 88-102). According to Hopper (1986: 231-239) the ankle, knee and hand are the most common sites to be injured. Various studies conclude that statistically the ankle and knee joints are the most susceptible to injury (Hopper *et al.*, 1995a; Trojian & McKeag, 2006: 610-613).

The most common mechanism of injury was incorrect landing technique (52.17%). A fall incident was reported as the mechanism of injury with 4.34% of the injuries. The existing literature correlated with these data. Incorrect landing (73.8%), a slip or a fall (74.2%) was the main causes of injuries with a study conducted by Hopper (1986). A similar incidence of perceived reason for injury was recorded for contact with another player (29%), and incorrect landing (29%) followed by a slip, trip or sudden stop (21%) (Hopper *et al.*, 1995b: 223-228). With some of the injuries (34.78%), the players could not report a specific traumatic incident that caused the injury, meaning that the origin of these injuries could be due to overuse. The existing literature correlates with these data. Overuse injuries are defined as injuries to a body part of an athlete or individual where no trauma was involved (Brukner & Khan, 2007).

Incorrect biomechanics is considered as a potential cause of overuse injuries (Arnheim & Prentice, 2008; Bell-Jenje & Bourne, 2003; Brukner & Khan, 2007; Fuller & Drawer, 2004:

349-356; Hopper & Elliot, 1993: 148-162; Kendall *et al.*, 1993; Rossouw & Rossouw, 2003: 52-54). Hopper and Elliot (1993: 148-162) conducted a study on the relations between lower limb and back injuries with perceived landing patterns and podiatric variables for injured and uninjured elite netball players. More than 25% of the 240 participants in that study had overuse type injuries. These injuries involved retropatellar pain (24%) and shin pain (38%) (Hopper & Elliot, 1993: 148-162). Ninety two percent of the 228 participants were given a podiatric assessment. The study found that 22.5% of the players were cleared as "normal" and

an astonishing 42.1% of the players presented with rear foot varus with compensating subtalar pronation. Excessive pronation may produce an unstable forefoot; therefore the netball player could be susceptible to an ankle sprain (Donatelli, 1990). Interestingly, during this study the pre-season testing procedure identified that 74% and 69% of the participants presented with rear foot pronation with the rear foot standing and lying tests respectively. With the post-seasonal tests, of this study, this tendency (rear foot pronation) occurred in 80% and 76% of the participants with the same tests (rear foot standing and lying tests). In other words, a large number of the netball players presented with rear foot pronation, which is considered a biomechanical deviation. Rear foot pronation could contribute to the occurrence of overuse injuries such as sesamoiditis; plantar fasciitis; Achilles tendinopathy; Peroneal tendinopathy; medial shin pain; patellar tendinopathy; patellofemoral syndrome; metatarsal stress fracture and navicular stress fracture. This biomechanical stressor (rear foot pronation) could have been the cause of a number of the overuse injuries which occurred during the season among the netball players participating in this study. These overuse injuries included injuries such as, patellofemoral syndrome; medial shin pain; groin and popliteus strains; lumbar facet joint impactions; and navicular ligament strain.

To conclude, the NWU club elite netball players showed a higher injury incidence than previous studies on netball injuries. A relation may exist between the high injury incidence and the numerous biomechanical deviations, poor anthropometry and inadequate motor abilities (average agility and balance and unacceptable explosive power) which were detected among these players. Most of the recorded injuries were moderately serious injuries, while the body part mostly affected was the ankle joint, with incorrect landing technique as the most common mechanism of injury.

CONCLUSIONS AND RECOMMENDATIONS

The physical profiles of club netball players from the NWU (aged between 18 and 23 years) with reference to their biomechanics, anthropometric measurements and physical/motor abilities (agility, balance and explosive power) were documented in order to address the primary aim of this study. Shortcomings in the physical profile of netball players that may contribute to musculoskeletal injuries were also investigated. Reasons for the high injury rate among the total group may be the results of biomechanical deviations, as well as poor anthropometry and relatively average physical/motor abilities. The average BMI of the group was considered ideal, with an unacceptable above-average fat percentage. The total group reported average agility and explosive power abilities for the physical/motor tests during the first testing occasion, but with poor balance. During the second testing occasion, the averages for agility and balance were considered acceptable, but the explosive power abilities were below average. These inadequate physical/motor abilities may have contributed to the netball players' injuries. Alterations or shortcomings with regard to any of these parameters (biomechanics, anthropometry and physical/motor abilities) could make netball players more

susceptible to traumatic and overuse injuries. It can thus be concluded that Netball players with more biomechanical deviations sustain more injuries. Shortcomings in the netball players' physical profile (biomechanical, anthropometry and physical/motor abilities), that may have contributed to the occurrences of musculoskeletal injuries, were identified.

It is recommended that prior to and during the netball season, coaches should facilitate "screening" procedures during which the physical profile of every netball player is determined. This should involve a biomechanical analysis, anthropometrical assessment and physical/motor tests (agility, balance and explosive power). The multidisciplinary team should apply testing protocols to address their needs; they could apply the same tests performed in this study, or use tests from other applicable studies (Elphinston & Hardman, 2006: 169-176; Venter *et al.*, 2005: 3-7; Young *et al.*, 2002: 282-288). These "screening" procedures should include parameters which are essential for a netball player to perform best during a game and to decrease her probability for injuries. The results of these "screening" procedures may also be compared to the data of this study.

The main shortcoming of this study is that the post-season testing of many players did not realise due to unforeseen circumstances. This negatively affected the data of the second testing occasion. The participation of an identical group in testing procedures one and two could have presented more reliable results. More attention should be paid to the communication between researchers, individual coaches and players regarding test dates and player commitment. However, the physical profile that was presented after tests procedures can be used by coaches as a norm for the profile of talented netball players as tested in this study. On the other hand, the results of test procedure 2 give a good indication of what has happened to the physical profile of players during the season, as well as the effect of injuries, despite the decrease in numbers that was tested.

REFERENCES

ARNHEIM, D.D. & PRENTICE, W.E. (2008). *Principles of athletic training.* Singapore: McGraw-Hill.

BALTACI, G. & KOHL, H.W. (2003). Does proprioceptive training during knee and ankle rehabilitation improve outcome? *Physical Therapy Review*, 8: 5-16.

BELL-JENJE, T. & BOURNE, C. (2003). "Going global" – clinically applied postural analysis and biomechanics. Handout provided at a course on the lower quadrant. Johannesburg: High Tech Therapy.

BOSCOSYSTEM ERGOJUMP (2007). *Switch sensory mat and psion organiser*. Hyperlink [www.boscosystem.com]. Retrieved 7 April 2007.

BRUKNER, P. & KHAN, K. (2007). *Clinical sport medicine.* Sydney: McGraw-Hill.

CLARK, V.M. & BURDEN, A.M. (2005). A 4-week wobble board exercise programme improved muscle onset latency and perceived stability in individuals with functionally unstable ankle. *Physical Therapy in Sport,* 6: 181-187.

DONATELLI, R. (1990). *The biomechanics of the foot and ankle.* Philadelphia, PA: FA Davis.

EGGAR, G. (1990). Sports injuries in Australia: causes, costs and prevention: a report to the National Better Health Program. Sydney: Centre for Health Promotion and Research.

ELLIS, S.M. & STEYN, H.S. (2003). Practical significance (effect sizes) versus or in combination with statistical significant (p-values). *Management Dynamics,* 12(4): 51-53.

ELPHINSTON, J. & HARDMAN, S.L. (2006). Effect of an integrated functional stability program on injury rates in an international netball squad. *Journal of Science and Medicine in Sport,* 9: 169-176.

FERREIRA, M.A. (2007). Biomechanical, anthropometrical and physical profile of the North-West University Club netball players and the relationship to musculoskeletal injuries. Unpublished MEd thesis in Movement Education. Potchefstroom: North-West University.

FULLER, C. & DRAWER, S. (2004). The application of risk management in sport. *Sports Medicine,* 34(6): 349-356.

GARRAWAY, M. & MACLEOD, D. (1995). Epidemiology of rugby football injuries. *Lancet,* 345(8963): 1485-1487.

HASS, C.J.; SCHICK, E.A.; TILLMAN, M.D.; CHOW, J.W.; BRUNT, D. & CAURAUGH, J.H. (2005). Knee biomechanics during landing: comparing of pre- and postpubescent females. *Medicine and Science in Sport & Exercise,* 37(1): 100-107.

HATTINGH, J.H.B. (2003). A prevention programme for rugby injuries based on an analysis among adolescent players. Unpublished PhD thesis. Potchefstroom: Potchefstroom University for Christian Higher Education.

HOPPER, D. (1986). A survey of netball injuries and conditions related to these injuries. *Australian Journal of Physiotheraphy,* 32(4): 231-239.

HOPPER, D. & ELLIOT, B. (1993). Lower limb and back injury patterns of elite netball players. *Sports Medicine,* 16(2): 148-162.

HOPPER, D.; ELLIOT, B. & LALOR, J. (1995a). Survey of netball injuries at the Matthews Netball Centre in Western Australia. *Australian Sports Medicine Federation Conference Proceedings.* Canberra: Australian Sports Medicine Federation.

HOPPER, D.; ELLIOT, B. & LALOR, J. (1995b). A descriptive epidemiology of netball injuries during competition: a five year study. *British Journal of Sports Medicine,* 29(4): 223-228.

KENDALL, F.P.; MCCREARY, E.K. & PROVANCE, P.G. (1993). *Muscles: testing and function.* Baltimore, MD: Williams & Wilkins.

KIRBY, R.F. (1991). *Kirby's guide to fitness and motor performance tests.* Cape Girardeau: Mo Ben Oak.

NEELY, F.G. (1998). Biomechanical risk factors for exercise-related lower limb injuries. *Sports Medicine,* 26: 395-413.

ROSS, W.D. & MARFELL-JONES, M.J. (1991). Kinanthropometry. In J.D. McDougall, H.A. Wenger & H.J. Green (Eds.), *Physiological testing of the high performance athlete* (223-308). Champaign, IL: Human Kinetics.

ROSSOUW, J. & ROSSOUW, R. (2003). Injury prevention in sport and exercise. *South African Journal of Natural Medicine,* 11: 52-54.

STEELE, J.R. (1990). Biomechanical factors affecting performance in netball. *Sports Medicine,* 10(2): 88-102.

SWANIK, C.B. & SWANIK, K.A. (1999). Plyometrics in rehabilitating the lower extremity. *Athletic Therapy Today,* 4(3): 16-22.

TECHNO THERAPY (1992). Computerised Balance Test Manual. Patent 92/6117. *Techno Therapy.*

TROJIAN, T.H. & McKEAG, D.B. (2006). Single leg balance test to identify risk of ankle sprains. *British Journal of Sports Medicine,* 40: 610-613.

VAN MECHELEN, W.; HLOBIL, H. & KEMPER, H.C.G. (1992). Incidence, severity, aetiology and prevention of sport injuries. *Sports Medicine,* 14(2): 82-99.

VENTER, R.E.; FOURIE, L.; FERREIRA, S. & TERBLANCE, E. (2005). *South African Journal of Sports Medicine,* 17(2): 3-7.

VERHAGEN, E.; VAN DER BEEK, A.; TWISK, J.; BOUTER, L.; BAHR, R. & VAN MECHELEN,

W. (2004). The effect of a propioceptive balance bord training program for the prevention of ankle sprains. *The American Journal of Sports Medicine*, 32: 1385-1393.

YOUNG, W.B.; JAMES, R. & MONTGOMERY, I. (2002).Is muscle power related to running speed with changes of direction? *Journal of Sports Medicine and Physical Fitness*, 42: 282-288.

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PSYCHOLOGICAL SKILLS OF SENIOR SOUTH AFRICAN RUGBY PLAYERS

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ABSTRACT

The objective of this study was to investigate the interaction between the prior experience, cognitive perceptions and psychological skills of senior rugby players in South Africa. The study population included 139 trans-national players, 106 provincial players and 95 club rugby players (N=340). A cross-sectional design was used to assess the players' psychological skills by means of the Athletic Coping Skills Inventory-28 (ACSI-28). Players' prior experience and cognitive perceptions were determined by means of a biographical questionnaire. Different biographical variables appeared to distinguish between the groups with respectively high and low levels of psychological skills on the different levels of rugby. The players' perceptions regarding their own abilities to optimally prepare themselves psychologically before a game appeared to be the only common denominator differentiating between the groups with high and low levels of psychological skills. A combination of perceptions and prior experience explained 44.81% of the variance in the psychological skills (ACSI-28 total) of the club rugby players, 9% of the variance on provincial level and 21.3% of the variance on trans-national level. There appeared to be significant interaction between prior sport experience, certain cognitive perceptions and the psychological skills of the rugby players involved in this study. Cognitive psychological intervention could therefore play an important part in the psychological preparation of senior rugby players in South Africa.

Key words: Psychological skills; Cognitive perceptions; Prior experience; Rugby.

INTRODUCTION

Recent research reported significant differences between the psychological skills of senior elite and club rugby players in South Africa (Kruger, 2005b). The rugby players with high levels of psychological skills were also reported to experience less cognitive and somatic anxiety in challenging circumstances than players with low levels of psychological skills (Kruger, 2005c). It is apparent that psychological skills play an important role in players' ability to cope with the demanding competitive environment in elite rugby. A number of researchers are in accord that high levels of psychological skills lead to better sports performance (e.g., Martens, 1987; Smith *et al*., 1995; Hodge & McKenzie, 1999; Lazarus, 2000; Hale & Collins, 2002). The reasons why athletes differ in the level of psychological

skills that they develop have however not been extensively researched. This necessitated an investigation into the factors that might contribute to the development of, or could have an influence on the utilization of psychological skills of senior rugby players in South Africa.

INFLUENCING FACTORS

Lazarus (2000) pointed out that in the highly competitive environment of professional sport, a variety of factors such as psychological skills, state anxiety, perceptions, life transitions and environmental factors can play a very significant role in athletes' performances. Kruger (2005a) argued that the coping model as suggested by Moos and Schaefer (1993) can provisionally be used to conceptualize and integrate a number of these seemingly unrelated factors that could influence athletes' performance in their highly competitive environment. This model (figure 1) suggests that environmental factors (panel 1), personal factors (panel 2) and event-related factors (panel 3) can influence a person's general health and well-being (panel 5), often through the mediating role of their cognitive appraisal of the situation and resultant coping responses that they employ (panel 4). It thus seems that, among other factors, cognitive appraisal plays an important part in a person's ability to adapt to trying circumstances. It is important to briefly focus on the important role that cognitive appraisal plays in sport.

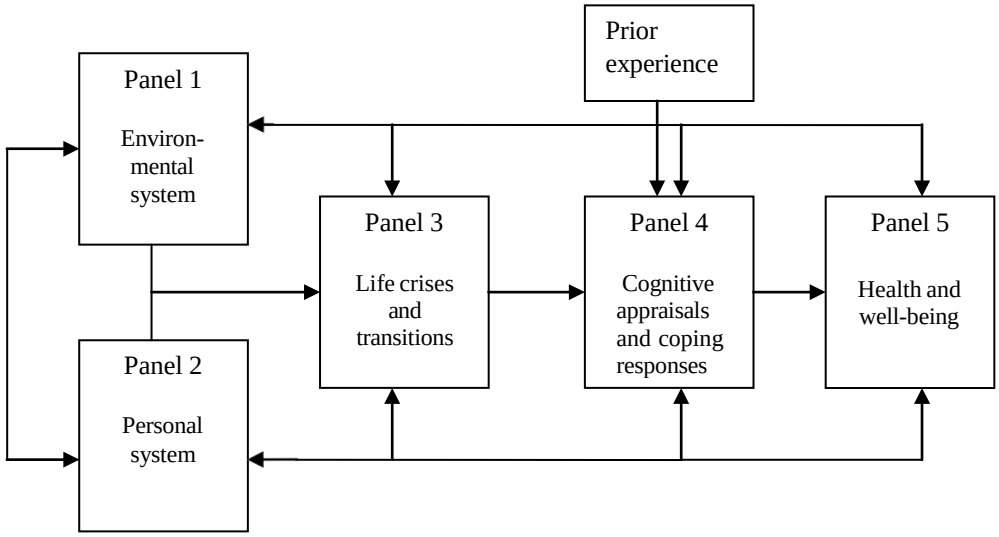

FIGURE 1. **THE INTERACTION BETWEEN THE PANEL OF THE GENERAL CONCEPTUAL MODEL OF THE COPING PROCESS THAT WERE INVESTIGATED, PRIOR EXPERIENCE INDICATED AS AN ADDITIONAL DIMENSION** (Moos & Schaefer, 1993)

Peoples' cognitive appraisal or evaluation of a specific situation or event will cause them to form a certain cognitive perception of that specific situation (Corey, 2001). One's cognitive *appraisal* of a situation is thus the first step in forming a cognitive *perception*. This cognitive perception can, in turn, be instrumental in determining the type of coping response that an individual will employ (Moos & Schaefer, 1993). The reciprocal interaction that exists between the different groups of factors in this model suggests that personal factors (such as

psychological skills) can have an influence on the cognitive perceptions that athletes experience. However, cognitive perceptions could also influence the psychological skills that the athletes possess and the way in which these skills are applied (as illustrated by the bidirectional pathways in figure 1).

The influence of prior experience on cognitive perceptions

A number of researchers are in accord that sport-specific cognitive perceptions are the result of athletes' prior experience in their specific sports (Lazarus, 2000; Salvador, 2005). These authors conclude that prior sport experience will be instrumental in developing athletes' perceptions of their abilities to perform. Lazarus (2000) postulates that athletes' "performance history" will be responsible for the realistic or unrealistic expectations of performing well in any given competition. This "performance history" is often reflected in athletes' current rankings, and influences their cognitive perceptions of their own as well as their opponents' abilities. The influence that an athletes' prior experience might have on his/her cognitive perceptions, can potentially play a vital role in determining their performance in competitive situations (Lazarus, 2000).

Salvador (2005) found that coping in competitive situations will depend on factors such as perceived possibilities of control over success. According to this author, these perceptions of the possibility of achieving success are created by prior experience in similar competitions or the rank of the opponent, among others. Other researchers have confirmed that the strongest predictor of sport-specific self-confidence is the abilities that the individual believe that he or she has, and that it depends strongly on the individual's prior experience in similar situations (Gould *et al*., 1984; Hall *et al*., 1998; Humara, 1999). Self-confidence thus appears to stem from prior experiences. Self-confidence, however, is also known to have an influence on a number of psychological skills that an athlete could possess and apply (Hodge & MacKenzie, 2002, Weinberg & Gould, 2003). It is therefore, reasonable to argue that prior experience could have a substantial influence on athletes' psychological skills.

Prior experience, however, does not only include an athlete's experiences in the sports arena. It could also include the athlete's prior exposure to sports psychological interventions. It is known that exposure to sports psychological interventions could significantly improve athletes' psychological skills (e.g., Hodge & McKenzie, 1999; Hale & Collins, 2002; Weinberg & Gould, 2003). In a study by Ferraro and Rush (2000), most professional and elite amateur athletes from a number of sports disciplines agreed that sports psychology had a large influence on their sports performance. Most of them conceded that they could benefit from the services of a sports psychologist. Despite this, the significant majority under-utilized sports-psychological services and did not have a history of consulting sports psychologists.

The role of cognitive perceptions in competitive sport

Studies have shown that in order to employ the correct coping strategies that could facilitate performance, athletes have to perceive a certain degree of control over any given situation (Pensgaard & Roberts, 2003; Ursin, 1988). Perception of control is thus related to lower levels of stress/anxiety and could contribute to effective coping (Butt *et al*., 2003; Hanton *et al*., 2004; Jennings, 1993). Apart from the perceptions that athletes have regarding themselves, the way in which they perceive their opponents can also influence the result of a competition. Perceptions regarding opponents could lead to positive or negative emotions, depending on the content of the specific perceptions (Barnes & Swain, 2002; Lazarus, 2000).

When athletes perceive their opponents as being better than they are, it could lead to a negative emotion, such as state anxiety. These negative thoughts and perceptions could influence the athletes' coping and application of psychological skills, thus influencing their performance as well.

When considering the above-mentioned discussion, the interaction between prior experiences (including sports-psychological exposure), cognitive perceptions and psychological skills appear to be worth investigating among senior South African rugby players.

Preamble to research

Although Moos and Schaefer (1993) do not clearly elucidate the role of prior experience in the development of cognitive appraisals or perceptions, the above literature suggest a link between these two constructs. Research findings by, among others Lazarus (2000) and Salvador (2005), justify an investigation into the interaction between prior experience, cognitive perceptions and the psychological skills of senior South African rugby players.

In accordance with the model of Moos and Schaefer (1993), the aim of this article is thus to investigate the interaction between the psychological skills (panel 2), prior experience and cognitive perceptions (panel 4) of senior rugby players in South Africa.

METHOD

Research design

A cross-sectional design was used to assess the psychological skills and other biographical constructs central to the stated aims of this study. The players were psychometrically evaluated during a single session in the week leading up to a game (usually 2-3 days before the game).

Participants

The participants in this research project were South African senior rugby players from all three levels of senior rugby (regional/trans-national level, e.g., Super 12, provincial level, e.g. Currie Cup and Vodacom Cup, as well as club level e.g., Super Sport National Club Championships) during the 2003/2004 seasons.

Data was gathered from all four South African Super 12 teams (henceforth referred to as trans-national teams), while at provincial level it was gathered from two large provincial rugby unions (Free State Cheetahs and Gauteng Lions Rugby Union) and two smaller rugby unions (Leopards Rugby Union and Falcons Rugby Union). Four of the best club rugby teams, including two university teams (the PUKKE of the North-West University and the team of the Tshwane University of Technology), one open club (Kimberly Combined Forces) and one combined club (the Leopards Amateur team) also participated in this study. Three of the four club teams were rated among the top eight club teams during the time of data collection. The number of players included in this study was thus 139 trans-national rugby players, 106 provincial rugby players and 95 club rugby players, resulting in a cumulative total of 340 senior players.

Psychometric instruments

1. The Athletic Coping Skills Inventory-28 (ACSI-28) was used to evaluate certain psychological skills of the rugby players. This inventory was designed to assess psychological skills (Smith *et al*., 1995), but in certain instances the subscales of the ACSI-28 appear to represent varied skill domains (Murphy & Tammen, 1998). In accordance with the way in which the authors of this instrument and subsequent users thereof conceptualised it, these subscales will be referred to as psychological skills in this research. The ASCI-28 has an internal validity of 0.86 (N=1027) and the test-retest reliability after a period of one week was found to be 0.87 (N=97) (Smith *et al*., 1995). The ACSI-28 consists of seven subscales measuring 1) coping with adversity, 2) peaking under pressure, 3) goal-setting, 4) concentration, 5) freedom from worry, 6) confidence and achievement motivation, as well as 7) coachability. This inventory also yields a total *Personal Coping Resource* score, which is assumed to reflect a multi-faceted psychological skill construct.

2. Biographical Questionnaire (compiled by researcher).

This self-compiled biographical questionnaire was adapted for each level of rugby players, in order to make the questions relevant to their level of participation. Only the questions relevant to this research are listed in table 1. It was used to obtain:

- Rugby history during school and senior rugby careers (questions 4 to16).
- Perceptions of sports psychology and sports-psychological exposure (questions 17 to 22).
- Perceptions of their physical and psychological abilities in comparison with those of their competitors (questions 23a to 23e).

Procedure

Each of the relevant rugby unions or clubs was contacted prior to the proposed evaluation to explain the rationale and purpose of the research project to the team management. After permission had been obtained for the research to be conducted, a time (as close as possible to an important game) and venue was negotiated with the coach.

Statistical analyses

Firstly, the interaction between prior experience, the measured cognitive perceptions and the psychological skills of the rugby players had to be determined. A median-split was used to divide the players on each level (i.e., club, provincial and trans-national) into groups with

high levels of psychological skills (high groups) and groups with low levels of psychological skills (low groups) based on their total scores on the ACSI-28. In order to achieve truly distinct groups within each level, participants who scored the same as the median (M=8) were omitted from the analysis.

Previous experience and cognitive perceptions of the players were used as independent variables. Means and standard deviations were determined for each of the groups (i.e., club, provincial and trans-national players) to compare the high-level and low-level psychological skills groups on each level. To establish practical significance for the difference of means, Cohen's *d* was used (Cohen, 1988; Kline, 2004). This entails dividing the difference in means by the maximum of the standard deviations of the two groups (Steyn, 2000). The guidelines for interpretation are:

- d = 0.2 : small effect
- d = 0.5 : medium effect
-

d = 0.8 : large effect

These guidelines were not strictly and rigidly applied, as they are considered *guidelines* and should be used accordingly (Steyn & Ellis, 2009). For the purpose of this study, values between 0.20 and 0.34 were interpreted as having a small effect and values between 0.35 and 0.70 as having a medium effect. Values of 0.71 and above were considered as having a large effect. Stepwise multiple linear regressions (Tabachnick & Fidell, 2001) were done to investigate the influence of previous experiences and cognitive perceptions on the psychological skills of senior South African rugby players. The ACSI-28 total score was used as a criterion, while prior experiences and cognitive perceptions were used as predictors. The results indicated which variables contributed, and also how much each variable contributed to the variance in the psychological skills of the South African senior rugby players.

RESULTS

Prior experience and cognitive perceptions

A number of questions in the biographical questionnaire were used to determine the rugby players' prior experience and to investigate certain cognitive perceptions that they had (table 1).

It was not possible to evaluate their perception of every single team they played against, and therefore the questions were asked in general. This provided the researchers with a fair idea of the players' general perceptions regarding their opponents. With a few exceptions, the questions were answered on a 5-point Likert scale.

TABLE 1. **BIOGRAPHICAL QUESTIONNAIRE RELATED TO PRIOR EXPERIENCE AND CERTAIN COGNITIVE PERCEPTIONS OF SENIOR SOUTH AFRICAN RUGBY PLAYERS**

Rugby history during school years.
Question 4: At what age did you start playing rugby? Question 5: How many years of high school rugby did you play? Question 6: What was the highest level of rugby that you achieved in high school?
Rugby history during senior rugby career.
Question 8: In what year did you make your senior provincial debut? Question 9: How many senior provincial games have you played? Question 10: For how many months have you been out of senior rugby due to injury? Question 11: Have you ever played for a Super 12 team in the past? Question 12: If yes, in which year did you make your Super 12 debut? Question 14: How many Super 12 games did you play in the past? Question 16: What is the highest level of rugby that you have played in South Africa?
Perceptions of sports psychology and sport psychological exposure.

Question 17: Have you consulted with a sports psychologist in the past? Question 18: If yes, how often did you go/ do you go? Question 19: What is your opinion regarding sports psychology? Question 20: What is your need in regard to sports psychology? Question 21: How well are you able to psychologically prepare yourself before a game? Question 22: Whose responsibility is it to look after the sports-psychological needs of players?
Perceptions of the players' physical and psychological abilities.
Question 23a: Other teams at your level of rugby have more sport psychological exposure than your team. Question 23b: Other teams on your level of rugby have better psychological skills than your team. Question 23c: In general, other teams have better "mental toughness" than your team. Question 23d: Your team has lower levels of physical capabilities (e.g. handling skills, strength, fitness etc.) than other teams on your level of rugby. Question 23e: Other teams on your level of rugby are all on the same level of psychological skills.

Prior sport psychological exposure

Although 44.82% (n=147) of the rugby players participating in this research (N=340) indicated that they had consulted a sports psychologist in the past, only 22.45% (n=25) of this group of players had a fixed pattern of consultation. At the time that the research was conducted, a mere 7.81% (n=25) of the entire research group was actively involved with a sports psychologist. Ironically, almost two thirds of these players (n=17) were club rugby players. This was surprising, since 78.97% (n=259) of the players indicated that they perceived sports psychology to be either important or very important to their performance. Only 2.5% (n=8) of the total research population indicated that they were not willing to consult with a sports psychologist and 1.83% (n=6) indicated that sports psychology was a waste of time. These results could be of value when interpreting the rest of the results, since this might give the reader an indication of why a number of players appear to be uninformed regarding sports psychological issues.

Differences between high and low psychological skills usage groups

After the median-split within all three levels (i.e. club, provincial and trans-national players) had been completed, effect sizes for each of the groups were determined to compare the high-level and low-level psychological skills groups on each level. Only the results that were of practical significance on any of the levels are presented in table 2.

TABLE 2. **EFFECT SIZE OF THE DIFFERENCES BETWEEN THE HIGH AND LOW PSYCHOLOGICAL SKILLS GROUPS (ACSI-28 TOTAL SCORE) REGARDING THE PRIOR EXPERIENCE AND COGNITIVE PERCEPTIONS OF THE DIFFERENT LEVELS OF SENIOR SOUTH AFRICAN RUGBY PLAYERS**

Variable	*d*-value (effect size)		
	Club	**Provincial**	**Trans-national**
Question 6 – Highest level at school.	-0.35*	-0.20▪	0.16

Question 9 – No. of senior provincial games.	-0.31▪	0.19	-0.27▪
Question 14 – No. of Super 12 games.	-	0.13	-0.22▪
Question 19 – Opinion of sports psychology.	0.30▪	0.47*	-0.12
Question 21 – Perception regarding own psychological preparation before a game.	0.77*	0.27▪	0.73*
Question 22_1 – The players feel that team management should provide them with sports-psychological services.	-0.57*	-0.03	0.03
Question 23b – Perception that other teams have better psychological skills.	-0.34▪	0.11	-0.20▪
Question 23c - Perception that other teams have better general "mental toughness".	-0.59*	0.18	-0.14
Question 23d - Perception that their team has lower levels of physical skills.	-0.35*	-0.07	-0.27▪
Question 23e - Perception that other teams are all on the same level of psychological skills.	-0.18	-0.03	0.36*

▪d= 0.20 – 0.34
*$d \geq 0.35$

Club rugby players

The results in table 2 indicate that the most significant differences between the high groups and low groups were found at club level. Club rugby players with high levels of psychological skills (n=38) differed significantly on eight of the biographical variables from the club players with low levels of psychological skills (n=57). Factors that appeared to be associated with their psychological skills included the highest level of rugby they played at school and their opinion regarding sports psychology. In the high group, 83.86% of the players played at least at provincial level at school, whereas only 68% of the low group could manage to play at a level higher than their school's first team.

The club players furthermore appeared to differ significantly regarding the perception of their own ability to do effective psychological preparation before a game. In the high group 89.19% of the players indicated that they perceived themselves as being able to prepare well or very well psychologically before a game. This provided a practically significant difference with a large effect between the high and low groups. Only 66.67% of the low group felt that they had the ability to prepare well or very well psychologically before a game. It is notable that the high group took responsibility for their own psychological preparation (66.16%), whereas the majority of the low group (64.91%) felt it was the responsibility of the coach or team management to provide the service.

The difference between the high and low groups regarding their perceptions of opponents' level of psychological skills was also significant, but with a small effect. In the high group only 32.44% of the players indicated that they perceive their opponents to have better

psychological skills than themselves. In the low group 42.11% of the players agreed that their opponents had better psychological skills than them. A total of 26.32% of the low group thought that their opponents had better mental toughness than them, but only 16.0% of the high group agreed with that statement. The majority of the high group (72.98%) rejected the statement that their team was on a lower level of physical preparation (e.g., handling skills, strength, fitness etc.) than their opponents. In contrast, only half of the low group (50.87%) disagreed with the statement.

From these results it appears that the groups with high and low psychological skills respectively differed significantly in respect of a combination of perceptions and prior experience.

Provincial rugby players

The only differences between the high group (n=43) and the low group (n=52) on provincial level were the highest level of rugby they had played at school, as well as their opinion regarding sports psychology and their perception regarding their abilities to do optimal psychological preparation before a game (table 2).

The significance of the difference between the high and low groups regarding the highest level of rugby they played at school was of small effect. A total of 88.37% of the high group had played at least provincial rugby at school, while 78.84% of the low group had reached the same level of achievement. The difference between the two groups regarding their opinions on the importance of sports psychology differed significantly, with medium effect. It was significant that 97.67% of the provincial players with high levels of psychological skills indicated that they perceived sports psychology to be important or very important. Only 76.93% of the low group indicated that they shared the same opinion. Lastly, 41.86% of the

high group thought that they had very good psychological skills and could prepare themselves psychologically very well before a game. A total of only 26.92% of the players in the low group shared that same view.

It thus seems that the perceptions of the players in the high and low groups respectively at provincial level differed regarding their own abilities and the importance of sports psychology. Prior experience, such as the highest level of rugby played at school, also appeared, to a lesser extent, to play a part in the difference between the high and low groups.

Trans-national rugby players

There were more significant differences between the high and low groups on trans-national level than on the provincial level. The trans-national high (n=77) and low groups (n=60) differed with regard to the number of senior provincial games and the number of trans-national games that they had played. The players in the high group had played an average of seventeen (17) trans-national games per player, whereas the low group played only twelve (12). This is a considerable difference if the fact that each team plays only 11 trans-national games per year is taken into account. The players who had a higher average of trans-national game experience appeared to have higher levels of psychological skills than the other players.

The biggest difference between the high and low groups on trans-national level involved their perceptions regarding their abilities to do optimal psychological preparation before a game. In

the high group, 46.75% of the players perceived themselves to have very good psychological skills and could prepare themselves very well psychologically before a game. In contrast, only 18.33% of the low group had the same perceptions of themselves.

Only 28.57% of the high group, and an even lower 21.66% of the low group, believed that their opponents had lower levels of psychological skills than their own teams. The rest of the players indicated that they were either not sure of the extent to which their opponents were psychologically prepared, or they agreed that their opponents had better psychological skills than they did. In contrast, 67.53% of the high group and 55.00% of the low group were of the opinion that they were physically on the same level as or better prepared (e.g., handling skills, strength, fitness etc.) than their opponents. However, it is important to note that 55.84% of the high group and 41.66% of the low group indicated that their trans-national rivals were not all on the same level of psychological preparation.

The only biographical variable that appeared to be a common denominator between the high and low groups on all three levels were the players' perceptions regarding their own abilities to do optimal psychological preparation before a game. The results in table 2 suggest that prior experience (such as highest level of rugby played, as well as the number of games played at provincial and trans-national level) and the indicated perceptions could have an influence on the psychological skills of rugby players. This raised the question of what the possible contribution of the prior experience and cognitive perceptions might be to the variance in psychological skills on the different levels of senior rugby players in South Africa.

The contribution of prior experience and cognitive perceptions to the variance in psychological skills

Stepwise multiple linear regressions were done to determine the contribution of the rugby players' prior experience and cognitive perceptions to their total psychological skills score (ACSI-28 total). Only the biographical variables that were shown to have a significant influence on the 0.1500 level in the stepwise model are displayed in table 3 and will be discussed. Each level of rugby players was again investigated separately, since the questions in the biographical questionnaire were tailored according to the settings on the specific levels.

TABLE 3. **STEPWISE MULTIPLE LINEAR REGRESSIONS BETWEEN THE PSYCHOLOGICAL SKILLS SCORE (ACSI-28 TOTAL), PRIOR EXPERIENCE AND COGNITIVE PERCEPTIONS FOR THE DIFFERENT LEVELS OF SENIOR SOUTH AFRICAN RUGBY PLAYERS**

Club			**Provincial**			**Trans-national**		
Variable	Partial R-square	Model R-square	Variable	Partial R-square	Model R-square	Variable	Partial R-square	Model R-square
Q21†	0.217	0.217	Q19	0,047	0.047	Q21	0.140	0.140
Q23c	0.122	0.340	Q21	0,043	0.090	Q6	0.054	0.195
Q22_1	0.048	0.388	-	-	-	Q16	0.018	0.213
Q19	0.038	0.427	-	-	-	-	-	-
Q9	0.025	0.4481	-	-	-	-	-	-

Total contribution to variance	44.81%		9.0%		21.3%

†Refer to table 1 for questions.

The results in table 3 indicate the combinations of factors on the different levels of rugby that appeared to have had an influence on the players' total psychological skills score. The partial R-square indicates the relative contribution of each of the variables to the ACSI-28 total, while the model R-square score gives an indication of the cumulative contribution of the variables to the total ACSI-28 score. The last row indicates the total percentage that each group of factors contributes to the variance in the psychological skills on each level of rugby.

From the results in table 3, it can be seen that a combination of perceptions (Q21, Q23c, Q22_1 and Q19) and prior experience (Q9) explained 44.81% of the variance in the psychological skills (ACSI-28 total) of the club rugby players. This is a large contribution and appears significant, especially when all the possible factors that could influence the players' psychological skills are considered. A combination of the players' 1) perceptions regarding their own abilities to do optimal psychological preparation before a game, 2) their perception of other teams' sport psychological exposure, 3) their perception of who should provide sport psychological services to their team and 4) their perception of the importance of sports psychology explained 42.7% of the variance in their psychological skills. The number of previous games that they have played contributed 2.5% to the variance. The major role that cognitive perceptions played in determining the level of psychological skills of the club rugby players is consequently emphasized.

There were only two biographical variables that contributed significantly to the variance in the psychological skills of the provincial rugby players. A combination of the provincial players' 1) perceptions of the importance of sports psychology and 2) the perceptions regarding their own abilities to do optimal psychological preparation before a game contributed 9% to the variance in their psychological skills. It seems that, apart from prior experience and cognitive perceptions, there were other factors that made a more significant contribution to the psychological skills of rugby players at provincial level. The identification of what exactly those factors are could be an interesting avenue for further research.

At the trans-national level, there was a combination of three of the biographical variables that were measured that contributed to the variance in the psychological skills of the players. Again the players' perceptions regarding their own abilities to do optimal psychological preparation before a game contributed to fairly low overall variance (14.0%). This time however, it combined with 1) the highest level of rugby they played at school level (5.4%), as well as 2) the highest level of rugby that they had played on senior level (1.8%). This combination between cognitive perceptions and prior experience contributed 21.3% to the variance in the psychological skills of the trans-national rugby players in South Africa. Although this contribution appears to be relatively small, it is significant if one considers the vast number of factors that could influence the players' psychological skills.

As was the case with the comparison between the high groups and low groups on the different levels of rugby (table 2), the same common denominator appears to surface. The players' perceptions regarding their own abilities to do optimal psychological preparation before a game contributed to the variance in their psychological skills on club (21.7%),

provincial (4.3%) and trans-national (14%) level. The other contributions varied between the different levels. However, prior experience and cognitive perceptions did contribute, to a greater or lesser extent, to the variance in the psychological skills on all of the levels of rugby in South Africa.

DISCUSSION

As suggested by the Moos and Schaefer model (1993) in figure 1, a vast number of factors could influence the degree to which athletes are able to cope with challenging or competitive situations. The results seem to confirm the findings of researchers like Ursin (1988) and Pensgaard and Roberts (2003). These researchers stated that athletes who perceive a certain degree of control over their competitive situation would find it easier to employ the correct coping response and would thus be able to apply the correct combination of psychological skills.

There appeared to be significant interaction between cognitive perceptions and psychological skills. A number of cognitive perceptions of the rugby players with high levels of psychological skills differed from those of the players in the groups with low levels of psychological skills. However, there was only one biographical variable that appeared to be a common denominator and differentiated between the high and low groups on all three levels.

This biographical variable was the players' perceptions regarding their own abilities to do optimal psychological preparation before a game. This coincides with research findings that the abilities that individuals believed they had were the strongest predictor of self-confidence (Gould *et al*., 1984; Hall *et al*., 1998; Humara, 1999). Self-confidence is known to have a significant influence on a number of the athletes' psychological skills (Hanton *et al*., 2004; Weinberg & Gould, 2003). This could explain why this specific perception appeared to play such a prominent role in the psychological skill levels of all the players in this research. As seen in the results in table 2, the players' perceptions regarding their abilities to prepare themselves optimally before a game differed significantly between the high and low groups on club (d=0.77), provincial (d=0.27) and trans-national (d=0.73) level. The relative contribution of this specific perception also contributed to the variance in psychological skills on all three levels (table 3).

As mentioned earlier, the way in which athletes perceive their opponents can also influence the result of a competition, depending on the content of the specific perceptions (Barnes & Swain, 2002; Lazarus, 2000). Rugby players who perceive their opponents to be psychologically and physically better prepared than they are could therefore struggle to cope and to compete successfully against these opponents. On the club as well as the trans-national level, there were noticeable differences in the way that rugby players from the high and low groups respectively perceived their opponents. The high groups generally had more favourable perceptions regarding their own psychological skills and physical abilities in relation to their opponents, possibly reflecting higher self-confidence. No differences, however, were found in this regard between the high and low groups on provincial level.

When using the model of Moos and Schaefer (1993) as reference, it is not possible to determine the direction of the interaction between these perceptions and psychological skills. It could be that the more positive perceptions influenced the psychological skills of the players, or conversely that the higher levels of psychological skills allowed the players to

develop more positive sport-specific perceptions. Despite the uncertainty regarding the direction of the interaction, it appears that these two factors are strongly associated.

Apart from the cognitive perceptions, the interaction between the players' prior experience and their psychological skills were also investigated. According to the results in table 2, prior rugby experience appeared to play a part in the differences that were found between the psychological skills of the high and low groups at different levels. Although the significance of the prior experience was of small or medium effect, the highest level of rugby played at school as well as the number of senior provincial and trans-national games played, differed between the high and low groups. This corresponds with the findings of other researchers (Lazarus, 2000; Perry & Williams, 1998), who suggested that prior experience might be responsible for the psychological patterns and cognitions seen in athletes. It is thus plausible that athletes' prior experience could influence the psychological skills that they apply in competitive situations. Salvador (2005) also lends support to these results and states that coping in competitive situations will depend on factors such as perceived possibilities of success, which in turn is brought about by prior experience in the athletes' specific sport.

According to the above-mentioned literature findings, the frequency of high-level exposure of the high group could explain why they have developed certain psychological skills to help them cope in the competitive environment of rugby in South Africa. This assumption corresponds with research conducted by Perry and Williams (1998). These authors found that advanced tennis players (individuals who had been participating in the sport for an extended period of time) appeared to cope more effectively and reported more facilitative interpretations of their anxiety than novices.

Apart from the difference between the high and low groups on each level, prior rugby experience also seemed to contribute to the variance in the psychological skills of the total group of club and trans-national players. The results in table 3 suggested that the number of senior provincial games played contributed 2.5% to the total variance in the psychological skills of the club players. A combination of the highest level of rugby played at school level and at senior level explained 7.2% of total variance in psychological skills of the trans-national group. There are an immense number of factors that could influence the rugby players' psychological skills. Thus, albeit a relatively small contribution that prior experience appears to make to the total variance of psychological skills of the club and trans-national players, it is still worth noting. Researchers like James (2003) suggest that a person's basic psychological patterns/skills would already have been established in his/her childhood. These patterns/skills and their application, however, could be influenced or changed by significant incidents in a person's life or by psychological intervention. It is thus possible that these players reached those high levels of rugby in the past due to the fact that they had already developed high levels of psychological skills.

Apart from the findings discussed above, a number of other noteworthy results came to the fore. A relatively high number of players on all three levels of rugby regularly indicated to certain specific questions that they did not want to give an opinion or did not know how their opponents compared to them. A possible explanation for this could be that these rugby players were uninformed regarding the role of sports psychology or had uncertainties regarding other teams' sport psychological exposure. This would not be surprising, since only 7.35% of the total research group ever had a fixed pattern of consulting a sports psychologist.

If players had more sport psychological exposure, they would have been better informed regarding the role of sport psychology. This could possibly have caused them to experience less uncertainty about the sport psychological exposure of their opponents. Uncertainty is a major situational source of stress (Weinberg & Gould, 2003). The mere possibility that South African senior rugby players are uninformed regarding sport psychological issues could cause uncertainty. This could influence psychological factors such as their anxiety and self-confidence levels, and hence their ability to cope in high-pressure situations (Weinberg & Gould, 2003).

Ferraro and Rush (2000) found that the main reported reason for the fact that athletes do not make use of sport psychological services is the fear of lost time and money. However, they concluded that the real reason could be that most athletes do not like experiencing affect of any kind. Sport, according to these authors, is often regarded as being about action and the expression of emotions through movement rather than through words. This could explain why, despite the fact that 78.97% (n=259) of the players in this research indicated that sports psychology is either important or very important to their performance, such a small percentage of players actually regularly consulted a sports psychologist. These results emphasize how important it is for elite rugby players to get more sport psychological exposure, since this could improve their psychological skills (e.g., Hale & Collins, 2002; Hodge & McKenzie, 1999; Weinberg & Gould, 2003). Psychologists could encourage their clients to discover their basic faulty perceptions and they can furthermore inform them of and eliminate a number of their uncertainties regarding their own and their opponents' psychological abilities (Corey, 2001).

In conclusion, it is important to acknowledge the contribution of prior experience and cognitive perceptions to the levels of psychological skills of the rugby players. The results suggested that both these factors could influence the psychological skills of the South African rugby players and could therefore also influence their coping abilities. Identifying the direction of interaction between prior experience, cognitive perceptions and psychological skills did not fall within the aims of this study. This could however be the objective of further investigation into this interaction, since it could clarify the exact role that these factors play in performing at the elite level of rugby in South Africa.

REFERENCES

BARNES, K. & SWAIN, A. (2002). Using stress for a competitive advantage. In B.D. Hale & D.J. Collins (Eds.), *Rugby tough* (113-133). Champaign, IL: Human Kinetics.

BUTT, J.; WEINBERG, R. & HORN, T.S. (2003). The intensity and directional interpretation of anxiety: Fluctuations throughout competition and the relationship to performance. *The Sport Psychologist*, 17(1): 237-248.

COHEN, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

COREY, G. (2001). *Theory and practice of counselling and psychotherapy* (6th ed.). Stamford, CT: Brooks/Cole.

FERRARO, T. & RUSH, S. (2000). Why athletes resist sport psychology. *Athletic Insight*, 3(2): 1-6.

GOULD, D.; PETLICHKOFF, L. & WEINBERG, R.S. (1984). Antecedents of temporal changes in and relationships between CSAI-I components. *Journal of Sport Psychology*, 6: 289-304.

HALE, B.D. & COLLINS, D.J. (2002). *Rugby tough*. Champaign, IL: Human Kinetics.

HALL, H.K.; KERR, A.W. & MATTHEWS, J. (1998). Precompetitive anxiety in sport: The contribution of achievement goals and perfectionism. *Journal of Sport and Exercise Psychology*, 20(2): 194-217.

HANTON, S.; THOMAS, O. & MAYNARD, I. (2004). Competitive anxiety responses in the week leading up to competition: the role of intensity, direction and frequency dimensions. *Psychology of Sport and Exercise*, 5(2): 169-181.

HODGE, K. & McKENZIE, A. (1999). *Thinking rugby: Training your mind for peak performance.* Auckland, NZ: Reed.

HODGE, K. & McKENZIE, A. (2002). Motivation and confidence. In B.D. Hale & D.J. Collins (Eds.). *Rugby tough* (35-59). Champaign, IL: Human Kinetics.

HUMARA, M. (1999). The relationship between anxiety and performance: a cognitive-behavioural perspective. World Wide Web [http://www.*athletic-insight.com*]. Retrieved 16 August 2005.

JAMES, O. (2003). *They f*** you up: how to survive family life*. London, UK: Bloomsbury.

JENNINGS, K.E. (1993). *Mind in sport: Directing energy flow into success.* Cape Town: Juta.

KLINE, R.B. (2004). *Beyond significance testing: reforming data analysis methods in behavioral research*. Washington, DC: American Psychological Association.

KRUGER, P. (2005a). Psychological skills, state anxiety and coping of South African rugby players: A cognitive perspective. Unpublished Ph.D. dissertation. Potchefstroom: North-West University.

KRUGER, P. (2005b). *A psychological skills profile of senior South African rugby players.* Manuscript submitted for publication in the *African Journal for Physical, Health Education, Recreation and Dance.*

KRUGER, P. (2005c). *The influence of state anxiety on the psychological skills of senior South African rugby players*. Manuscript submitted for publication in the *International Journal of Sport Psycholgy.*

LAZARUS, R.S. (2000). How emotions influence performance in competitive sports. *The Sport Psychologist*, 14: 229-252.

MARTENS, R. (1987). *Coaches guide to sport psychology*. Champaign, IL: Human Kinetics.

MOOS R.H. & SHAEFER, J.A. (1993). Coping resources and processes: Current concepts and measures. In L. Goldberger & S. Breznitz (Eds.). *Handbook of stress: Theoretical and clinical aspects* (2nd ed.) (234-257). New York, NY: Free Press.

MURPHY, S.M. & TAMMEN, V. (1998). In search of psychological skills. In J.L. Duda (Ed.). *Advances in sport and exercise psychology measurement* (195-209). Morgantown, WV: Fitness Information Technology.

PENSGAARD, A.M. & ROBERTS, G.C. (2003). Achievement goal orientations and the use of coping strategies among Winter Olympians. *Psychology of Sport and Exercise*, 4(2): 101-116.

PERRY, J.D. & WILLIAMS, J.M. (1998). Relationship of intensity and direction of competitive trait anxiety to skill level and gender in tennis. *The Sport Psychologist*, 12: 169-179.

SALVADOR, A. (2005). Coping with competitive situations in humans. *Neuroscience and Behavioral Reviews*, 29(1): 195-205.

SMITH, R.E.; SHUTZ, R.W.; SMOLL, F.L. & PTACEK, J.T. (1995). Development and validation of a multidimensional measure of sport-specific psychological skills: The Athletic Coping Skills Inventory – 28. *Journal of Sport and Exercise Psychology*, 17: 379-398.

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

STEYN, H.S. & ELLIS, S.M. (2009). Estimating an effect size in one-way multivariate analysis of variance (MANOVA). *Multivariate Behavioural Research*, 44(1): 106-129.

TABACHNICK, B.G. & FIDELL, L.S. (2001). *Using multivariate statistics* (4th ed.). Boston, MA: Allyn and Bacon.

URSIN, H. (1988). Expectancy and activation: an attempt to systematize theory. In D. Hellhammer; I. Florin & H. Weiner (Eds.). *Neurobiological approaches to human disease* (313–334). Toronto, ON: Hans Huber.

WEINBERG, R.S. & GOULD, D. (2003). *Foundations of sport and exercise psychology* (3rd ed.). Champaign, IL: Human Kinetics.

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NON-PARTICIPATION IN SPORT BY BLACK LEARNERS WITH SPECIAL REFERENCE TO GENDER, GRADES, FAMILY INCOME AND HOME ENVIRONMENT

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ABSTRACT

This study was aimed at finding reasons for non-participation in sport by black learners at secondary school level. According to the findings of this research, factors that have the most important influence on non-participation in sport by black secondary learners are (in order of importance), facilities, political factors, social factors , self-image, economic factors and health. In terms of facilities it has been revealed that black township schools do not have adequate equipment, properly organized recreational facilities, coaches for the different sport codes and upgraded as well as well-maintained sport fields. Cultural isolation of black players in sport surfaced as an important political factor for non-participation. Through this research it has also emerged that while gender and income do seem to have an influence on non-participation in sport, grades and home environment do not. The results indicate that income as a reason for non-participation in sport is significantly more important for learners from low-income families than for learners from average-income families.

Key words: Sport; Physical Education; Black learner; Secondary school level; Political factors; Self-image; Social factors; Gender; Motivation; Exercise.

INTRODUCTION

According to Potgieter (2003:182), among the non-traditional methods of preventing psychological problems, physical exercise is increasingly recommended for the maintenance and enhancement of mental health. It is generally accepted that there are many psychological benefits offered by regular exercise such as promoting feelings of well-being and self-efficacy. Much of modern sport involves learning to control emotions, disciplining the self and managing emotional lives (Coakley & Dunning, 2000:477). Sport experiences can enrich emotional development by cultivating capacities for care, self-worth, strength of will, good judgement, compassion, understanding, love and friendship. With so much research pointing to many benefits like healthy bodies producing healthy minds, sport boosting school spirit and participation in school sport increasing students‟ self-esteem, it is disconcerting to see many learners, especially at secondary school, being less interested or developing a negative attitude towards sport.

According to McComb (2004:9), “every person is born with athletic capability and every person is predestined to develop that physical potential”. Even Abraham Maslow (1970), who was the foremost 20th century theorist concerning human motivation, recognized the fact of predestined physicality. If this is the case, then what are the influences propelling some people to undertake physical activity and what discourages others from doing so? Hill (2001:89) views motivation in sport as “the desire to engage and persist in sport, often despite disappointments, sacrifice and discouragements”. Diamant (1991:17) avers that of a number of reasons why some individuals continue exercising for a significant portion of their lives, the post-exercise affective state or “feel better” phenomenon appears to be a primary one.

Research evidence supports the hypothesis that regular exercise promotes feelings of well-being and can serve as a positive coping strategy (Biddle *et al.,* 2000:4; Coakley & Dunning, 2000:408; Singer *et al.,* 2001:643; Kirkcaldy, 2002:544; Hagger & Chatzisarantis, 2005:10). It is also believed that sport participation teaches young people useful lessons applicable to social life (Bar-Or, 1995:353).

Crews and Landers (cited in Potgieter, 2003:184) also discovered that sport not only has physiological benefits but it contributes to our psychological health as well. They concluded that no matter what type of psychological or physiological instruments are used, people who are aerobically fit show a decreased psychosocial stress response. Brown and Siegel (cited in Potgieter, 2003:185) also found that children who exercise regularly (aerobically or anaerobically) and are exposed to high levels of stress in life are ill less frequently than their peers who rarely exercise but experience similar stressful conditions. Self-concept is also frequently posited as a mediating variable that facilitates the attainment of other desirable outcomes, such as increased exercise adherence or health-related physical fitness (Andersen, 2000:61).

Research done by Orlick (cited in Bar-Or, 1995:418) concluded that at times overemphasis placed on winning and a fear of failure predominantly influence some students‟ decision to withdraw from sport. Other reasons cited for the decline in sport participation are that sport is too demanding and time consuming; too much pressure; dislike for the coach; „conflict of interests‟ as students want to try other non-sport activities and are „not having fun‟ (Bar-Or, 1995:418). Orlick‟s findings are important in that they suggest that the structure and climate in which sports are held are inadequate in meeting the needs of students and this might have a bearing on non-participation.

Research evidence has also found that parental support is significantly associated with enjoyment in sport and with the importance players ascribe to their game. Singer *et al.* (2001:617) attest to this view and state that adults, peers and learners themselves shape the social context within which they play sport. Parents are primarily responsible for providing children with initial opportunities to play sport and helping to maintain their involvement in it. Research evidence also exists which points to the fact that parents have the potential to affect their children‟s withdrawal from sport (Singer *et al.*, 2001:617).

Peers, on the other hand, are extremely influential in terms of the adolescent‟s self-perceptions, feelings of belonging and identity as well as social status. Consequently, adolescents may find themselves propelled to demonstrate athletic ability or to avoid demonstration of low ability in front of their peers.

Since little evidence exists about the reasons for non-participation in sport by black secondary school learners in the South African context, this study therefore focused on black secondary school learners per se.

METHOD OF RESEARCH

Selection of the sample

Black secondary school learners in Durban township schools, who did not participate in school sport, were the main population for this study. The subjects were selected using stratified random sampling in terms of age and gender. According to McMillan and Schumacher (2001:172), for stratified random sampling the population is divided into subgroups or strata from which samples are then drawn randomly either proportionally or non-proportionally. This is more efficient than simple random sampling as a smaller number of subjects would need to be used and it also allows the researcher to compare subgroup results. A total of 246 learners in Grades 9 to 12 from four schools participated in this study.

TABLE 1: **DISTRIBUTION OF LEARNERS IN TERMS OF GENDER AND GRADE**

	Gr 9	**Gr 10**	**Gr 11**	**Gr 12**	**Total**
Male	27	34	30	24	**115**
Female	38	34	28	31	**131**
Total	**65**	**68**	**58**	**55**	**246**

The measuring instrument

Data were collected by means of a structured questionnaire with closed-form scaled items chosen for their objectivity and the fact that it would be very time consuming for the researcher to categorize many open-ended responses. According to McMillan and Schumacher (2001:261), scales are used extensively in questionnaires because “they allow fairly accurate assessments of beliefs or opinions”. The questionnaire was selected for its suitability of being economical, has the same questions for all subjects and can ensure anonymity (McMillan & Schumacher, 2001:257).

The questionnaire was compiled in line with a literature search on factors affecting sport participation. The following factors emerged and were used as a basis for the development of the questionnaire (Mchunu, 2008):

- Economic factors, for example parents cannot afford a sport kit or taking part in sport costs a lot of money.
- Availability of facilities, for example schools do not have adequate equipment for sport or lack recreational facilities.

- Factors related to self-image, for example learners might not have enough confidence to compete or they are afraid to make mistakes in front of others.
- Political factors, for example black learners might feel they have little chance to be selected for national teams or that sport is still associated with the apartheid era.
- Health related factors influencing non-participation in sport, for example learners are on medication or have allergies.
- Social factors, for example a specific culture does not encourage sport or friends might think sport is for nerds.

Section A of the questionnaire was used to elicit important biographical information and the socioeconomic background of the learners, while section B formed the main part of the questionnaire. It consisted of closed questions to elicit information on the factors mentioned above. Between 10 and 15 items were created to represent each of the factors. The following are examples of the statements under each of the factors:

Economic factors (for example financial ability)
I have to do some chores at home after school as there is no maid.
My parents cannot afford the sport kit needed.

Availability of facilities (coaches, transport, type of sport offered etcetera)
At school, grounds are not well-maintained for sport participation.
Our school ground needs a security fence.

Factors related to self-image
Other learners laugh at you when you play sport.
Exercise makes me look sweaty.

The following 6-point Likert scale was used:

Disagree					Agree
1	2	3	4	5	6

Prior to the study, the questionnaire was pilot tested among a group of learners representative of the sample from one of the schools. This enabled the researcher to gauge the amount of time it would take learners to complete the questionnaire and what words they would have difficulty understanding. Minor adjustments and revisions were then made before finalizing the measuring instrument.

The SAS computer program was used to analyse the data. The following steps were taken:

- By calculating the means and standard deviations of the different factors, those factors which contributed the most to non-participation in sport by black learners at secondary school level were determined.
- An item analysis of the different factors established which items correlated the best with a particular factor. In this way, a certain factor‟s specific contribution to non-participation in sport by black secondary school learners could be determined.

- Application of t-tests indicated whether there were significant differences between the reasons for non-participation with regard to gender, grade, family income and environment.

RESULTS

The most important factors contributing to non-participation in sport by black learners at secondary school level

In the light of the aim of this study previously discussed, the following six factors were identified as the reasons for black learners‟ non-participation in sport at secondary school level. They are facilities, self-image and economic, political, health and social factors. In order to determine the sequence of importance of the different factors, the mean and standard deviation for each of the factors were calculated. The results appear in table 2.

TABLE 2: **MEAN AND STANDARD DEVIATION OF THE SIX FACTORS AFFECTING NON-PARTICPATION IN SPORT BY BLACK SECONDARY SCHOOL LEARNERS**

VARIABLE	N	MEAN	STD DEV
Facilities	246	34.84	7.13
Political factor	246	28.18	6.54
Social factor	246	27.02	6.49
Self-image	246	26.32	6.54
Economic factor	246	22.07	6.73
Health	246	21.17	6.50

According to table 2, **facilities** seem to be the most important factor relating to non-participation in sport by black learners at secondary school level. This factor is followed by political, social, self-image and economic factors. The least important factor for non-participation in sport is **health.**

Upon further analysis it was decided to consider the most important items that influence non-participation in sport by black secondary school learners. The top five items that correlate best with the total of each of the four most important factors were identified and are listed in order of importance (Note: Only five items and four factors were selected in order to comply with editorial requirements).

Item analysis of individual factors

Facilities

The items that correlate best with the total for the factor facilities are:

- Item 55 – my school does not have adequate equipment for sport
- Item 58 – there are no properly organized recreational activities in our area
- Item 38 – my school does not have a coach for sport
- Item 42 – black schools generally have very poor and underdeveloped sporting facilities
- Item 29 – at school, grounds are not well maintained for sport participation

From the above it can be concluded that the factor facilities boil down to adequate equipment, properly organized recreational amenities, coaching as well as upgraded and well-maintained grounds. For sport managers and administrators wanting to improve sport participation at secondary school level, these are the vital areas to focus on.

Political factor

The items which correlate best with the total of the political factor are:

- Item 78 – sport is being dominated by white administrators
- Item 27 – black learners are politically conscientized to believe that education is more important than sport
- Item 52 – black players are culturally alienated and isolated off the field
- Item 65 – a black player has to be exceptionally good to merit the attention of coaches
- Item 63 – it seems like a forced activity trying to make up for sins of the past

The most important items under the political factor are racial inequality in sport, cultural isolation of black players and bias of coaches. Learners also seem to feel that sport is forced on them to bridge political gaps that were created in the past.

Social factor

The items that correlate best with the total for social factors are:

- Item 64 – my siblings do not like sport at all
- Item 44 – my culture does not encourage sport participation
- Item 15 – my community associates sport participation with drugs
- Item 57 – my family think I am not good in any sport
- Item 59 – my siblings always laugh at my sporting abilities

Family members seem to play a huge role when it comes to reasons given for non-participation in sport. If learners do not get adequate encouragement and motivation from their siblings, they seem not to be interested in participating in sport. Besides the family, culture and the community also influence whether learners will participate in sport or not. Different cultures and communities have different expectations from the activities of their members and learners might not participate in sport out of respect for or restrictions of cultural norms (Kirk *et al*., 2006:770).

Self-image

The items that correlate best with the total for self-image are:

- Item 74 – my face is too important to me right now to get it sunburnt
- Item 22 – I am too shy to make mistakes in front of others

Item 66 – I do not like publicity
Item 72 – I am not happy with my present weight
Item 46 – I fear failure

An analysis of the above items seems to indicate that learners who do not participate in sport are more concerned with how they present themselves to others. These learners seem to be too self-conscious about their looks and public image and do not want to be seen as failures by others. According to Merchant *et al*. (2007:196), restrictive and revealing sport kits may make some girls very aware of and sometimes embarrassed about their bodies as they are subjected to taunts and ridicule from insensitive and unsympathetic classmates and educators.

As a next step in the empirical investigation, an analysis was done to compare the responses of the candidates according to **gender, family income, grades and home environment.** This was done for each of the selected factors.

Reasons for non-participation in sport by black secondary school learners according to gender

To determine whether the average reasons for non-participation in sport by black males differ from those of black females, the mean of each group was calculated and compared. The t-test was used to determine whether the two means differ significantly. The results appear in table 3.

TABLE 3: **DIFFERENCE BETWEEN THE MEANS FOR NON-PARTICIPATION IN SPORT FOR BLACK MALES AND FEMALES**

VARIABLE	GROUP	NO.	MEAN	S	T	D.F.	P
FACILITIES	1=males	115	34.27	7.22	1.17	244	$p > 0.05$
	2=females	131	35.34	7.05			
POLITICAL FACTOR	1	115	27.56	6.82	1.40	244	$p > 0.05$
	2	131	28.73	6.26			
SOCIAL	1	115	25.93	6.33	2.49	244	$p < 0.05$
FACTOR	2	131	27.98	6.51			
SELF-IMAGE	1	115	24.48	6.02	4.27	244	$p < 0.01$
	2	131	27.93	6.57			

According to table 3, males and females do not differ significantly with regard to their reasons for non-participation in sport in terms of facilities and political factors ($p>0.05$). However, females consider their self-image as a significantly more important reason for non-participation in sport than males ($p<0.01$). Females also consider social reasons as significantly more important for non-participation in sport than males ($p<0.05$).

Reasons for non-participation in sport by black secondary school learners according to family income

The subjects were divided into the following three groups on the basis of confidential information such as income, size of families and occupation, gained from the learners‟ files,

and also from interviews held with the principals and teachers of the different schools:

Group 1: low income
Group 2: average income
Group 3: above-average income

The mean for each of the three groups was calculated for each of the four selected factors. In order to compare these averages, an analysis of variance was carried out.

TABLE 4: **DIFFERENCE IN REASONS BETWEEN THE INCOME GROUPS FOR NON-PARTICIPATION IN SPORT WITH REGARD TO THE FACILITIES FACTOR**

GROUP	N	MEAN	S
1= low income	53	35.94	6.42
2= average income	184	34.50	7.29
3= above- average income	9	35.33	7.95

F (2.243) = 0.86 $p > 0.05$

There is no significant difference between the means of the three groups regarding facilities as a reason to not participate in sport ($p>0.05$). This implies that learners from all three income groups ascribe the same importance to facilities as a reason for non-sport participation.

TABLE 5: **DIFFERENCE IN REASONS BETWEEN THE INCOME GROUPS FOR NON-PARTICIPATION IN SPORT WITH REGARD TO THE POLITICAL FACTOR**

GROUP	N	MEAN	S
1= low income	53	29.60	5.05
2= average income	184	27.70	6.95
3= above- average income	9	29.77	4.46

F (2.243) = 2.03 $p > 0.05$

There is no significant difference between the three groups with regard to the importance of political factors as a reason for non-participation in sport ($p>0.05$). This implies that learners from all three income groups ascribe the same importance to political factors as a reason for non-sport participation.

TABLE 6: **DIFFERENCE IN REASONS BETWEEN THE INCOME GROUPS FOR NON-PARTICIPATION IN SPORT WITH REGARD TO THE SOCIAL FACTOR**

GROUP	N	MEAN	S
1= low in come	53	28.94	6.38
2= average income	184	26.41	6.54
3= above- average income	9	28.33	3.70

F (2.243) = 3.37 $p < 0.05$

There is a significant difference between the three groups with regard to the importance of the social factor as a possible reason for non-participation in sport ($p<0.05$). In order to determine the groups between which this difference exists, t-values were calculated.

A significant difference was found between group 1 and group 2 with $t(244) > 2.41$ ($p<0.05$). This implies that learners from low-income families consider social aspects to be a more important reason for not participating in sport than learners from average-income families. A possible explanation for this finding might be that families with a low income regard sport as an important socializing agent where children can make friends, while families with an average income do not.

TABLE 7: **DIFFERENCE IN REASONS BETWEEN THE INCOME GROUPS FOR NON-PARTICIPATION IN SPORT WITH REGARD TO THE SELF-IMAGE FACTOR.**

GROUP	N	MEAN	S
1= low income	53	27.79	5.25
2= average income	184	25.65	6.78
3=above- average income	9	31.44	5.05

$F(2.243) = 5.24$ $p < 0.01$

There is a significant difference between the reasons of the three groups for non-participation in sport with regard to self-image ($p<0.01$). In order to determine between which groups significant differences exist, t-values were calculated. A significant difference was found between group 2 and group 3 with $t(244)>2.41$ ($p<0.05$). This implies that for learners from families of above-average income, their self-image is a significantly more important factor for non-participation in sport compared to learners from families with an average income.

Reasons for non-participation in sport by black secondary school learners according to grades

TABLE 8: **DIFFERENCE IN REASONS BETWEEN GRADES FOR NON-PARTICIPATION IN SPORT WITH REGARD TO THE FACILITIES FACTOR**

GRADE	N	MEAN	S
9	65	34.03	6.42
10	68	34.51	8.33
11	58	34.48	7.45
12	55	36.60	5.75

$F(3.242) = 1.50$ $p > 0.05$

There is no significant difference between learners in the different grades with regard to the importance of facilities as a possible reason for non-participation in sport ($p>0.05$).

TABLE 9: **DIFFERENCE IN REASONS BETWEEN GRADES FOR NON-PARTICIPATION IN SPORT WITH REGARD TO THE POLITICAL**

FACTOR

GRADE	N	MEAN	S
9	65	29.41	6.38
10	68	28.17	6.88
11	58	26.56	6.53
12	55	28.45	6.13

F (3.242) = 2.00 p > 0.05

There is no significant difference between learners in the different grades with regard to the importance of the political factor as a possible reason for non-participation in sport (p>0.05).

TABLE 10: **DIFFERENCE IN REASONS BETWEEN GRADES FOR NON-PARTICIPATION IN SPORT WITH REGARD TO THE SOCIAL FACTOR**

GRADE	N	MEAN	S
9	65	27.61	6.48
10	68	26.98	6.18
11	58	26.72	6.43
12	55	26.70	7.05

F (3.242) =0.26 p > 0.05

There is no significant difference between learners in the different grades with regard to the importance of the social factor as a possible reason for non-participation in sport (p>0.05).

TABLE 11: **DIFFERENCE IN REASONS BETWEEN GRADES FOR NON - PARTICIPATION IN SPORT WITH REGARD TO THE SELF-IMAGE FACTOR**

GRADE	N	MEAN	S
9	65	27.15	5.57
10	68	27.14	6.97
11	58	25.84	7.09
12	55	24.83	6.31

F (3.242) = 1.78 p > 0.05

There is no significant difference between learners in the different grades with regard to the importance of self-image as a possible reason for non-participation in sport (p>0.05).

Reasons for non-participation in sport by black secondary school learners according to home environment

The subjects were divided into the following three groups:

Group 1 – urban
Group 2 – township
Group 3 – rural

TABLE 12. **DIFFERENCE IN REASONS FOR NON-SPORT PARTICIPATION WITH**

REGARD TO THE FACILITIES FACTOR, TAKING HOME ENVIRONMENT IN CONSIDERATION

GROUP	N	MEAN	S
1= urban	27	33.74	8.29
2= township	196	35.02	6.94
3= rural	22	35.04	7.40

F (2.242) = 0.39 $p > 0.05$

There is no significant difference between the three groups with regard to the importance of facilities as a possible reason for non-participation in sport ($p>0.05$).

TABLE 13: **DIFFERENCE IN REASONS FOR NON-SPORT PARTICIPATION WITH REGARD TO THE POLITICAL FACTOR, TAKING HOME ENVIRONMENT IN CONSIDERATION**

GROUP	N	MEAN	S
1= urban	27	28.55	7.07
2= township	196	28.13	6.49
3= rural	22	28.68	6.32

F (2.242) = 0.11 $p > 0.05$

There is no significant difference between the three groups with regard to the importance of the political factor as a possible reason for non-participation in sport ($p>0.05$).

TABLE 14: **DIFFERENCE IN REASONS FOR NON-SPORT PARTICIPATION WITH REGARD TO THE SOCIAL FACTOR, TAKING HOME ENVIRONMENT IN CONSIDERATION**

GROUP	N	MEAN	S
1= urban	27	27.92	6.58
2= township	196	26.96	6.58
3= rural	22	26.77	5.74

F (2.242) = 0.28 $p > 0.05$

There is no significant difference between the three groups with regard to the importance of the social factor as a possible reason for non-participation in sport ($p>0.05$).

TABLE 15: **DIFFERENCE IN REASONS FOR NON-SPORT PARTICIPATION WITH REGARD TO THE SELF-IMAGE FACTOR, TAKING HOME ENVIRONMENT IN CONSIDERATION**

GROUP	N	MEAN	S
1= urban	27	33.74	8.29
2= township	196	35.02	6.94
3= rural	22	35.04	7.40

F (2.242) = 1.29 $p > 0.05$

There is no significant difference between the three groups with regard to the importance of

self-image as a possible reason for non-participation in sport ($p>0.05$).

DISCUSSION

According to this study, the following factors were identified (in order of importance) as the reasons for black learners‟ non-participation in sport at secondary school level: **facilities, political factors, social factors, self-image, economic factors and health**.

The results of this study correspond with those reported in the literature. According to Goldsmith (2003:152), lack of proper facilities conducive to athletic participation, economic reasons such as lack of proper sport kit, political factors, health related factors, factors related to self-image and social factors contribute to non-participation in sport at school level. It appears that the factors that militate against black learners participating in sport dovetail and merge into each other. The political environment that creates a social underclass results in a set of learners that have a poor self-image and self-esteem and who lack the stimulus to go for it, to be ambitious and to pit themselves against others, or to set themselves high goals (Goldsmith, 2003). These qualities of self-image, self-esteem, internal stimulus, ambition and setting of high goals are just as essential to participating in sport as they are the result of it.

To comply with editorial requirements, only the first four most important factors were included in the statistical analysis. The responses of the respondents to these factors were compared according to **gender, family income, grades and home environment**.

Gender: Males and females do not differ significantly with regard to their reasons for non-participation in sport in terms of facilities and political factors. However, females consider their self-image as a significantly more important reason for non-participation in sport than males. This seems to be a period when females are exploring their identities and struggling with the changes in their bodies and changing sexuality. The role of self-image may provide a reason for the decline in sport participation as shown by Guillet *et al*. (2000:420). Girls are more concerned with the way they present themselves to society. The image of slimness that is promoted in the media seems to be more appealing to females than the bulging muscles appreciated by males (Klomsten *et al*., 2005:625-636). Females also consider social reasons as significantly more important for non-participation in sport than males.

Family income: Families were classified according to low-income, average income and above-average income. It was found that learners from low-income families consider social aspects to be a significant more important reason for not participating in sport than learners from average-income families. A possible explanation for this finding might be that families with a low income regard sport as an important socializing agent where children can make friends, while families with an average income do not. It was also found that learners from families of above-average income , regard self-image as a significantly more important factor for non-participation in sport, compared to learners from families with an average income. Self-image is usually an important factor for people from the higher income groups (Mchunu, 2008).

Grades: No significant differences were found between the reasons for non-sport particpation by black secondary school learners in the different grades with regard to facilities, the political factor , the social factor and the self-image. One cannot say, for example, that black secondary school learners in grade 11 differ significantly from learners in

grade 10 with regard to reasons for non-participation in sport.

Home environment: The type of home environment does not seem to be an important factor to non-participation in sport. Learners from urban, rural or township home backgrounds do not differ significantly with regard to their reasons for non-participation in sport.

SUMMARY

The results suggest that most black learners get discouraged from participating in sport because of a lack of well-maintained and accessible facilities. Most schools in the townships do not have their own sport fields and equipment for use by learners. If any grounds are available, they are often subject to neglect or vandalism, as most of the schools cannot afford a security fence. From the literature studied, the subject of facilities is hardly ever canvassed, especially with regard to black township schools. It is a significant factor since it is one that is easier to rectify than others.

In terms of the political factor as a reason for non-participation in sport, it has surfaced that there are perceptions of cultural isolation of black players in sport. Learners also indicated that some of the reasons they do not participate in sport are racial inequality and the bias exhibited by coaches. Through this research it has also emerged that while gender and income do seem to have an influence on non-participation in sport, grades and home environment do not. The results indicate that income as a reason for non-participation in sport is more important for learners from low-income families than for learners from average-income families. Low-income families seem to have pressing priorities other than sport and there is not enough income to take care of sporting expenses.

REFERENCES

ANDERSEN, M.B. (2000). *Doing sport psychology.* Melbourne: Human Kinetics.

BAR-OR, O. (1995). *The child and adolescent athlete.* Cambridge, MA: Blackwell Science.

BIDDLE, S.J.H.; FOX, K.R. & BOUTCHER, S.H. (2000). *Physical activity and psychological well-being.* London: Routledge.

COAKLEY, J. & DUNNING, E. (2000). *Handbook of sports studies.* London: Sage.

DIAMANT, L. (1991). *Psychology of sports, exercise, and fitness – social and personal issues.* New York, NY: Hemisphere.

GOLDSMITH, P.A. (2003). Race relations and racial patterns in sports participation. *Sociology of Sport Journal,* 20(2): 147-171.

GUILLET, E.; SARRAZIN, P. & FONTAYNE, P. (2000). If it contradicts my gender role I‟ll stop. *European Review of Applied Psychology,* 50(4): 417-421.

HAGGER, M. & CHATZISARANTIS, N. (2005). *Social psychology of exercise and sport.* New York, NY: Open University Press.

HILL, K.L. (2001). *Frameworks for sport psychologists.* Champaign, IL: Human Kinetics.

KIRK, D.; MACDONALD, D. & O‟SULLIVAN, M. (2006). *The handbook of physical education.* London: Sage.

KIRKCALDY, B.D. (2002). The relationship between physical activity and self-image and problem behaviour among adolescents. *Social Psychiatry and Psychiatric Epidemiology,* 37(11): 544-550.

KLOMSTEN, A.T.; MARSH, H.W. & SKAALVIK, E.M. (2005). Adolescents‟ perceptions of

masculine and feminine values in sport and physical education. *Sex Roles*, 52(9-10): 625-636.

MASLOW, A.H. (1970). *Motivation and personality*. New York, NY: Harper & Row.

McCOMB, D.G. (2004). *Sports in world history*. New York, NY: Routledge.

MCHUNU, S.J.A. (2008). Reasons for non-participation in sport by black learners at secondary school level. Unpublished MEd thesis. Pretoria: Unisa.

McMILLAN, J.H. & SCHUMACHER, S. (2001). *Research in education*. New York, NY: Longman.

MERCHANT, J.; GRIFFIN, B.L. & CHARNOCK, A. (2007). *Sport and physical activity: The role of health promotion*. New York, NY: Palgrave Macmillan.

POTGIETER, J.R. (2003). *Sport psychology*: *Theory and practice.* Stellenbosch: Institute for Sport Science, Stellenbosch University.

SINGER, R.; HAUSENBLAS, H. & JANELLE, C.M. (2001). *Handbook of sport psychology*. New York, NY: John Wiley & Sons.

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DOES AEROBIC EXERCISES INDUCE mtDNA MUTATION IN HUMAN BLOOD LEUCOCYTES?

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ABSTRACT

The aim of this study was to determine the effect of eight weeks aerobic training on mitochondrial DNA (mtDNA) mutation in human blood leucocytes. Twenty untrained healthy students (training group: n =10, age = 20.7±1.5 yrs, weight = 67.7±10 kg, BF% = 17.5±7.35 & control group: n =10, age = 21±1.3 yrs, weight = 78.5±18.5 kg, BF% = 18.2±6.4) were randomly assigned to two groups and participated in an eight weeks aerobic training program. Blood samples were collected before and after the eight weeks aerobic training. mtDNA mutation were analyzed using a multiplex polymerase chain reaction (PCR) method. Although, all subjects were fairly young and the possibility of mtDNA mutation at normal condition was unlikely, just to be certain, all blood samples were also analyzed for possible mutation. Those subjects who had mutant mtDNA prior to the study, were excluded. The findings show that there were no changes in mtDNA mutation in human leucocytes in both groups before and after eight weeks aerobic training (P>0.05). These results demonstrate that eight week aerobic training dose not causes mtDNA mutation in human blood leucocytes.

Key words: mtDNA; Oxidative stress; Common deletion; Aerobic training.

INTRODUCTION

Human mitochondrial DNA (mtDNA) is a 16,569-bp circular double-stranded molecule that encodes 37 genes including 13 critical subunits of the respiratory chain complexes, 2 ribosomal RNAs and 22 transfer RNAs. Each nucleated human cell contains a few thousand copies of mtDNA. Because each mitochondrion contains multiple copies of genome (Wallace, 1992), injury results in heteroplasmy, in which each cell contains mtDNA molecules with varied sequences (Grossmann, 1990; Wallace, 1992).

Mitochondria are composed of gene products originating from both nuclear and mitochondrial DNA (nDNA and mtDNA, respectively). Mutations within mtDNA occur at a

significantly higher frequency than in nDNA because mtDNA lack a protective histone sheath, has minimal DNA repair activity, and is located in close proximity to reactive oxygen species (ROS) produced via the electron transport chain (Bohr *et al.*, 2002; Adhihetty *et al*., 2003). Also, this mutation in the regulatory regions of mtDNA could interfere with replication, transcription, or processing of mitochondrial transcripts (Larsson & Clyton, 1995). Increased mtDNA mutation frequently occurs in humans with aging (Fayet *et al.*, 2002; Liu *et al*., 1998) and has been associated with a number of age related degenerative diseases (Berneburg *et al*., 2006).

In addition, oxygen metabolism within the mitochondria cause the production of ROS such as the superoxide radical, the hydroxyl radical and hydrogen peroxide (Chance *et al*., 1979). The production of such potentially harmful substances increases during aerobic exercise where oxygen consumption within the mitochondria increases 10-40 times the resting level which could damage mtDNA (Ji, 1995; Liu *et al.*, 2000; Leeuwenburgh & Heinecke, 2001).

Many studies have identified mutations or deletions of mtDNA as responsible for dysfunction of energy production or an increase in necrosis in tissues (Sakai *et al.*, 1999). Also, acute overload exercise has been demonstrated to cause a mtDNA deletion in the soleus muscle and

the tibial anterior muscle of Wistar rats (Sakai *et al.,* 1999). One of the deletions appears in regions of the same alignment and is known as a common deletion (Schon *et al.,* 1989; Corral-Debrinski *et al.,* 1992; Chung *et al.,* 1994). This mtDNA deletion is 4977 bp in length ($mtDNA^{4977}$) in human mtDNA and is often seen with increasing age (Hayakawa *et al*., 1992).

Iwai *et al.* (2003) examined dynamic changes of deleted mtDNA in human leucocytes after endurance exercise. They demonstrated that a common deletion in leucocytes disappears over a period of several days after endurance exercise and reappears a number of days thereafter. Sakai *et al.* (1999) showed that acute exercise loading causes a deletion in mtDNA in rat skeletal muscle, and concluded that the oxidative stress induced by acute exercise modifies mtDNA. Jafari *et al.* (2005) demonstrated that one session of aerobic exercise dose not cause mtDNA deletion in rat skeletal muscle.

However, there is not consensus about aerobic training induced mtDNA deletion in human blood leucocytes. In addition, in previous studies mtDNA has been extracted from tissues. These studies have been limited to the biochemical and histochemical aspects. This method can, however, be painful and distressing for the human subjects. Also, there is a strong correlation between the degree of heteroplasmy in blood leukocyte and oral mucosa DNA (Van Essen *et al.,* 2000). In order to determine whether mtDNA mutations are notable in easily accessible tissue, we examined the effect of aerobic exercise training on mtDNA deletion in blood leucocytes of untrained healthy young men.

MATERIAL AND METHODS

Subjects

Twenty untrained male students voluntarily participated in this study and were randomly assigned to either aerobic training (mean ± SD: age = 20.7±1.5 yrs, weight = 67.7±10 kg, BF% = 17.5±7.35, n =10) or a control group (mean ± SD: age = 21±1.3 yrs, weight = 78.5±18.5 kg, BF% = 18.2±6.4, n = 10). Subjects were informed of the experimental risks and signed an informed consent document prior to the investigation. Exclusion criteria included: evidence of coronary heart disease; congestive heart failure; uncontrolled hypertension; chronic obstructive pulmonary disease; renal failure; major orthopedic disability; smoking and supplementing by vitamins A, C and E. Subjects were asked to follow their normal routine diet during the study and not to perform any strenuous exercise two days before attending the laboratory. The study protocol was reviewed and approved by the research committee at the University of Guilan. Physical examination prior to the test revealed no barriers to endurance exercise in any of the subjects.

Exercise and blood sampling

Subjects exercised three times a week at 60 rpm for 30 min in a session for eight weeks on a cycle ergometer. Training load was increased gradually during the study from 50 to 75% of heart rate reserve (HRR) on each subject. Peripheral blood samples were obtained from the subjects' antecubital vein before and after eight weeks of aerobic training.

Extraction of mtDNA and multiplex PCR

DNA was extracted from blood samples after lyses of white blood cells using a DNA extraction kit **(**Diatom DNA Extraction Kit, Gen fanavaran, Iran). Multiplex polymerase chain reaction (PCR) (table 1) was carried out using two sets of primers: ONP89/ONP86 and ONP74/ONP25. The primers were used to amplify at 279-bp fragment in the deleted region as an internal control in each sample. PCR products were separated on 2% agarose gels, run in 0.5X TBE at 110 V for 50 min, stained in 0.02 µg/mL ethidium bromide and visualized by means of UV light (figure 1). Genomic DNA (50 ng) was added to Multiplex PCR mixture and amplified as follows: 94°C for 5 minutes, followed by 35 cycles of 94°C for 60 seconds, 55°C for 60 seconds, and 72°C for 60 seconds, with a final extension at 70°C for 10 minutes. Position and oligonucleotide sequences of primers used in PCR amplification are presented in table 2.

TABLE 1. **THE MULTIPLEX POLYMERASE CHAIN REACTION (PCR)**

Taq 0.5u	ONP_{86} 10ρmol/µl	ONP_{89} 10ρmol/µl	ONP_{74} 10ρmol/µl	ONP_{25} 10ρmol/µl	DNA 50ng/µl	dNTP 10mmol	PCR $buffer_{10}$ ^{x} + Mgcl2	H_2O
1 µl	1 µl	1µl	1µl	1µl	1 µl	0.7 µl	2.5 µl	15.8 µl

TABLE 2. **POSITION AND OLIGONUCLEOTIDE SEQUENCES OF PRIMERS USED IN PCR AMPLIFICATION**

Gen Sequencing	**Position of oligonucleotide**	**Primer**
ND_2 CCCTTACCACGCTACTCCTA-3'	5'- 5461 – 5480	ONP_{86}
OL GGCGGGAGAAGTAGATTGAA-3'	5'- 5740 – 5721	ONP_{89}
CO_{II} CTACGGTCAATGCTCTGAAA-3'	5'- 8161 – 8180	ONP_{25}
ND_5 GGTTGACCTGTTAGGGTGAG-3'	5'- 13640 – 13621	ONP_{74}

Statistical analysis

All values were expressed as mean ±SD. The sign test was used to compare mtDNA mutation before and after the eight weeks aerobic training.

RESULTS

Blood samples were screened for $mtDNA^{4977}$ site using the multiplex PCR. No mtDNA mutation was found in human blood leucocytes samples before and after the eight weeks aerobic training. Also, the results of sign test revealed no significant difference in mtDNA mutation between pre- and post test in both groups ($P>0.05$).

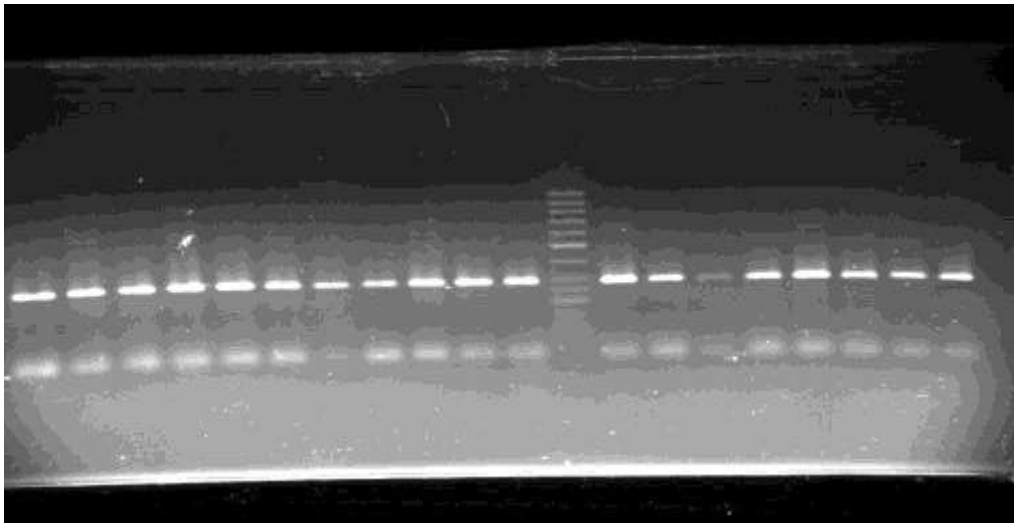

FIGURE 1. **IMAGE OF AGAROSE GEL WITH THE CONTROL BANDS AMPLIFIED. THE FRAGMENTS OF MTDNA WERE SEPARATED ON 2% AGAROSE GEL AND STAINED WITH ETHIDIUM BROMIDE AND VISUALIZED BY MEANS OF UV LIGHT**

DISCUSSION

The most frequent and best characterized mutation of mtDNA is a 4977 bp deletion, designated as the common deletion. This deletion includes genes for the NADH dehydrogenase complex, cytochrome-c oxidase and ATP-synthetase, all of them functionally important enzymes in the respiratory chain. The common deletion has been detected in suprabasal levels in hereditary diseases (Boles *et al.*, 1998), developmental disorders, aging tissues and following UV radiation (Berneburg *et al.*, 2000). Furthermore, it is closely linked to ROS which the common deletion is almost absent when ROS quenching agents (antioxidants) were added (Bernburg *et al.*, 1999).

Alternatively, reports indicate that prolonged and intense exercise is associated with increases in skeletal muscle oxidative stress and ROS production, which have the potential to damage mtDNA and increase susceptibility of mitochondrial membrane proton conductance to oxidative stress (Di Meo & Venditti, 2001; Ji, 1999).

There are a few studies on mtDNA damage induced by aerobic training. Our findings however showed that eight week aerobic training (three times a week at 60 rpm for 30 min at 50 to 75% HRR) did not induced mtDNA deletion which is in accordance with Jafari *et al.*, (2005), demonstrating that one session of aerobic exercise does not cause mtDNA deletion in rat skeletal muscle. However, our results are inconsistent to the findings of Sakai *et al.* (1999) that showed that acute exercise loading causes a deletion in mtDNA in rat skeletal muscle, and concluded that the oxidative stress induced by acute exercise modifies mtDNA. This difference may be due to difference in subjects, training intensity, volume, training period (acute versus chronic) and the difference between mtDNA in tissues and blood leucocytes.

Iwai *et al.* (2003) examined the dynamic changes of the deleted mitochondrial DNA in human blood leucocytes after endurance exercise. In this study, the $mtDNA^{4977}$ deletion in leucocytes was detected prior to the exercise regime in all five subjects, who were all living normal, exercise-free lifestyles. They demonstrated that the common deletion in leucocytes disappear over a period of several days after endurance exercise and reappears a number of days thereafter. In our study, the $mtDNA^{4977}$ deletion in leucocytes was not observed prior to the exercise regime and aerobic exercises did not induce mtDNA deletion in human blood leucocytes.

To date, there have been no investigations examining the effect of long-term aerobic exercise on mtDNA deletions in blood leucocytes of young healthy men. However, mtDNA deletions have been quantified before and after resistance training in patients with mitochondrial disease (Taivassalo *et al.,* 1999). Parise *et al.* (2005) reported that fourteen weeks of progressive resistance exercise training resulted in a significant reduction in oxidative damage to DNA, and there was no change in the number of mtDNA deletions.

Importantly, the findings from our study suggest that aerobic training does not augment the number of mtDNA deletions, and we hypothesis that positive adaptation, may serve to help reduce the rate at which mtDNA aberrations accumulate with age. Although the precise mechanisms underlying this adaptation requires further investigation, we postulate that prolonged aerobic exercise can lead to up-regulation of inducible antioxidant systems

including antioxidant enzymes and the GSH systems (not measured) which have demonstrated prominent adaptive responses to chronic aerobic training (Ji, 1997; Hollander *et al.,* 2000; Radak *et al.,* 2001). It is proposed that ROS production decreases due to antioxidant system adaptations subsequently attenuating mtDNA damage. In addition, it appears that oxidative stress-induced adaptations therefore play an important role in the beneficial effects of regular exercise.

In conclusion, eight week aerobic training did not induce mtDNA deletion in human blood leucocytes. The lack of any effect on mtDNA in the present study may be due to the relatively short period of exercise training in this study precluding our ability to detect changes in mtDNA. Also, small sample size may affect on our results. Further work is needed to elucidate the mechanism responsible for the positive effect of aerobic exercise on mtDNA damage. Also, further work is needed to examine the effect of different types of aerobic training on mtDNA deletion, oxidative DNA damage biomarkers, and mtDNA content.

REFERENCES

ADHIHETTY, P.J.; IRRCHER, I.; JOSEPH, A.M.; LJUBICIC, V. & HOOD, D.A. (2003). Plasticity of skeletal muscle mitochondria in response to contractile activity. *Experimental Physiology,* 88: 99-107.

BERNEBURG, M.; GRETHER-BECK, S.; KURTEN, V.; RUZICKA, T.; BRIVIBA, K.; SIES, H. & KRUTMANN, J. (1999). Singlet oxygen mediates the UVA-induced generation of the photoaging-associated mitochondrial common deletion, *Journal of Biological Chemistry,* 274: 15345-15349.

BERNEBURG, M.; PLETTENBERG, H. & KRUTMANN, J. (2000). Photoaging of human skin, *Photodermatology, Photoimmunology and Photomedicine*, 16: 239-244.

BERNEBURG, M.; KAMENISCH, Y. & KRUTMANN, J. (2006). Repair of mitochondrial DNA in

aging and carcinogenesis. *Photochemical & Photobiological Science*, 5: 190-198.

BOHR, V.A.; STEVNSNER, T. & DE SOUZA-PINTO, N.C. (2002). Mitochondrial DNA repair of oxidative damage in mammalian cells. *Gene*, 286: 127-134.

BOLES, R.G.; ROE, T.; SENADHEERA, D.; MAHNOVSKI, V. & WONG, L.J.C. (1998). Mitochondrial DNA deletion with Kearns sayre syndrome in a child with Addison disease, *European Journal Pediatrics*, 157: 643-647.

CHANCE, B.; SIES, H. & BOVERIS, A. (1979). Hydroperoxide metabolism in mammalian organs. *Physiological Reviews*, 59: 527-605.

CHUNG, S.S.; WEINDRUCH, R.; SCHWARZE, S.R.; McKENZIE, D.I. & AIKEN, J.M. (1994). Multiple age-associated mitochondrial DNA deletions in skeletal muscle of mice. *Aging Clinical Experimental Research*, 6: 193-200.

CORRAL-DEBRINSKI, M.; HORTON, T.; LOTT, M.T.; SHOFFNER, J.M.; BEAL, M.F. & WALLACE, D.C. (1992). Mitochondrial DNA deletions in human brain: regional variability and increase with advanced age. *Nature Genetics*, 2: 324-329.

DI MEO, S. & VENDITTI, P. (2001). Mitochondria in exercise-induced oxidative stress. *Biological Signals and Receptors*, 10: 125-140.

FAYET, G.; JANSSON, M.; STERNBERG, D.; MOSLEMI, A.R.; BLONDY, P.; LOMBES, A.; FARDEAU, M. & OLDFORS, A. (2002). Ageing muscle: clonal expansions of mitochondrial DNA point mutations and deletions cause focal impairment of mitochondrial function. *Neuromuscular Disorders*, 12: 484-493.

GROSSMANN, L.I. (1990). Mitochondrial DNA in sickness and in health. *American Journal* of *Human Genetics*, 46: 415-417

HAYAKAWA, M.; HATTORI, K.; SUGIYAMA, S. & OZAWA, T. (1992). Age-associated oxygen damage and mutations in mitochondrial DNA in human hearts. *Biochemistry & Biophysics*, 189: 979-985.

HOLLANDER, J.; BEJMA, J.; OOKAWARA, T.; OHNO, H. & JI, L.L. (2000). Superoxide dismutase gene expression in skeletal muscle: fiber-specific effect of age. *Mechanisms of Ageing and Development*, 116: 33-45.

IWAI, K.; MIYAO, M.; WADANO, Y. & IWAMURA, Y. (2003). Dynamic changes of deleted mitochondrial DNA in human leucocytes after endurance exercise. *European Journal Applied Physiology*, 88: 515-519.

JAFARI, A.; POURFAZI, M.A.H.; RAVASI, A.A. & HOUSHMAND, M. (2005). Effect of aerobic exercise training on mtDNA deletion in the skeletal muscle of trained and untrained Wistar Rats. *British Journal of Sports Medicine*, 39: 517-520.

JI, L.L. (1995). Oxidative stress during exercise: implication of antioxidant nutrients. *Free Radical Biology and Medicine*, 18: 1079-1086.

JI, L.L. (1997). Adaptations of glutathione antioxidant system to endurance training are tissue and muscle fiber specific. *American Journal Physiology*, 272: R363-R369.

JI, L.L. (1999). Antioxidants and oxidative stress in exercise. *Proceedings of the Society for Experimental Biology and Medicine*, 222: 283-292.

LARSSON, N.G. & CLYTON, D.A. (1995). Molocholar genetic aspects of human mitochondrial disorders. *Annual Review of Genetics*, 29: 151-178.

LEEUWENBURGH, C. & HEINECKE, J.W. (2001). Oxidative stress and antioxidants in exercise. *Current Medicinal Chemistry*, 8: 829-838.

LIU, V.W.; ZHANG, C. & NAGLEY, P. (1998). Mutations in mitochondrial DNA accumulate differentially in three different human tissues during ageing. *Nucleic Acids Research*, 26: 1268-1275.

LIU, J.; YEO, H.C.; OVERVIK-DOUKI, E.; STEPHANIE, J.T.; DANIEL D.W.; GEORGE C.;

BROOKS, A. & AMES, B.N. (2000). Chronically and acutely exercised rats: biomarkers of oxidative stress and endogenous antioxidants. *Journal of Applied Physiology*, 89: 21-28.

PARISE, G.; BROSE, A.N. & TARNOPOLSKY, M.A. (2005). Resistance training decreases oxidative damage to DNA and increases cytochrome oxidase activity in older adults. *Experimental Gerontology*, 40: 173-180.

RADAK, Z.; TAYLOR, A.W.; OHNO, H. & GOTO, S. (2001) Adaptation to exercise-induced oxidative stress: from muscle to brain. *Exercise Immunology Review*, 7: 90-107.

SAKAI, Y.; IWAMURA, Y.; HAYASHI, J.; YAMAMOTO, N.; OHKOSHI, N. & NAGATA, H. (1999). Acute exercise causes mitochondrial DNA deletion in rat skeletal muscle. *Muscle & Nerve*, 22: 258-261.

SCHON, E.A.; RIZZUTOTO, C.T.; MORAES, C.T.; NAKASE, H.; ZEVIANI, M. & DIMAURO, S. (1989). A direct repeat is a hotspot for large-scale deletion of human mitochondrial DNA. *Science*, 244: 346-349.

TAIVASSALO, T.; FU, K.; JOHNS, T.; ARNOLD, D.; KARPATI, G. & SHOUBRIDGE, E.A. (1999). Gene shifting: a novel therapy for mitochondrial myopathy. *Human Molecular Genetics*, 8: 1047-1052.

VAN ESSEN, E.H.R.; ROEP, B.O.; 't HART, L.M.; JANSEN, J.J.; VAN DEN OUWELAND, J.M.W.; LEMKES, H.H.P.J. & MAASSEN, J.A. (2000). HLA-DQ polymorphism and degree of heteroplasmy of the A3243G mitochondrial DNA mutation in maternally inherited diabetes and deafness. *Diabetic Medicine*, 17: 841-847.

WALLACE, D.C. (1992). Disease of mitochondrial DNA. *Annual Review of Biochemistry*, 61: 1175-1212.

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RISK MANAGEMENT PRACTICES OF HIGH SCHOOL SPORT COACHES AND ADMINISTRATORS

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ABSTRACT

Sport and recreation constitute a significant part of the learning experiences at schools in South Africa. They provide the subject matter of learning and instruction in sport and physical education. Research on safety in sport has been conducted in the USA, Britain, Canada, Australia and other developed countries since the 1950s. There is a paucity of empirical, evidence-based information on safety and security of learners participating in sport activities in South Africa. The purpose of this study was to identify the key safety dimensions of school sport, and to assess the risk management practices implemented by coaches and administrators at high schools. The aim was also to highlight the chief problems associated with safety in sport and to develop strategies to protect learners. The findings could raise awareness of coaches, administrators and relevant role players concerning their legal duties. A previously validated and pilot tested instrument was used to gather data. Purposive sampling was done in three provinces. Several dimensions and individual safety factors were not adequately addressed by relevant personnel, and certain basic minimum requirements were not met at a fair number of schools. These findings support previous reports by researchers that coaches and administrators are not adequately aware of, or do not fully appreciate the implications of their legal liability relative to sports activities at schools. Recommendations and guidelines have been offered to enable coaches and educators manage potential risks so that athletes and other learners experience a non-threatening environment where they gain optimally from sports activities.

Key words: Safety; Learners; Coaches; Administrators; Liability; Risk management.

INTRODUCTION

Most educational institutions in Africa have been influenced by the British system of education. One of the lasting legacies of British colonialism is the philosophy that significant benefits could be derived from participation in sport activities, and the diversity of such activities continues to grow. The central idea is that personal and social development of learners can be considerably improved through such activities (Grayson, 2001).

South African schools provide learners opportunities to participate in both intramural and extramural sports. Where the resources permit, schools also offer Physical Education (PE) as a component within the Life Orientation syllabus. It is not the authors‟ intention here to debate the merits of participation in school based sports activities. These have long been established globally (UNESCO, 1978; UN, 1989; Trost *et al*., 2002; Kemp, 2008; Naidoo *et al*., 2009). What is crucial though is to investigate the manner in which the expected outcomes are met, and in particular what preventive strategies coaches and administrators implement to ensure that learners are not exposed to unnecessary risks through their participation in sport activities.

Schools are one of the accepted settings for promotion of health and well-being. However, in most South African schools formal PE is non-existent. Wherever PE was offered, it has been significantly rationalised. This situation can be ascribed to a lack of qualified PE specialists and limited funding available for such low priority, non-examination subjects at schools (Singh, 2004; Naidoo *et al*., 2009). These circumstances provide the backdrop for the key research questions of this study:

1. Do secondary schools provide appropriate facilities and equipment for sport participation?
2. Do the learners participating in sports have the appropriate level of skills and knowledge to engage safely without risk of harm to themselves and opponents?
3. Are the learners sufficiently prepared (in terms of health and fitness) to participate in competitive sports activities?
4. Do the coaches and administrators (who are not qualified specialists) have the requisite knowledge and skills to offer instruction in sport without exposing learners to unnecessary accidents, injury or harm?
5. Do the coaches and administrators appreciate and understand why it is vital for a non-threatening, nurturing environment to be provided during school sport participation?
6. Do these adult personnel comprehend their legal responsibilities of providing the appropriate standard of care to learners in sport?
7. Do schools have comprehensive risk management plans to ensure that all learners are protected from foreseeable risks of harm, injury and even death?

As the Government‟s national agenda appears to be focused on promoting elite sport at the expense of PE (Van Deventer, 2004), it exerts even further pressure on learners to excel in school sport so that they feed into the club system of high performance sport. While this sport development continuum is based on a sound philosophy, the concern is about the state of play within school sport. This concern is heightened as several studies indicate that the actual

numbers of learners participating in sport and recreational activities has increased overall. This is due to the increased access of learners to sport participation and to the pervasive influence of the media and sport on youth and children (Grayson, 2001; Singh, 2004).

AIMS

This project aimed to identify and assess the current practices related to the management of school sport. The following were specific aims:

1. To determine how risks in school sport are managed, and what policies, procedures and practices are established.
2. To assess the management of risks in sport by coaches and administrators at secondary schools.

In particular, the paper aims to establish how high school coaches and administrators address their responsibilities in terms of providing safe learning environments and opportunities for learners in sport activities. A secondary aim of this study was to raise the awareness of educators about legal issues involving learners participating in sport and physical recreation activities; and to educate youth sport leaders to what is current, practical and safe. In a learner-centred environment it is expected that the learners would be the primary beneficiaries of any improvements made to the manner in which coaches and administrators plan and implement safety precautions and procedures.

THE LEGAL BACKGROUND TO SAFETY AT SCHOOLS

The three main parliamentary laws promulgated to regulate the management of education and schools are the National Education Policy Act, 27 of 1996, the South African Schools Act, 84 of 1996 and the Educators‟ Employment Act, 138 of 1994. One of the general laws which was not specifically promulgated for education but which may impact on education is The Child Care Act, 74 of 1983, which focuses on the protection of children. The other general legislation is The Occupational Health and Safety Act, 85 of 1993, which regulates safety in the work environment. Another source of law that impacts on education is common law. Many of the statutory provisions relating to education directly or indirectly embody doctrines and principles of common law such as the Rules of Natural Justice, *Audi alteram partem* and *In loco parentis* (Oosthuizen, 1998).

The principle of *in loco parentis* applies to all people in a relationship with children (ie. learners in their care) be they school principals, administrators, coaches, educators, referees, and even volunteers who undertake certain responsibilities. The term literally means “in the place of parents”. In other words, educators should take care of learners in their charge as their parents would take care of them. For effective and safe coaching to exist it is required that coaches are aware of and understand their legal responsibilities in addition to possessing technical competence in the specific sport. The *in loco parentis* doctrine creates legal liability based on the duty of care to be exercised where there is foreseeable risk of harm or injury for which a breach will lead to liability. Understandably, the standard of care will be influenced by several factors such as the age and maturity of learners, their size, and skill levels (Grayson, 2001).

Because of international concerns, Singh (2001) identified the following key dimensions in a content analysis of risk management principles and practices that sport organisations should

apply in order to promote safety in sport: Supervision and Instruction; Facilities and Equipment; Medical Care; Travel and Transportation; Insurance; Civil Rights; and the use of Written Documentation. Within each dimension the various factors that comprise them are discussed.

Instruction and Supervision

The content analysis revealed that instruction to staff, from staff to students, and from staff to the community dominated the literature. Firstly, staff must be trained to adopt existing legal standards (Carpenter, 1995). Secondly, qualified personnel must be hired to utilize safe teaching methods and techniques and to provide safe environments. Court rulings in South

Africa, England, and USA have made it clear that skilled education professionals and their employers are placed in the same legal frame as doctors, dentists, nurses and other skilled practitioners in terms of the competent exercise of their specialist skills (Grayson, 2001). The active supervision of activities was emphasised by all authors. The responsibility to adequately warn participants and spectators of the risk of injuries was discussed by all. The matching of participants in sport was mentioned by most of the writers. The importance of educating the public in reducing litigation cannot be underestimated (Parmanand, 1987; Gardiner *et al*., 1998).

Facilities and Equipment

The duty to provide safe facilities for athletes and spectators and proper equipment for athletes was another area that was outlined by all authors. Most of the authors recognized the importance of well-defined emergency procedures for an accident or injury to athletes. About half the researchers saw the necessity for accurately compiled injury reports based on facts. Authors also discussed the issue of medical permission to return to activity following an injury incurred by an athlete (Singh, 2001).

Travel and Transportation

Researchers also mentioned safe travel and transportation as important concerns. They pointed out the need for insurance, emphasizing liability insurance rather than accident or catastrophic insurance (Singh, 2001).

Written Records

The one approach recommended in all sources to identify and reduce risk was the use of printed forms to record what had been done and to provide evidence as a solid defense against liability (Opie, 1993; Carpenter, 1995). The courts demand that any practice used to reduce risk be verified in writing to provide any protection. The writing could take a variety of forms eg. checklists, log-sheets, handbooks, manuals and records of events. Documentation should cover accident reporting, medical history, staff meetings, coach or instructor certification, hiring procedures, requests for equipment repair, and so forth. Even the documentation of the risk management plan is important.

METHODOLOGY

The study design comprised a survey. Primary data was gathered by the use of a questionnaire that was developed by Gray (1995) and adapted by the authors to suite the

conditions prevalent in the South African education system. A panel of three South African researchers, and three specialists (1 international) in sport law reviewed the questionnaire and made further suggestions that would improve its reliability. A statistician (STATKON) validated the questionnaire. The survey was divided into two parts: the first part dealt with the risk management behaviours of principals of these schools, and this data has already been published; the second part dealt with the risk management practices of coaches and administrators, and is the subject focused on in this paper.

The questionnaire sought information on six broad areas: 1. General legal liability (insurance; sport association rules & regulations; standard of care, transport; supervision & instruction); 2. Facilities; 3. Equipment; 4. Legal concepts/aspects; 5. Medical aspects (pre-season; in-season; and post-season); 6. Records and Information on Athletes (health records; documents from parents). The questionnaire made use of a differential sliding scale checklist to assess the various aspects of risks anchored on a 5 point scale, with 1= strongly disagree to 5=strongly agree. Frequencies, means, standard deviations and cross tabulations were computed and used to report on.

Secondary data was obtained by the use of a literature study on risk management related to educational institutions. Policies and procedures of the Department of Education related to school sport were reviewed to provide additional information. The most relevant legislation was reviewed and taken into consideration. Purposive sampling was done from secondary schools in Gauteng, KwaZulu-Natal and the Free State. Three hundred questionnaires were distributed, and approximately 30% (91) of them were returned. This could possibly have occurred because coaches and administrators did not want to report on matters that they considered could have legal implications for their schools, despite the promise of confidentiality.

RESULTS AND DISCUSSION

Demographics

Public schools comprised 91% of the sample, private schools 6.7% and independent schools 2.2%. Regarding their location, 57.1% of schools were urban, 20.2% were suburban and 22.6% were rural. The mean (rounded off to nearest whole number in this section) number of boys at these schools was 388 and the mean number of girls was 414. The mean number of male staff at these schools was 15 and the mean number of female staff was 21. The mean number of coaching staff comprised 11 full time educators, eight paid coaches and three volunteers. Males comprised 81.9% and females 18.1% of the sample of coaches and administrators.

Of the respondents, 96.6% were coaches and 83.7% were also administrators. It must be emphasized that with limited human resources, most educators at schools serve a dual function in relation to sport responsibilities. Schools are hardly in a position to afford dedicated coaches who are not also administrators. The exception is where paid external coaches are hired. With regard to coaching or administration status, 57.1% worked full-time, 60.3% were part-time coaches, administrators or PE teachers. The proportion who coached more than one sport was 78.2%. This has added implications for safety as these coaches consequently need to be prudent, up to date and vigilant to ensure that they utilize current knowledge and techniques to reduce or prevent accidents and injuries.

The mean number of years of coaching or administration experience respondents had was 12 years, whereas their mean age was 38.37 years. Their highest academic qualifications were a teacher‟s diploma (39.7%), bachelor‟s degree (25%), or an honours degree (22.1%). The first qualification was sport related for 38.8% of the sample. It is therefore expected that with such a profile educators at secondary schools should have a fair knowledge and awareness of

liability issues in sport related activities. It is significant to bear in mind that Singh (2005) and Basson and Loubser (2003) emphasized the standard of care educators owe to learners is not just that of an ordinary, prudent person (*diligens paterfamilias*). Educators have to possess an inherent body of knowledge about and skill and experience in the profession or industry. As a result of this „professionalism‟, educators are raised to a higher standard of care.

Whereas 53.6% of educators did possess a certificate of competence from one of the National Sport Federations, 46.4% had no such certification. Valid first aid certification was held by only 39.1% in comparison with 60.9% who had no certification. In the case of coaches it is a legal requirement that they be competent in the sport they coach, and that they possess a valid first aid certificate. According to Basson and Loubser (2003), the coach is responsible for helping to provide a safe environment for players; for evaluating injury or capacity; for properly matching participants; and for administering first aid and activating the emergency medical system. Hence it is clear that high proportions of relevant personnel do not have the requisite qualifications or expertise to address these responsibilities.

The problem of competence of educators engaging in sport duties is a serious concern especially in terms of the quality of instruction and supervision learners receive (Grayson, 2001; NASPE, 2004). It raises an important question. Who has the responsibility to train these coaches, officials or sport administrators? It is clear that National Sport Federations assist with this responsibility partially, but it cannot be their legal responsibility to do so as they do not have a relationship with the educator and therefore no duty. As the Department of Education or School Governing body is the employer of educators, a relationship exists and the responsibility is squarely theirs. Educators are expected to perform certain functions in sport within the course and scope of their jobs. The Education Authority therefore could be held vicariously liable for acts of educators that breach their duty of care which may create liability. Hence, at almost half of the schools (46.4%) there appears to be a problem to meet this basic legal requirement. It implies that at almost one in two schools learners participating in sport activities are exposed to risks of injury and harm resulting directly from the incompetence of educators.

GENERAL LEGAL RESPONSIBILITY

For ease of reporting, the strongly disagree and disagree columns of all components have been totaled together and regarded as disagreement with the statements, and similarly the strongly agree and agree columns have been added together and regarded as agreement.

Insurance

While 32.5% of schools have a comprehensive insurance plan, more schools (36%) do not. More schools (35.2%) do not have a legal advisor for insurance than those that do (33%). More school coaches or administrators know the difference between accident and liability

insurance (37.9%) than those that do not (26.4%). More schools reported that they do not cover volunteers for accident and liability insurance (44.9%) than those that do provide cover (12.3%). More schools (31.5%) do not have adequate monetary amounts of sport insurance than those that do (28.1%). At more schools (29.3%) monetary amounts of sport insurance are not kept up to date in comparison to 27% of schools where they are.

The purpose of insurance is to help schools protect their property and meet their legal obligations without having recourse to the scarce funds required to provide education. It is therefore critical that schools ensure that they arrange insurance and that educators in management positions understand the different categories of insurance, especially the need for liability insurance. There is little advantage in having insurance, if the monetary amounts are not adequate nor kept current. Where the school does not have expertise in insurance matters, it is recommended that they engage a legal advisor (Grayson, 2001; Basson & Loubser, 2003). It is a concern that most schools do not provide insurance cover for volunteers, especially since there is a high level of reliance on the services of volunteers in school sport throughout South Africa. This is probably due to the prevalent misconception that volunteers cannot be held liable for certain misdemeanours since they are not part of school staff. On the contrary, volunteer coaches or administrators of school sport are held to the same duty of care as paid professional educators are.

Sport association rules and regulations

In the vast majority of schools (85.6% on average) coaches and administrators are aware of and adhere to the rules and regulations of the relevant school sport governing association. In only an average of 6% of schools this is not the case. It is crucial that coaches, officials and sport coordinators at schools enforce their association‟s rules and regulations so that injuries and accidents are reduced or prevented. Particular care should be demonstrated by referees in the application of safety rules, as opposed to ordinary playing rules, of a sport that involves risks of serious injury in the game. This is particularly relevant in the case where laws of a game such as rugby have been amended specifically with the aim of reducing the risk of injury in the scrum, or modified rules have been introduced for younger players to protect them from harm (Grayson, 2001; Basson & Loubser, 2003).

Standard of care

On average 66.4% of respondents agreed that an appropriate standard of care was provided to learners, whereas an average of 16.9% disagreed. A total of 30.1% indicated that special supervision is not provided for inexperienced and/or less qualified coaches. A total of 20.5% indicated that competent coaches or administrators are not assigned to conduct and/supervise practice in the absence of the coach. A total of 16.5% of coaches and administrators do not realize that if they assign unqualified personnel to conduct an activity, they may be held liable should a learner suffer any harm as a result.

In terms of the *in loco parentis* doctrine, it creates legal liability based on the duty of care to be exercised where there is foreseeable risk of harm or injury for which a breach will lead to liability (Grayson, 2001; Singh & Gray, 2002). In this regard, Basson and Loubser (2003) stress that educators and supervisors have a duty to exercise reasonable care towards children, implying that conditions on the schools premises or sports fields should be safe. In *Knouwds v Administrateur, Kaap,* (1981), an eight year old school girl was injured on the school premises when she fell over a lawn mower that was operated by a caretaker while she and her

friend were racing across the lawn. Her friend pushed her to prevent her from passing and winning the „race" and she was injured when she lost her balance and put her hand on the mower. The court found the caretaker and staff negligent as they should have foreseen and

guarded against the probability that young children might collide with the lawn mower as it was used at that particular time and space (Basson & Loubser, 2003).

Transport

In general, 64.8% of respondents were in agreement that travel and transport were adequately arranged in terms of safety, whereas 15.5% disagreed. Of concern is that 28.9% were not aware of the liabilities involved in allowing learners to drive their own vehicles to games away from their school. Additionally, 17.6% of respondents did not ensure that vehicles used for transporting athletes were checked for roadworthiness. At 15.6% of schools it is not the practice to ensure that school-owned vehicles or licensed public carriers are used for transporting athletes at all times.

The responsibility of providing appropriate transport could raise additional areas for consideration such as parental consent, indemnities, adequacy and competence of other parent or helper drivers, and the roadworthiness and safety of the school"s minibus or hired transport (Grayson, 2001). While the implications here may appear fairly obvious, it is nevertheless a concern that coaches and administrators at schools expose themselves to potential liabilities for ignoring basic responsibilities relating to providing safe transportation to athletes.

Supervision and Instruction

An average of 67.8% of respondents generally agreed that the level of supervision and instruction was acceptable, whereas an average of 13.7% were in disagreement. Amongst those that disagreed, 23.1% cited the absence of good written policies that prohibit unsupervised sport practice sessions. Further, 21.6% denied that adequate supervision was provided in specialized areas such as change rooms and weight rooms or gymnasiums. Experienced sport educators and coaches would certainly be able to attest to the significance of supervision in these specialized spaces as potentially risky behaviours naturally manifest after boisterous physical activity. At 20% of schools the number of supervisors during practice and competition sessions is insufficient for the number of participants and the kind of activity.

At such schools where inappropriate supervision and instruction at practice sessions or competitions are permitted the learners are clearly exposed to potential risks of accidents and injuries that could be serious and invoke liability. It has been highlighted that supervision and instruction are delegated responsibilities that are crucial and school heads or heads of sport and PE departments are required to ensure that coaches and administrators address athlete safety in their sessions (Singh & Gray, 2002). Grayson (2001) identified adequate supervision as one of the most crucial elements in a risk assessment of any sport. Its control and management are probably the most important issues since they also work in concert with an appreciation of the suitability of premises and equipment. It is recommended that the experience of the chief sport coach or administrator should include the ability to deal with any medical emergency and first aid in addition to the ability to teach or coach the sport itself.

FACILITIES

An average of 52% of respondents reported that facilities at their schools were appropriate for safe participation in sport, whereas an average of 14.6% were in disagreement. Of those that expressed above average dissatisfaction with most statements relating to safe facilities, 23% indicated that there was no clear written policy that identifies who is responsible for the inspection and maintenance of safe sport facilities. Further, 18.9% reported that periodic inspections related to maintenance of sport facilities are not conducted and recorded, whereas 17.8% pointed out that there was no control exercised over the practice of vehicles parking on the edge of playing fields.

At least 12.2% of respondents reported that very basic precautions were not taken as in the case of hazards around playing fields being considered and protective padding or warning with chevron tape being provided. Further, 12.2% reported that potential hazards such as hard walls, slippery floors and glass windows, etcetera were not attended to in order to prevent the possibility of injury. The implications of the results are that for at least half of the schools, it cannot be asserted definitively that their facilities provided environments that were safe for sport participation. These findings are indicative of a serious risk to learners who may be exposed to non-inherent risks purely because of inadequate inspection or poor maintenance of sports facilities. As emphasized by Singh (2004), educators have a legal responsibility to ensure that sport facilities meet the minimum safety standards that are prescribed.

EQUIPMENT

The majority of respondents on average (71.4%) reported that sport and recreation equipment used was safe. However, an average of 9.6% was in disagreement. Of those in disagreement, 15.5% indicated that coaches and administrators were not aware that an athlete is not responsible for knowing necessary kinds of protective equipment needed, or whether equipment is properly fitted or in a safe condition. It was disconcerting that 12.2% of respondents reported that coaches and administrators do not keep up to date equipment and inventory records, whereas a further 12.2% indicated that coaches and administrators do not regularly examine equipment used in contests to ensure that they are free of defects that could cause injury. Further, 12.1% reported that coaches and administrators are not aware that they are liable if rules that specify the use of protective equipment such as helmets, pads or mouthpieces are not enforced.

In terms of the Occupational Health and Safety Act (1993), as well common law principles, educators should not permit damaged or defective apparatus to be used under any circumstances in their sessions. This is vital in the context of the discharge of their duty of care that measures are taken to prevent foreseeable accidents and injuries (Grayson, 2001).

LEGAL ASPECTS

An average of 66.3% of respondents agreed with their coaches‟ and administrators‟ handling of the legal aspects in a safe manner. However, an average of 13.2% disagreed with them. In particular, a total of 20.3% reported that coaches and administrators do not require consent forms from parents before a learner participates in sport activities; a further 18.7% of them do

not know what constitutes liability; 13.2% indicated that coaches and administrators do not

understand the concept of negligence; 12.5% disagreed that coaches and administrators know how to avoid damage suits through preventive measures; and 12.2% do not know and understand the SA Schools Act.

Hence, in more than 13% of schools the legal aspects surrounding sport provision and management are not adequately addressed, creating loopholes in their risk management systems. However, it should be noted that statistics do not reveal the entire risk. It may be misleading that the percentage (13%) of schools where this may apply appears low, to be wary that when the total population of learners of these schools are taken in to account, it represents a significant number of learners who are thus exposed to risks. Another phenomenon that is particularly significant to consider is that any one factor or variable in itself may pose a minor risk of harm, but when non-compliance to numerous factors and variables are considered jointly, then the exposure of learners to risks in sport activities increases exponentially.

MEDICAL ASPECTS

Pre-season

On average 54.3% were in agreement that appropriate medical attention was given to athletes in the pre-season whereas an average of 21.7% disagreed. Over one third (33.8%) of respondents indicated that coaches and administrators do not keep accurate records of injuries occurring during practices and competitions. This finding is consistent with previous results on coaches and administrators at tertiary institutions in South Africa (Singh, 1999), and may be indicative of a national trend. Almost another one third (32.5%) reported that all coaches or administrators do not have proper and up to date first aid training. These findings are exacerbated by the 23% who reported that coaches or administrators do not liaise with medical personnel regarding the prevention of injuries in sport, and a further 19% who reported that schools do not have suitable first aid equipment which is readily available in emergencies. It is alarming that at least 16.3% reported that all coaches or administrators do not have the competence to recognize symptoms that are indicative of injury in sport.

Schools are advised to consult with appropriately trained medical practitioners and to engage their services as independent practitioners or agents where required, as educators cannot be expected to possess the necessary expertise in handling the wide range of medical conditions and emergencies that may arise in sport participation.

In-season

An average of 60% of respondents agreed that medical aspects in-season were adequately addressed, whereas 17.8% were in disagreement. The chief concerns of those who disagreed were the following specific reasons: 28.4% reported that coaches or administrators do not insist on written medical clearance for an injured athlete to return to competition; 25% reported that they are not competent at training and conditioning athletes throughout a season; 21.3% indicated that they are not knowledgeable about proper post injury care and rehabilitation; and 19.3% that there is no ready access to a telephone at all times. These

findings are significant since the literature (Grayson, 2001; Basson & Loubser, 2003) clearly stipulates that seriously injured athletes must not be permitted to return to practice or

competition without written medical clearance.

Post-season

An average of 38.2% agreed that post season medical care of athletes was adequate, whereas an average of 28.5% disagreed. Over one quarter (29.2%) reported that participants in sport are not trained in respect of what to do and what not to do when injuries occur. Further, 28% reported that they do not ensure that athletes maintain their fitness levels in the post season.

It is thus apparent that at fairly high proportions of schools inadequate post-season care is taken of athletes‟ fitness and well-being. It is recommended that coaches and administrators pay attention to providing adequate care of these aspects since it is in their own best interests and that of their athletes that they maintain reasonable levels of fitness in the post season and that they should know what to do when they sustain injuries.

RECORDS AND INFORMATION

Health records

Over one third of respondents (34%) were in agreement that adequate and appropriate health records of athletes were maintained whereas almost an equal proportion (33.35%) disagreed. Over two fifths (40.2%) reported that pre-season physical screening data on athletes were not kept; 33.4% respectively indicated that accurate records of injuries occurring during practices and contests were not kept, and written records on all medical treatment given to athletes were not kept on file; and 26.4% reported that written permission by a doctor allowing injured athletes to re-enter competition were not kept on file.

Documents from parents

Over two thirds of respondents (67.1%) reported that appropriate documentation from parents was maintained on file whereas 12.97 disagreed. At least 16.6% indicated that they did not keep a written letter of consent from parents on file that allows learners to participate in sport, while 12.5% reported that letters from parents requesting that athletes return from sport trips by means other than official transport are neither required nor kept on file. Further, 9.8% indicated that a copy of the athlete‟s birth certificate is not kept on file to verify birth dates.

The importance of maintaining adequate and appropriate documentation and records of athletes cannot be over-emphasised. The literature (Singh, 1999; Singh, 2005; Spengler *et al*., 2006) clarifies that over and above all other reasons for maintaining such accurate records, they provide evidence of measures taken to reduce or prevent accidents and injuries and thus enable sports personnel to defend themselves and their sport programmes in the event of a lawsuit.

CONCLUSION

Although the majority of school coaches and administrators reported that they comply with most legal requirements, it is nevertheless a serious concern that there are a fair proportion of them who do not to comply with the minimum requirements. These non-compliant coaches and administrators would be in violation of the Schools Act, the Occupational Health and Safety Act, Department of Education policies and directives, as well as common law principles. It is morally, educationally, medically, physiologically and legally unacceptable

that learners at educational institutions such as schools be exposed to unreasonable risks of harm at the hands of professional educators. It would be in violation of all the established benefits and values that learners expect from participation in school sport activities.

It is recommended that professional preparation programmes for all educators be revised to include relevant aspects of safety and risk management in sport and physical recreational activities. School Governing Bodies and the school operational management team should engage the services of professionals to assist them in planning and implementing comprehensive risk management plans that address the key components of safety and security in the school environment. By doing this, schools would be demonstrating that they are proactively placing the welfare of their learners above all else.

REFERENCES

BARRIOS, L.C.; JONES, S.E. & GALLAGHER, S.S. (2007). Legal liability: The consequences of school injury. *Journal of School Health*, 77(5): 273-279.

BASSON, J.A.A. & LOUBSER, M.M. (Eds.) (2003). *Sport and the Law in South Africa*. Durban: Lexisnexis Butterworths.

CARPENTER, L.J. (1995). *Legal concepts in sport: A primer*. Reston, VA: AAHPERD.

GARDINER, S.; FELIX, A.; JAMES, M.; WELCH, R. & O"LEARY, J. (2001). *Sports Law* (2nd ed.). London: Cavendish.

GRAY, G. (1995). Risk management behaviors of high school principals in the supervision of their high school physical education and athletic programs. *Journal of Legal Aspects of Sport*, 5(1): 52-59.

GRAYSON, E. (2001). *School sports and the Law*. London: Croner CCH Group.

GREENBERG, M.J. & GRAY, J.T. (1992). *Reduce your risk: Risk management for high school athletic programs*. Milwaukee: National Sports Law Institute, Marquette University Law School.

KEMP, C. (2008). The effect of a physical activity, diet and behaviour intervention on obesity with 9-12 year old children. Unpublished Master"s thesis. Potchefstroom: University of the North-West.

NAIDOO, R.; COOPOO, Y.; LAMBERT, E.V. & DRAPER, C. (2009). Impact of a primary school-based nutrition and physical activity intervention on learners in KwaZulu-Natal, South Africa: A pilot study. *South African Journal of Sports Medicine*, 21(1): 7-12.

NATIONAL ASSOCIATION FOR SPORT AND PHYSICAL EDUCATION (NASPE) (2004). "Health, mental health and safety: physical education and activities". Hyperlink [http://www.nationalguidelines.org/guideline_print.cfm?chapter=physEd]. Retrieved 8 April 2009.

OOSTHUIZEN, I.J. (Ed.) (1998). *Aspects of educational law*. Pretoria: Van Schaik.

OPIE, H. (1993). Coaching and the law. *Sports Coach*, 16(3): 3-8.

PALUSKA, S.A. & SCHWENK, T.L. (2000). Physical activity and mental health: Current concepts. *Sport Medicine*, 29(3): 167-180.

PARMANAND, S.K. (1987). *Sport injuries in the civil law*. Johannesburg: Lex Patria.

SINGH, C. (1999). Tertiary sport and recreation: Playing it safe. Unpublished Doctoral dissertation. Pretoria: University of Pretoria.

SINGH, C. (2001). A review of 20th century literature related to sport law. *South African Journal for Research in Sport, Physical Education and Recreation*, 23(1): 75-83.

SINGH, C. & GRAY, J.T. (2002). Supervision of physical activity: A legal perspective. *The African Journal for Physical, Health Education, Recreation and Dance*, 8(2): 408-424.

SINGH, C. (2004). Risk management in school sports. Unpublished paper delivered at the pre-Olympic

scientific congress, Thessaloniki, Greece, 6-11August.

SINGH, C. (2005). Risk management in sport. In R. Cloete (Ed.), *Introduction to sports law in South Africa* (119-135). Durban: Lexisnexis Butterworths.

SPENGLER, J.O.; CONNAUGHTON, D.P. & PITTMAN, A.T. (2006). *Risk management in sport and recreation*. Champaign, IL: Human Kinetics.

TROST, S.G.; PATE, R.R.; DOWDA, M.; WARD, D.S.; FELTON, G. & SAUNDERS, R. (2002). Psychosocial correlates of physical activity in white and African-American girls. *Journal of Adolescent Health*, 31(3): 226-233.

UNITED NATIONS (1989). *Convention on the rights of the child*. Geneva: UN.

UNESCO (1978). *Charter of physical education and sport*. Geneva: UNESCO.

VAN DEVENTER, K.J. (2004). A case for physical education/life orientation: the health of a nation. *South African Journal for Research in Sport, Physical Education and Recreation*, 26(1): 107-121.

Case Law

Knouwds v Administrateur, Kaap 1981 (1) SA 544 (C) 553.

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TRAVEL MOTIVES OF PARTICIPANTS IN THE CAPE ARGUS PICK N PAY CYCLE TOUR

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ABSTRACT

The Cape Argus Pick n Pay Cycle Tour is the largest cycling events in South Africa. The event attracts approximately 32 000 cyclists from around the world and is hosted in the city of Cape Town. The question underlying this research is, what are the motives for cyclists participating in this event. Therefore the purpose of this article is to determine the reasons (the travel/participation motives) that cyclists participate. The literature review recorded that little research has been done on travel motives of participants in sport events and this was the first of its kind in South Africa. The research was conducted by means of a questionnaire survey and 583 questionnaires were administered. A factor analysis was conducted to determine the travel motives. Five factors were identified socialisation, event attractiveness, personal motivation, escape & relaxation and event attributes. The motives for cyclists are primarily intrinsic. Some of these motives were confirmed by similar research in the field of leisure travel, but new motives were also noted.

Key words: Travel motives; Cape Argus Cycle Tour; Cycling, South Africa; Marketing; Factor analysis.

INTRODUCTION

In 1977, Bill Mylrea and John Stegmann organised the Big-Ride-In cycling event in the city of Cape Town. The reason behind the sport event was to draw attention to the need for cycle paths in Cape Town thereby improving the public infrastructure for the benefit of cyclists in Cape Town. As the event grew, Cape Town's largest newspaper, *The Cape Argus* became the main sponsor. Thereafter, Pick n Pay (a major retailer) became a sponsor hence the name Cape Argus Pick n Pay Cycle Tour (hereafter referred to as ACT). Cycling in South Africa has grown significantly, and this sport event currently attracts in excess of 32 000 participants (Saayman *et al*., 2008). These range from amateur to professional cyclists. The number of foreign cyclists is also on the increase.

The term *sport event* refers to the organisation, marketing, implementation and evaluation of any type of event related to sport. Examples are local school and community sport events, not-for-profit and corporate events (Graham *et al*., 2001).

According to Crockett (1994:1) and Masterman (2005), sport events such as ACT that get significant television coverage will be the best for promoting one's country, region or city. This televised marketing is claimed to be good for attracting future tourists after the event has been telecast. In highlighting the importance of sport events McIntosh *et al*. (1995) stated that

the profession of sport tourism became a growing reality and gave impetus to the pursuit of business entrepreneurship, economic impact and profitability within the tourism industry. To support this, Saayman and Roussouw (2008) indicated that the economic value of an event such as the 2010 FIFA World Cup in South Africa is estimated at approximately R7.6 billion.

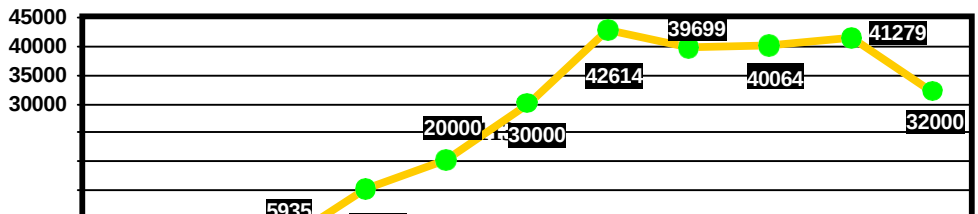

FIGURE 1. **NUMBER OF ENTRIES**

(Source: compiled by the authors)

However, according to figure 1, the number of entries in the ACT from 2007 to 2008 dropped significantly by 9 279 cyclists. Possible reasons for this drop could be due to an increase in similar events as well as a rise in the cost of attending the event. Events are run, participated in, and attended by people and it is therefore important to consider the personal interactions that take place in the nature of the product (Masterman, 2005) Therefore, the purpose of this study is to determine the reasons (the travel motives) that cyclists participate in the ACT in order to market the event effectively. To achieve this purpose, the article is organised as follows: the literature review follows the introduction, then the method of research, which is followed by the results of the research, after which certain implications and conclusions are drawn.

LITERATURE REVIEW

This event, like any other event, consists of a set of role players as illustrated in figure 2. The relationship, the motivation and complexity between these role players eventually determines the success of an event. In this article the focus is primarily on the cyclists.

Traditionally, event marketing refers to the actual marketing of events by event organisers involves marketing to: (1) athletes (cyclists) to secure their participation in the event, (2) the media to cover the event, (3) the general public to attend the event and/or follow the event via print and electronic media, (4) corporations to sponsor and support the event, (5) government officials to provide public support, and (6) private vendors to provide efficient and reasonable services (Graham *et al*., 2001). The aim of marketing, according to Saayman (2006), is the effective and efficient use of resources in the changing environment of today to ensure a profit, survival, and growth of the tourism organisation or destination.

Masterman (2005) states that the common practice of marketing to mass audiences is not an approach that will bear rewards in such operating domains, and so the need for marketing planning in the industry, where customers can be more finely targeted, is becoming more critical. From the literature review it is clear that researchers have experimented with a wide range of variables in order to determine specific target markets (Hsu & Crotts, 2006. The most frequently used variables include demographic (gender, age, income, education), geographic (town, city, country), and psychographic (travel motives, visitor expenditure, behavioural characteristics) (Halan *et al*., 2006). Fodness (1994) and Masterman (2005) stated that effective tourism marketing is impossible without the knowledge and understanding of the consumers' (cyclists') behaviour and motives or, to put it differently, what motivates people to travel or in this case to participate in the event? Motivation refers to the psychological process that gives behaviour purpose and direction whilst the motive is the main objective in

order to satisfy a need (Kreitner, 1989). Rachael and Douglas (2001) add that travel motives also differ from one attraction or event to the next. Therefore Boo and Jones (2009) emphasize that travel motives should be seen as a prerequisite to an effectives marketing strategy.

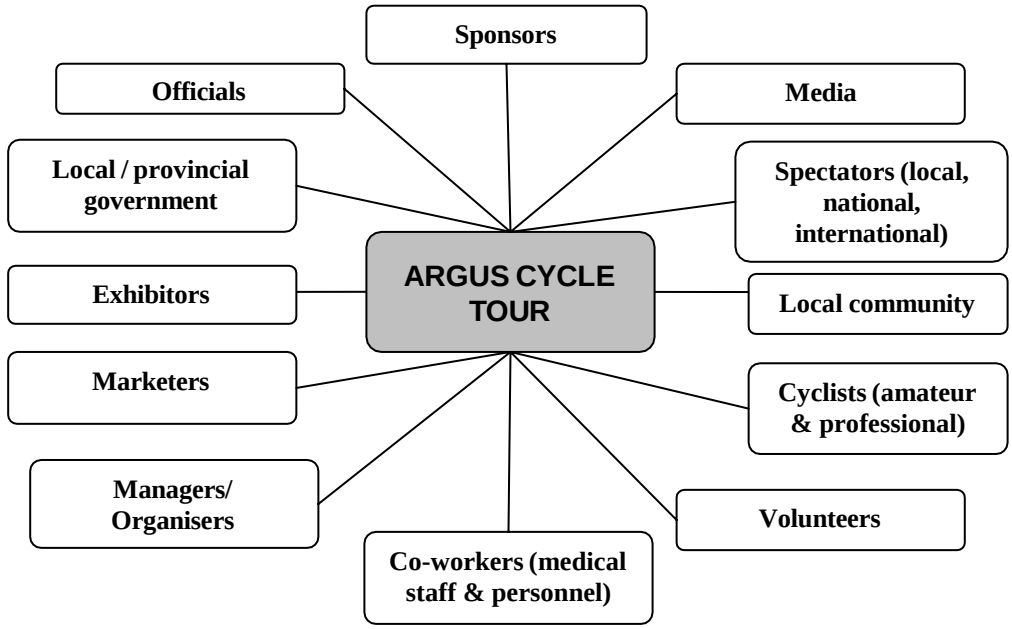

FIGURE 2: **ROLE PLAYERS IN THE ACT**

Mill and Morison (1985) support the notion that motives play a very important role in the process of travelling, vacation, and when visiting friends and relatives. Motives comes into play when a person wants to satisfy a need and must take action to do so. These motives can be intrinsic, extrinsic or a combination.

A literature review revealed that a large amount of research regarding travel motives for leisure travel was conducted by researchers such as Crompton (1977); Loker and Perdue (1992); Fodness (1994); Backman *et al*. (1995); Oh *et al.* (1995); Weaver and Opperman (2000); Goeldner *et al*. (2000); Kozak (2002); Bansal and Eiselt (2004); Tao *et al*. (2004); Awaritefe (2004); Yoon and Uysal (2005); Jang and Wu (2006) and Swanson and Horridge (2006); Correia *et al.* (2007). Research was also conducted by Molera and Albaldejo (2007); Saayman and Van der Merwe (2007) and Saayman and Saayman (2008) regarding travel motives for nature-based tourism. Table 1 shows the research specifically conducted at events.

TABLE 1: **ANALYSIS OF RESEARCH ON TRAVEL MOTIVES**

Researcher/s	**Travel motives**

Schneider & Backman (1996) – visitors at a festival	Family togetherness Socialisation Social/leisure Festival attributes Escape Event excitement
Lee *et al*. (2004) – visitors at a festival	Cultural exploration Family togetherness Novelty Escape Event attractions Socialisation
Kim *et al*. (2006) – visitors at a festival	Family togetherness Socialisation Site attraction Festival attraction Escape from routine
LaChausse (2006) – cyclists at a sport event	Health orientation Weight concern Goal Achievement Competition Recognition Affiliation Coping Life-meaning Self-esteem

The literature review above clearly shows that very little research has been done on the travel motives of tourists attending sport events and only one study was conducted regarding the motives of participants of a sport event. The travel motives also differ from event to event. Important to note that the study conducted at the sport event showed that the motives of cyclists are primarily intrinsic, while visitors to the festival have a combination of both extrinsic and intrinsic although their motives lean stronger toward extrinsic. The question

remains to what extend will research at the ACT differ in this regard. Oh *et al*. (1995) stated that if sport events strive to increase their share of participants, it becomes essential to understand why people travel and why they choose a specific event. Fodness (1994) adds that further insights into tourists' travel motives can benefit tourism marketing specifically with regard to product development, service quality evaluation, image development, and promotional activities. This knowledge allows an organisation to identify groups of customers with similar and generic attributes that make it possible for the organisation to then be more efficient and effective in reaching them with its communications (Masterman, 2005).

METHODOLOGY

The questionnaire was developed by means of a comprehensive literature review and based on the research by the authors listed in table 1. The questionnaire consisted of three sections. In Section A, demographic details were surveyed while Section B focused on spending behaviour and Section C determined the motivational factors. For the purpose of this article

Sections A and C were used.

The survey took place in the city of Cape Town at the Good Hope Centre in the registration hall from the 5 to 8 March 2008. A total of 600 questionnaires were distributed by fieldworkers in the registration hall before participants entered into the expo area. Five hundred and eighty three (583) questionnaires were completed and were received for data analysis. Random sampling was based on the willingness and availability of cyclists to complete the questionnaires.

The data was captured in Microsoft Excel and the statistical analyses were performed using the Statistical Programme for Social Sciences (SPSS 14.0). The statistical analyses included descriptive analysis and a factor analysis. The purpose of a factor analysis is to describe the covariance relationships among many variables in terms of a few underlying, but unobservable, random quantities called factors. The factor model can be motivated by the following argument: Suppose that variables can be grouped according to their correlations. That is, all variables in a particular group are highly correlated among themselves, but have small correlations with variables in a different group. If this is the case, it is conceivable that each group of variables represents a single underlying factor that is responsible for the observed correlations. It is this type of structure that a factor analysis seeks to confirm (Johnson & Wichern, 2002:477-478).

RESULTS

The results will consist of two sections. Firstly, an overview of the profile of cyclists participating in the ACT and, secondly, the results of the factor analysis will be discussed.

The profile of cyclists participating in the ACT

Based on the results captured in table 2, cyclists have participated at least 1-4 times in the Cycle Tour. The cyclists are bilingual and are approximately 35 years old, coming mainly from Gauteng and the Western Cape Provinces. Cyclists participating in the Cycle Tour travelled in groups of 4.8 persons. The latter include cyclists, family and/or friends.

TABLE 2: **BRIEF PROFILE OF CYCLISTS PARTICIPATING IN THE ACT**

CATEGORY	CYCLISTS – 2008
PROFILE	
Gender	Male (68%)
Age	35 years
Marital status	Married
Language	Afrikaans / English
Province of residence	Gauteng (39%), Western Cape (32%)
Average number of people in travelling group	4.8 persons
Times participated in the Argus	1-4 times

Motives for participating in the ACT

This section focuses on exploring the underlying patterns of the reported travel motives by

means of a factor analysis. To determine the appropriateness of principal components analysis (data reduction procedure) for the collected data, a correlation matrix for the motivational data, Kaiser-Meyer-Olkin measure of sampling adequacy and the Barlett test of sphericity were examined. The Kaiser-Meyer-Olkin measure of sampling adequacy aims to examine whether the strength of the relationship between variables is large enough to proceed to a factor analysis. The measure was 0.893 which is acceptable. The Barlett test was found to be significant ($p<.0001$). Therefore the data reduction by principal components would be legitimate. A factor analysis with varimax rotation was performed on the 22 motivational statements for the Argus Cycle Tour. The varimax rotation method was chosen because there was very little correlation between factors. The factor analysis was performed to identify the underlying dimensions of the respondents' motives to participate in the Argus Cycle Tour. An eigenvalue of 1.0 was used as a factor extraction criterion and loadings of 0.40 were used for item inclusion. This resulted in five factors. The five factors accounted for 62.4% of the total variance. The factors were labelled according to similar characteristics. They were labelled as Socialisation (Factor 1), Event attractiveness (Factor 2), Personal motivation (Factor 3), Escape and relaxation (Factor 4), Event attributes (Factor 5). Eigenvalues for these factors ranged from 1.00 to 7.98. Cronbach's coefficients were also examined for each factor to check the reliability of the data and to serve as a measure of internal consistency among the items. Table 3 shows that the Cronbach coefficients are all >0.720, which shows high levels of internal consistency.

TABLE 3: **FACTOR ANALYSIS OF MOTIVES FOR PARTICIPATING IN THE ACT**

Motives for participation	**Factors**				
	Socia-lisation	**Event attractiveness**	**Personal motivation**	**Escape & relaxation**	**Event attributes**
Family can participate	.815				
Family recreation	.598				
Had to participate	.434				
Reason to visit Cape Town	.428				
Enjoy cycling		-.829			
Well organised		-.823			
Atmosphere		-.758			
Annually		-.530			
Type of events		-.521			
Self-confidence			-.836		
Discover and evaluate myself			-.792		
Major challenge			-.762		
Level of fitness			-.703		
Level of difficulty			-.422		
New area				-.820	

Get away				-.738	
Do something with friends				-.734	
Scenic route				-.396	
Live in Cape Town					.855
International event					.686
Major event					.422
After event tours					.397
Cronbach's Alpha	**.723**	**.804**	**.861**	**.759**	**.730**

- ***Factor 1: Socialisation***
  Socialisation included aspects such as the family can participate, for family recreation, had to participate, and reason to visit Cape Town. This factor is confirmed by Backman *et al*. (1995), Schneider and Backman (1996), Lee *et al*. (2004), Jang and Wu (2006), Kim *et al*. (2006), Swanson and Horridge (2006) and Correia *et al*. (2007) as an important motive. It should be noted, however, that none of these studies were conducted at a sport event. Socialisation as a factor has a mean value of 3.2689, which is the second lowest of the five factors.

- ***Factor 2: Event attractiveness***
  Event attractiveness includes sub-categories such as enjoy cycling, atmosphere, well-organised, annually, and type of events. The main reason that cyclists participated in the ACT, is because they enjoy cycling. Saayman *et al.* (2009) conducted a study on travel motives to two marine destinations in South Africa and found destination attractiveness

  to be one of the main motivators for tourists visiting the destination. Of the five factors, this one received the highest mean value of 3.9280.

- ***Factor 3: Personal motivation***
  Personal motivation (intrinsic) includes aspects such as self-confidence, discover and evaluate myself, major challenge, level of fitness, and level of difficulty. In a study conducted by LaChausse (2006) regarding motives of competitive and non-competitive cyclists, the motives identified show a strong resemblance to personal motivation. This factor achieved the second highest mean value of 3.4666.

- ***Factor 4: Escape & relaxation***
  Factor four consists of a new area, get away, do something with friends, and scenic route. This motive is found to be the most common motive in all research conducted in this research field (see table 1) and is therefore supported by a great number of researchers: Crompton (1977), Loker and Perdue (1992), Schneider and Backman (1996), Goeldner *et al*. (2000) to name but a few. Hence tourists, in general, want to "escape from their everyday routine. Swanson and Horridge (2006:677) also identified escape as an important travel motivator, and included aspects such as "seeing spectacular scenery", "visiting places I've never seen before" and "visiting exciting places". This factor got a

mean value of 3.4563.

- ***Factor 5: Event attributes***
  Event attributes include living in Cape Town, international event, major event, and after event tours. This factor has the lowest mean value of 2.8850.

Based on the results of the component correlation matrix as captured in table 4, the low correlation between the different factors shows that the factors can be clearly distinguished. The motives why cyclist participate in the ACT are thus very specific and well defined. Stating that cyclists participate in the ACT for socialisation is not the same as those participating because of event attractiveness or personal motives (intrinsic), for example.

TABLE 4: **COMPONENT CORRELATION MATRIX FOR THE ACT**

Component	Socialisation	Event attractiveness	Personal motivation	Escape & relaxation	Event attributes
Socialisation	1.000	-.319	-.302	-.325	.241
Event attractiveness	-.319	1.000	.407	.247	-.095
Personal motivation	-.302	.407	1.000	.335	-.286
Escape & relaxation	-.325	.247	.335	1.000	-.278
Event attributes	.241	.095	-.286	-.278	1.000

Based on this research, the next section will discuss the findings and conclusions.

IMPLICATIONS AND CONCLUSIONS

The aim of this paper was to determine the travel motivations of cyclists participating in the ACT in Cape Town. This was the first time this type of research was conducted at a sport event in South Africa.

The research revealed five travel (participation) motives - socialisation, event attractiveness, personal motivation, escape and relaxation, and event attributes. From the results of the literature review, it became clear that different factors and destinations feed different motives to travel. The results of this research confirmed the latter by supporting current motives as well as adding new ones. Motives such as socialisation and escape and relaxation were confirmed by Schneider and Backman (1996), Lee *et al*. (2004) and Kim *et al*. (2006).

Travel motives of cyclists at the ACT differed in terms of event attractiveness and personal motivation. The reason being that these cyclists are primarily motivated by intrinsic motives. In fact the three motives with the highest mean value namely event attractiveness, personal motivation and escape and relaxation fall in the intrinsic category. Compared to visitors attending festivals there is a significant difference because the latter leans more towards extrinsic. Therefore the personal challenge offered by the ACT is very important. This finding somehow supports research by LaChausse (2006) although the latter did a comparison between competitive and non-competitive cyclists. Therefore it is difficult to compare these studies. Event attractiveness had the highest mean value implying that the

event itself is the major drawcard since it offers cyclists an opportunity to enjoy cycling. The implication of these findings is that an event of this magnitude can be marketed as an attraction on its own. However, it would make sense to combine event attractiveness with achievement of personal (intrinsic) goals in the ACT marketing campaign. The importance of identifying travel (participation) motives for an event such as this, from a tourism point of view, is because cyclists as indicated in the table 2 travel in groups of approximately 4.8 people. Hence more cyclists would imply more visitors to Cape Town and an increase in all the benefits, especially economic benefits, deriving from an increase in participants. This is especially important since one of the benefactors of the event is a charity organisation.

The contribution of this research lies in the fact that it supports the notion that different events have different travel motives and this applies to participants as well. These motives could be intrinsic, extrinsic or a combination. It is therefore recommended that future research should be conducted amongst different role players as indicated in figure 2 to determine their motives to participate or become involved in an event of this nature. Research should also be conducted at different sport events. Aspects that need clarity include, for example, how do travel motives differ if one compares professional cyclists with amateur cyclists. This could also be applied to international versus national cyclists or spectators versus cyclists. Further insights into tourists' travel motivation can benefit tourism marketing especially with regard to product development, service quality evaluation, image development, and promotional activities as indicated by Fodness (1994) and Masterman (2005). This knowledge allows an organisation to identify groups of customers with similar and generic attributes that make it possible for the organisation to then be more efficient and effective in reaching them with its marketing communications. It also proves that, even though the literature shows that a sport event promotes a city or destination, this is not necessarily the motive of the participant (cyclist) in the event. Therefore this research shows that research of this nature can be useful in making informed marketing and product development decisions.

REFERENCES

AWARITEFE, O.D. (2004). Motivation and other considerations in tourist destination choice: a case study in Nigeria. *Tourism Geographies*, 6(3): 303-330.

BACKMAN, K.F.; BACKMAN, S.J.; UYSAL, M. & SUNSHINE, K.M. (1995). Event tourism: An examination of motivations and activities. *Festival Management and Event Tourism*, 3(1): 15-24.

BANSAL, H. & EISELT, H.A. (2004). Exploratory research of tourist motivations and planning. *Tourism Management*, 25: 387-396.

BOO, S. & JONES, D.L. (2009). Using a validation process to develop market segmentation based on travel motivation for major metropolitan areas. *Journal of Travel and Tourism Marketing*, 26(1): 60-79.

CORREIA, A.; OOM DO VALLE, P. & MOCO, C. (2007). Why people travel to exotic places. *International Journal of Culture, Tourism and Hospitality*, 1(1): 45-61.

CROMPTON, J.L. (1977). Motives for pleasure vacation. *Annals of Tourism Research*, 1(4): 408-424.

CROCKETT, S. (1994). Tourism sport - bidding for international events. *Journal of Sport Tourism*, 1(4): 11-21.

FODNESS, D. (1994). Measuring tourist motivation. *Annals of Tourism Research*, 21(3): 555-581.

GOELDNER, C.R.; RITCHIE, J.R. & McINTOSH, R.W. (2000). *Tourism principles: practices and philosophies* (8th ed.). New York, NY: Wiley.

GRAHAM, S.; NEIROTTI, L.D. & GOLDBLATT, J.J. (2001). *The ultimate guide to sport marketing* (2nd ed.). New York, NY: McGraw-Hill.

HALAN, J.; FULLER, D. & WILDE, S. (2006). An evaluation of how market segmentation approaches aid destination marketing. *Journal of Hospitality and Leisure Marketing*, 15(1): 5-26.

HSU, C. & CROTTS, C. (2006). Segmenting mainland Chinese residents based on experience intention and desire to visit Hong Kong. *International Journal of Tourism Research*, 8(4): 279-287.

JANG, S. & WU, C.E. (2006). Seniors' travel motivations and the influential factors: an examination of Taiwanese seniors. *Tourism Management*, 27: 306-316.

JOHNSON, R.A. & WICHERN, D.W. (2002). *Applied multivariate statistical analysis* (5th ed.). Upper Saddle River, NJ: Prentice Hall.

KIM, H.; BORGES, M.C. & CHON, J. (2006). Impacts of environmental values on tourism motivations: the case of FICA, Brazil. *Tourism Management*, 27: 957-967.

KOZAK, M. (2002). Comparative analysis of tourist motivations by nationality and destinations. *Tourism Management*, 23: 221-232.

KREITNER, R. (1989). *Management* (4th ed.). Boston, MA: Houghton Mifflin.

LACHAUSSE, R.G. (2006). Motives of competitive and non-competitive cyclists. *Journal of Sport Behavior*, 29(4): 304-314.

LEE, C.K.; LEE, Y.K. & WICKS, B.E. (2004). Segmentation of festival motivation by nationality and satisfaction. *Tourism Management*, 25: 61-70.

LOKER, L. & PERDUE, R. (1992). A benefit segmentation of a non-resident summer travel market. *Journal of Travel Research*, 31(1): 31-35.

MASTERMAN, G. (2005). *Strategic sports event management: an international approach*. Oxford: Elsevier Butterworth-Heinemann.

McINTOSH, R.W.; GOELDNER, C.R. & RITCHIE, J.R. (1995). *Tourism principles: practices and philosophies* (7th ed.). New York, NY: Wiley.

MILL, R.C. & MORRISON, A.M. (1985). *The tourism system: an introductory text*. Englewood Cliffs, NJ: Prentice-Hall.

MOLERA, L. & ALBALDEJO, I.D. (2007). Profiling segments of tourists in rural areas of South-eastern Spain. *Tourism Management*, 28: 757-767.

OH, H.C.; UYSEL, M. & WEAVER, P.A. (1995). Product bundles and market segmentation based on travel motivations: a canonical correlation approach. *Hospitality Management*, 14(2): 123-137.

RACHAEL, E.N. & DOUGLAS, G.P. (2001). Why do people attend events: a comparative analysis of visitors travel motivations at four South Island events. *Journal of Travel Research*, 39(4): 449-460.

SAAYMAN, M. (2006). *Marketing tourism. Product & destinations: getting back to basics* (2nd ed.). Potchefstroom: Leisure Consultants and Publications.

SAAYMAN, M. & VAN DER MERWE, P. (2007). Travel motivations of tourists visiting Kruger National Park. First International Tourism Conference of ICNT, 23-24 November. National Parks and Tourism. Heide: Germany.

SAAYMAN, M. & ROSSOUW, R. (2008). The economic value of the 2010 Soccer World Cup. *Acta Commercii*, 8: 1-14.

SAAYMAN, M. & SAAYMAN, A. (2008). Why travel motivations and socio-demographics matter in managing a national park. 1st QATEM workshop (Quantitative approaches in Tourism Economics and Management), 27 June 2008. Perpignan: University of Perpignan..

SAAYMAN, M.; SAAYMAN, A. & STREICHER, H. (2008). *The economic impact of the Cape Argus Pick n Pay Cycle Tour*. Potchefstroom: Institute for Tourism and Leisure Studies.

SAAYMAN, M.; VAN DER MERWE, P. & SLABBERT, E. (2009). Travel motivations: A tale of two

marine destinations in South Africa. *Journal for Sport, Physical Education and Recreation*, 31(1): 81-94.

SCHNEIDER, I.E. & BACKMAN, S.J. (1996). Cross-cultural equivalence of festival motivations: a study in Jordan. *Festival Management and Event Tourism*, 4(3/4): 139-144.

SWANSON, K.K. & HORRIDGE, P.E. (2006). Travel motivations as souvenir purchase indicators. *Tourism Management*, 27: 671-683.

TAO, C.H.; EAGLES, P.F.J. & SMITH, S.L.J. (2004). Profiling Taiwanese ecotourists using a self-definition approach. *Journal of Sustainable Tourism*, 12(2): 149-168.

WAEVER, D.B. & OPPERMAN, M. (2000). *Tourism management*. Brisbane:Wiley.

YOON, Y. & UYSAL, M. (2005). An examination of the effects of motivation and satisfaction on destination loyalty: A structural model. *Tourism Management*, 26: 45-56.

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THE USE OF RECOVERY MODALITIES BY ELITE SOUTH AFRICAN TEAM ATHLETES

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ABSTRACT

Athletes competing at the highest level, should optimally balance training and competition stress with adequate recovery. However, athletes are not always aware of the available recovery options. This study investigated the recovery modalities currently used by elite South African sports persons. Research questions focused on types and frequency of recovery strategies used by players from four different sport codes (hockey, netball, rugby and soccer), as well as from different levels of participation. A total of 890 elite South African team sport players (507 males; 383 females) completed a questionnaire, specifically designed for the study. Results showed that recovery modalities are used to varying degrees by players from the four different sport codes, as well as from different levels of participation. The post-match recovery modality used the most by hockey, netball and soccer players was an active cool-down. Rugby players used a strategy for rehydration the most. The frequency of using an active cool-down and rehydration was not affected by level of participation. There seems to be an increased need for player and coach education regarding recovery modalities.

Key words: Recovery modalities; Elite team athletes; Hockey; Netball; Rugby; Soccer.

INTRODUCTION

It is often stated that optimal performance is only achievable if athletes balance training and competition stress with adequate time for recovery (Coutts & Sirotic, 2004; Fuller & Paccagnella, 2004; Kellmann, 2009). Lambert and Borresen (2006) suggested that inadequate recovery is a training error preventing athletes from producing peak performances. Athletes do not only have to deal with physical strain, but also have to cope with psychological, emotional, social, and behavioural stressors. Training programs and competition schedules are so demanding that "natural" means of recovery alone can no longer provide adequate outcomes (Rushall & Pyke, 1990). The athlete should implement a variety of recovery modalities as part of an effective regeneration strategy. According to Peterson (2005: 64), "the concept of effective, regular, and varied recovery activities has become part of the language of today's smart, professional athlete".

Athletic performance is a result of a synergistic interaction of a complex of physical, emotional, mental, and social factors that interact with an external environment. Benjamin and Lamp (1996) discussed the whole-athlete model, while Kenttä and Hassmén (2002: 58) described the athlete as a "psychosociophysiological entity." It is emphasised that athletes bring the totality of their lives to their sports participation. It is thus implied that effective recovery strategies involve active processes with the aim of re-establishing psychological, physiological, emotional, social, and behavioural components that will allow the athlete to tax these resources again (Kellmann & Kallus, 2001; Botterill & Wilson, 2002; Noakes, 2003).

Large amounts of money are spent in elite sport. Attempts are made to improve performance through the development of shoes, clothes, and equipment. Advanced technology is implemented to conduct biomechanical and match analyses. Innovative training systems and techniques are also implemented with state of the art equipment. However, the question can be asked: are athletes investing enough time and money on modalities to enhance the recovery process?

The aim of the study was to assess which recovery strategies are currently used by elite South African team players during the competitive phase of the year. For the purpose of this study, the various recovery strategies available to the athletes were grouped into four sections, namely *natural strategies* (e.g., active recovery, nutrition, sleep), *physical strategies* (e.g., cryotherapy, thermotherapy, contrast-temperature therapy, massage), *psychological strategies* (e.g., imagery, progressive muscle relaxation, music, prayer), as well as *complementary/alternative medicine strategies* (CAM) (e.g., reflexology, acupuncture, herbal therapy). This classification was based on literature referring to the psychological, physiological, emotional, and social components which should be addressed in the recovery process (Calder, 2000; Kellmann & Kallus, 2001; Botterill & Wilson, 2002; Kenttä & Hassmén, 2002; Noakes, 2003; Barnett, 2006).

The research was guided mainly by the following questions: Which recovery modalities do elite team players mostly use during the competitive season? Are there differences between the four sport codes (field hockey, netball, rugby union, soccer) regarding the recovery modalities applied? Are there differences in the use of recovery modalities between different

levels of performance?

The study was approved by the Ethics Committee of Stellenbosch University (registration number 38/2007).

METHODOLOGY

Participants

A total of 890 South African team athletes (mean age 22.3 years, SD = 3.4) from field hockey, netball, soccer and rugby union, who played in the highest division or section of their major competitions at national and international level, participated in the study. These are all field-based team sports, classified as complex sports, "where there is a high variability of motor actions under conditions of advancing fatigue and varying intensity of work" (Siff & Verkhoshansky, 1993: 362).

Subjects volunteered to participate in the study. Players were excluded from the study if they were unable to read English, because the questionnaire was in English. Players were also excluded if they were younger than 18 years. Subjects provided written informed consent for participation in the study. Players were informed that their responses would be anonymous.

Questionnaire and data collection

Data were collected by means of a questionnaire specifically designed for the study. There were no questionnaires available which could be used in the study. The first draft of the questionnaire items was tested informally on two sport science colleagues at a tertiary institution, two former elite players not participating in the study, and two subject-matter experts. After revision of the instrument, a pilot test was done, involving a group of 67 team players who volunteered to participate in the pilot study.

The introductory part of the questionnaire consisted of the demographics of the players, as well as their level of participation. The subsequent sections of the questionnaire dealt with questions on the players' use of various recovery modalities. Questions on the use of each recovery modality were fitted onto one page and divided into three sections. To add an element of consistency throughout the questionnaire, the three sections and response choices for each recovery modality was the same.

The first part of a section began with a contingency question format (Babbie, 2004), where subjects were asked whether they used the recovery strategy mentioned in that section. Only those whose response was *Yes*, were asked to continue with the questions in that section. This helped the respondent to complete the questionnaire by eliminating irrelevant questions. Players had to indicate *when* they use a specific recovery modality (*after training*, *between training sessions*, *after matches*, *on non-training days*), and the *frequency* of using the recovery modality in the abovementioned situations (*never*, *sometimes*, *regularly*, *always*).

In the second part of the section on a specific recovery modality, check listing was used where players could choose their applicable choices to show what techniques they apply and why they use the recovery modality. In the section on an active cooldown, for example, players had to indicate what they used by marking any one or more of the following

activities: slow jogging, stretching, low-intensity activities in a cold swimming pool, low-intensity activities in a heated swimming pool, low-intensity cycling. To include all possible responses, an open category labelled *Other* (*please specify*) was added.

Procedure

A number of survey methods for data collection were considered. These included mail surveys, telephone or face-to-face interviews, internet surveys, group-administered questionnaires, or combinations of methods. According to Groves *et al*. (2004), a combination of methods for collecting data maximises response rates. The logic of mixed modes is to exploit the advantages of modes while neutralising the disadvantages, and optimise resources to improve cooperation. After consideration of various factors, it was decided to use multiple modes of data collection, namely, personal-visit group-administered questionnaires, mailed surveys, and combinations and variations of the two. Permission to conduct the study was obtained from the relevant authorities.

Data analysis

The StatSoft *STATISTICA* data analysis package (Version 8) was used for data analysis. For descriptive purposes means with standard deviations were reported for ordinal measurements

and frequency histograms for categorical data. For comparison of ordinal data between different groupings of respondents, a one-way ANOVA was used with Bonferonni post-hoc testing. Statistical significance was set at $p<0.05$.

RESULTS

The response rate of the completed questionnaires for the total group was 74%. Response rates for the four sport codes were as follows: hockey 74%; netball 81%; rugby 80%; and soccer 61%.

The total group of players (890) consisted of 507 (57%) males and 383 (43%) females. Of the total group, 668 (75%) of the players were from national and provincial teams, and 222 (25%) from club teams.

Rugby players were significantly older ($p<0.05$) than players from hockey, netball and soccer, while soccer players were significantly younger ($p<0.05$) than players from the other sport codes. A statistically significant difference ($p<0.05$) was found between the ages of the players who competed in national teams (23.0±3.58 years), and players from clubs (22.1±2.73 years) and provincial (22.07±3.55 years) teams, with players from national teams being significantly older. Rugby players and national-level players spent on average between nine and ten hours per week training, which is significantly more than players from the other sport codes or levels of participation. Table 1 includes the number of players from each sport in terms of Mean age in years and Standard Deviation (SD).

TABLE 1. **NUMBER AND AGE OF PLAYERS WITHIN EACH SPORT CODE**

Group	N (% of total group)	Mean age (years)±SD
Hockey	213 (24%)	21.78±3.29

Netball	215 (24%)	22.00±4.00
Rugby	317 (36%)	23.19±3.03*
Soccer	145 (16%)	21.33±2.23*
Total sample of players	890 (100%)	22.26±3.37

(*$p<0.05$)

Natural strategies

Active cool-down. Players indicated that they use an active cool-down to varying degrees. The soccer players used an active cool-down after training and matches significantly more ($p<0.05$) than players from the other sport codes. Rugby players used an active cool-down after training and matches significantly less ($p<0.05$) than hockey, netball and soccer players. Rugby players used an active cool-down after matches less than after training sessions and not as regularly as players from the other sport codes. Players from hockey, netball and soccer used an active cool-down after matches more than after training sessions.

The national- and provincial-level players used an active cool-down more after matches than after training ($p<0.05$**)**. They also used an active cool-down after matches regularly, and significantly ($p<0.05$) more than the club-level players. The national-level players used an active cool-down after training significantly ($p<0.05$) more than the provincial-level players.

Stretching and *slow jogging* were most often used during an active cool-down. Players could add to the list under the option *Other*. Four players mentioned that they use *walking* or *walking down* as part of their active cool-down, while one player mentioned *rowing* and another sportsperson mentioned *self-massage*.

Refuelling and rehydration. In terms of a strategy for rehydration, 44% of the players from the total group indicated that they *never* had a strategy for rehydration after training sessions, 15% of the players *sometimes* had a strategy, 22% *regularly* had a strategy, and 19% stated that they *always* had a rehydration strategy. With regard to having a strategy for rehydration after matches, 41% of the players reported that they *never* had a strategy. With reference to a strategy for refuelling after training sessions, 48% of the players *never* had a strategy, 14% *sometimes* had a strategy, 20% *regularly* had a strategy, and 18% of the players *always* had a strategy after training. When it comes to a strategy for refuelling after matches, results showed the following: 49% of the players *never* had a strategy, 15% *sometimes*, 19% *regularly*, and 17% *always*.

Results showed that players from all four sport codes did not have a strategy for rehydration on a regular basis. A statistically significant difference ($p<0.05$) was found between soccer and rugby players in terms of having a strategy for rehydration after training sessions, with soccer players having less of a strategy than rugby players. With reference to a strategy for refuelling after matches, a statistically significant difference ($p<0.05$) was found between soccer players and players from netball and rugby teams, with netball and rugby players having more of a strategy for refuelling after matches than soccer players.

With regard to a strategy for rehydration, the results showed that players from all levels of participation had more of a strategy for fluid intake after matches than after training sessions,

although not regularly. Statistically significant differences ($p<0.05$) existed between players from the various levels of participation with provincial- and national-level players having more of a strategy for rehydration after matches than club-level players.

No significant differences were found between players from the different sport codes in terms of having a consistent refuelling strategy after training and after matches. A statistically significant difference ($p<0.05$) existed between national- and club-level players in terms of a strategy for refuelling after training, with national-level players having more of a strategy than club-level players.

Sleep. A regular sleep routine was indicated by 67% of the players. Most (75%) of the players reported that they slept between six and eight hours per night. Changes in sleep patterns occurred over weekends where 11% indicated that they slept less than six hours, 60% slept between six and eight hours, and 29% slept more than eight hours per night.

In terms of falling asleep at night, 59% of the players stated that they *never* had problems falling asleep. Players (60%) indicated that they experienced problems waking in the morning to varying degrees. With regard to taking a nap during the day, 32% of the players *never* took a nap, 47% *sometime*s took a nap, 17% *regularly* took a nap, and 4% *always* took a nap. Players reported that *noise* and *light* in the sleep environment were the two factors that affected the quality of their sleep the most.

Physical strategies

Cryotherapy (external cold). Players indicated that they used cryotherapy to varying degrees after training and after matches. Rugby players used cryotherapy more ($p<0.05$) after training sessions and matches than players from hockey, netball and soccer sport codes. Soccer players used cryotherapy significantly less ($p<0.05$) than hockey, netball and rugby players.

Players from the different levels of participation did not use cryotherapy on a regular basis. Cryotherapy was used more often after matches than after training sessions by players from all levels of participation. National-level players used cryotherapy statistically significantly ($p<0.05$) more than club-level players after training sessions and matches. Provincial-level players used cryotherapy statistically significantly ($p<0.05$) more after matches than club-level players.

Methods of cooling that were used (in order of frequency) included: *Ice packs*, *ice bath*, *cold shower*, and *activities in cold swimming pool*. Some players added the following to the list under the option *Other*: *compression with Rocket skins*, *Arnica ice*, *Ice-man (ice-rub on muscles)*, and *Jacuzzi after game*.

Contrast temperature therapy. The majority (68%) of players stated that they *never* used contrast temperature therapy after training and 65% indicated that they *never* used it after matches. *Hot and cold showers* and *a cold pool with a hot shower* were the main methods used to apply contrast temperature therapy. Most players indicated that they started and ended the session with *cold application*, and spent more time exposed to the colder temperature than the warmer temperature. Some players added the following methods to the list under *Other*: *ice and a hot water bucket*, *cold bath and hot jacuzzi*, *hot packs and cold packs*, *ice bag and hot bean bag*.

Massage. From the total group of players who responded to the section on massage as a recovery modality, 372 (43%) mentioned that they used massage to varying degrees. Most of the massage sessions were performed by a therapist and consisted of a *deep massage*. Hockey, netball and soccer players used massage mostly after matches, while rugby players used massage mostly on non-training days. National-level players used massage more ($p<0.05$) than club- and provincial-level players after training sessions and on non-training days. However, massage was not used on a regular basis for recovery purposes.

Psychological strategies

Progressive muscle relaxation was used by 29% of the players. Soccer players used progressive muscle relaxation the most, and significantly more ($p<0.05$) than players from the other three sport codes. Rugby players performed progressive muscle relaxation the least and significantly less than netball players.

A large portion (67%) of players *never* used breathing exercises as a recovery strategy. Imagery was used by 43% of the players. Netball players used imagery the most and more ($p<0.05$) than rugby and soccer players. National-level players used imagery more ($p<0.05$) than provincial- and club-level players.

Eighty percent of the respondents *never* used meditation and 82% *never* used autogenic training. Prayer, in contrast, was used by 72% of the players for recovery purposes. Netball players used prayer more ($p<0.05$) than hockey, rugby and soccer players. Rugby and soccer players used prayer more ($p<0.05$) than hockey players.

Music was *always* used by 12% of the players after a match. Fourteen percent *regularly* used music, and 13% *sometimes* used music. The remaining 61% of the total group, *never* used music after matches. Players used music for recovery purposes more after matches than after training sessions. Players from hockey, netball and soccer used music more ($p<0.05$) than rugby players after training sessions and after matches. The most popular types of music were *rock* and *gospel* music. A number (77) of players added other types of music than those listed in the questionnaire. *House music* and *R&B* were mentioned by most of the players, followed by *Hiphop, Kwaito* and *dance beats*. *Calm music, chants and Gregorian music, love songs, panpipes, soul* and *traditional African music* were also mentioned.

Complementary/alternative strategies

Acupuncture was *never* used by 77% of the players who responded to this section. Rugby players used acupuncture significantly more ($p<0.05$) than netball and soccer players. National-level players used acupuncture significantly more ($p<0.05$) than club- and provincial-level players. Reflexology was *never* used by 92% of the respondents.

DISCUSSION

Recovery modalities from the *natural strategies category* were used by many players. Modalities from the natural strategies are seen as specific modalities that do not require any special equipment (Bompa, 2009). It should therefore be relatively easy for players from all levels of participation to address natural strategies for recovery. Pickett and Morris (1975: 49) wrote: “Next to the air we breathe, food and sleep are the two most crucial physical essentials

for maintaining a sound and healthful state of living." Davis *et al*. (2002) mentioned nutrition and sleep as part of the basics that athletes have to address with regard to recovery, with Williams (2007) also emphasising nutrition and rest as key components of recovery.

With regard to the natural strategies identified in this study, players could respond to aspects pertaining to sleep, nutrition and an active cool-down. Most (75%) of the players indicated that they sleep between six and eight hours per night. This supports the findings of a number of studies showing that individuals older than 18 years tend to sleep between six and eight hours per night during weeknights (Hicks & Pellegrini, 1991; National Sleep Foundation, 2005). Although Ferrara and De Gennaro (2001) wrote that seven to eight hours should be

enough for most people, Bompa (2009) and Calder (2003) stated that athletes require nine to 10 hours of sleep, of which 80-90% should be during the night. Athletes should be encouraged to take a 20-minute nap (often called a "power nap") during the day (Kenttä & Hassmén, 2002; Postolache & Oren, 2005).

Some (41%) players indicated that they experience problems falling asleep at night. Carney and Waters (2006) mentioned "worry" as a major contributor to pre-sleep cognitive arousal, while a strange setting (Lee, 1997), noise, light, extreme temperatures (Kawada & Suzuki, 1995; Öhrström & Skånberg, 2004; Axt & Axt-Gadermann, 2005), caffeine and nicotine (Zarcone, 1989; Van Dongen *et al.*, 2001; Sierra *et al*., 2002) can all negatively affect the onset of sleep. Players could be educated with regard to these factors as well as on various methods to help them to relax at bedtime. Players mentioned that noise and light in the sleep environment were the two factors that affected the quality of their sleep the most. Hanton *et al*. (2005) reported that disturbed sleep patterns were mentioned as a major environmental stressor by elite sport performers. It is important for management staff to consider aspects in the environment, which could affect sleep quality when players are at training camps, tournaments or on tour. The importance of making appropriate accommodation arrangements should therefore not be underestimated.

A number of players reported that they experience problems waking in the morning, which could indicate sleep deprivation. The fact that some players mentioned that they increase the amount of hours they sleep over weekends might be an indication that they addressed their lack of sleep over weekends. It should be noted that most of the players who participated in the study were not from full-time professional teams. Various factors under these circumstances, such as academic and work demands, and family commitments, make it difficult for athletes to sleep as well as they would like.

In hockey, netball, rugby and soccer, play involves intermittent high-intensity exercise, which reduces muscle glycogen stores (Williams, 2007). Reilly and Ekblom (2005) stated that, by the time a soccer game ends, those players who had played for the entire game are likely to have almost depleted their active-muscle and liver glycogen stores. The restoration of glycogen stores after exercise should be a priority for players. Maughan *et al.* (1997) wrote that, if players begin an event with muscle glycogen stores that are low as a result of inadequate glycogen repletion, performance will be impaired. Team sport players are advised to refuel effectively between matches, undertaken every four to seven days during the competitive season, as well as the conditioning sessions undertaken between matches. It has been shown that repetition of high-intensity exercise on successive days is difficult, but better restoration of muscle carbohydrate stores can enhance recovery (Burke *et al*., 2006). The time

to recover between successive competitions or training sessions is often short (less than eight hours), and rapid glycogen synthesis becomes even more crucial under these circumstances (Jeukendrup & Gleeson, 2004; Burke *et al.*, 2006), as in tournament situations.

The results showed that players from all the groups did not apply these strategies on a regular basis. However, national-level players applied these strategies more often. National-level players might experience a greater need for rehydrating and refuelling due to the intensity of competition at that level. They might also have members of management that regard these aspects as important, and the players might generally be well looked after.

Athletes are often advised to gradually recover from high-intensity exercise through a cool-down period (Hawley & Burke, 1998; Harris & Elbourn, 2002). It is suggested that an active cool-down could consist of stretching as well as up to 20 minutes of low-intensity aerobic exercise, with the intensity of the aerobic exercise no higher than 50% of the athlete's maximum heart rate (Bompa, 2009). An active cool-down is the recovery modality that ass used the most by hockey and soccer players, second most by netball players and third most by rugby players. Rugby players also used an active cool-down more after training than after matches, while the other players used an active cool-down more after matches than after training. It might be that, due to the fact that rugby is a contact sport, players felt more fatigued and sore after a match than after a training session. They might therefore not regard an active cool-down as important or suitable to their specific post-match situation and needs.

The players in this study did use cryotherapy for recovery purposes, but it was not used regularly. Rugby players used cryotherapy more compared to other players. Rugby players may, due to the fact that rugby is a professional sport, have better access to facilities where they can use cryotherapy after training and after matches, which might not be the case with the other sport codes. Rugby is also a contact sport and rugby players might have looked for modalities which they believed could address the effects of contact on the body. National-level players used recovery more than club-level players after training sessions. Provincial and national-level players also used cryotherapy more after matches than club-level players. Players at higher levels of participation often have better access to specialised facilities and might be more exposed to trainers focusing on aspects of recovery. As results showed that players did not use cryotherapy on a regular basis, it might reflect that these cryotherapy methods were only applied in specific instances, like at a training camp or at a tournament.

Although not used regularly, players from all four sport codes and levels of participation indicated that massage was used. Hockey, netball and soccer players mentioned that massage was used after matches, while rugby players indicated that massage was used more on non-training days. Some researchers suggested that a massage should not be applied after training or after a match, because post-exercise massage could cause further trauma where training has caused tissue damage (Barnett, 2006). Holey and Cook (2003) wrote that there are opinions that an intense, vigorous massage might stress the body like a training session and that activity should therefore be reduced slightly over the following 24 to 48 hours.

Players from hockey, netball, rugby, and players from different levels of participation indicated that they used imagery in some instances. Netball players used imagery the most. Whitehead and Basson (2005) reported from their study on the use of imagery by athletes that players from team contact-sports (rugby) used imagery more than players from non-contact sports. This trend was not found in the current study. National-level players used imagery

more than club- and provincial-level players.

Prayer activity seems to be present throughout various levels of sport participation (Todd & Brown, 2003). The therapeutic potential of spirituality is acknowledged increasingly. Spirituality is attracting attention as a moderator of stress, with Ridnour and Hammermeister (2008) indicating that spiritual well-being may be a construct that is useful in developing an enhanced coping-aptitude necessary for excellence in sport. The use of prayer in coping with the uncertainties in sport is prevalent among athletes and more so for athletes playing elite sport. Jones (2003) mentioned that many people reported using prayer as a stress-management technique. This is supported by the study by Plaatjie (2006) where soccer players indicated that they used prayer as a post-match coping strategy. In this study, some players mentioned that prayer helped them with emotional recovery. Of all the recovery modalities players could respond to, prayer was used the most by netball and rugby players, followed by an active cool-down for netball players and fluid replacement for rugby players. Prayer was used second most by hockey and soccer players, following an active cool-down. No differences were found in the use of prayer between different levels of participation.

Players used music for recovery purposes more after matches than after training sessions. Players from hockey, netball and soccer used music more often than rugby players after training sessions and after matches. The most popular types of music that were listened to, were *rock* and *gospel*. Music preferences are diverse and for music to have a positive effect, it needs to be a pleasant and meaningful experience for the listener. The athlete's preferences must therefore be taken into account when music is used for recovery and regeneration purposes. Athletes should be encouraged to create a bank of music they like which generate a range of moods and atmospheres, to produce a stimulating or calming effect (Calder, 2000).

Cohen *et al.* (2005) and Johnson and Blanchard (2006) mentioned the substantial increase internationally in the popularity of alternative medicine for a variety of illnesses and symptoms as well as for preventative health practices and general self-care. MacLennan *et al*. (2006) identified an increase in CAM use in Australia, while Johnson and Blanchard (2006) found that 58% of the undergraduates in their survey used at least one type of CAM during the previous 12 months. White (1998) stated that many athletes use CAM when conventional medicine, according to them, fails to relieve their musculoskeletal symptoms. In this study, athletes indicated that they seldom used complementary and alternative therapies for recovery purposes.

This study revealed some similarities in the recovery modalities that hockey, netball, rugby and soccer players used in the recovery process. There might be an impression that players used the recovery modalities extensively, but results showed that this was not the case. The only recovery modality that was applied on a regular basis was an active cool-down after training and matches by hockey, netball and soccer players. All the other modalities were not applied regularly.

There might be various reasons why the players in this study were not applying recovery modalities regularly. In this study, on average the highest number of hours per week spent training indicated by rugby and national-level players were between nine and ten hours. It might be that most of the players from the other groups did not have more than one training session per day and that they therefore did not regard recovery as important.

Alternatively, players might not be serious about recovery and did not regard it as a high priority. It might also be that players did not have the knowledge to know what to do if they wanted to use a specific modality. Kellmann (2009) mentioned that, although coaches recognise that recovery is crucial, they often have limited knowledge of what recovery modalities are available. The lack of application of recovery modalities could also be monetary related, as money has to be paid for specific services (e.g., massage) and players

might not want to pay for services related to their recovery. Simjanovic *et al.* (2009) mentioned time and cost as key considerations in their study of factors influencing the use of different recovery modalities.

This study provided insight into the current use of recovery modalities by elite team athletes. The results suggest that there is scope for further athlete and coach education with regard to the use of recovery modalities for team players.

REFERENCES

AXT, P. & AXT-GADERMANN, M. (2005). *The joy of laziness: How to slow down and live longer*. London: Bloomsbury.

BABBIE, E. (2004). *The practice of social research*. Belmont, CA: Wadsworth/Thomson Learning.

BARNETT, A. (2006). Using recovery modalities between training sessions in elite athletes. Does it help? *Sports Medicine*, 36(9): 781-796.

BENJAMIN, P.J. & LAMP, S.P. (1996). *Understanding sports massage*. Champaign, IL: Human Kinetics.

BOMPA, T.O. (2009). *Periodization: Theory and methodology of training* (5th ed). Champaign, IL: Human Kinetics.

BOTTERILL, C. & WILSON, C. (2002). Overtraining: Emotional and interdisciplinary dimensions. In M. Kellmann (Ed.), *Enhancing recovery: preventing underperformance in athletes* (143-159). Champaign, IL: Human Kinetics.

BURKE, L.M.; LOUCKS, A.B. & BROAD, N. (2006). Energy and carbohydrate for training and recovery. *Journal of Sports Sciences*, 24(7): 675-685.

CALDER, A. (2000). *Advanced coaching study pack: Recovery training*. Belconnen, ACT: Australian Sports Commission.

CALDER, A. (2003). Recovery strategies for sports performance. *USOC Olympic Coach E-Magazine.* Available online at [http://coaching.usolympicteam.com/coaching/kpub.nsf/v/3Sept03]. Accessed 6 February 2006.

CARNEY, C.E. & WATERS, W.F. (2006). Effects of a structured problem-solving procedure on pre-sleep cognitive arousal in college students with insomnia. *Behavioral Sleep Medicine*, 4(19): 13-28.

COHEN, M.M.; PENMAN, S.; PIROTTA, M. & COSTA, C. (2005). The integration of complementary therapies in Australian general practice: Results of a national survey. *Journal of Alternative and Complementary Medicine*, 11(6): 995-1004.

COUTTS, A. & SIROTIC, A. (2004). Post-match recovery practices. *Sports Coach*, 27(2): 20-23.

DAVIS, H.; BOTTERILL, C. & MACNEILL, K. (2002). Mood and self-regulation changes in underrecovery: An intervention model. In M. Kellmann (Ed.), *Enhancing recovery: Preventing underperformance in athletes* (161-180). Champaign, IL: Human Kinetics.

FERRARA, M. & DE GENNARO, L. (2001). How much sleep do we need? *Sleep Medicine Reviews*, 5(2): 155-179.

FULLER, K. & PACCAGNELLA, M. (2004). Revitalising body and soul - physiological and psychological strategies for recovery. *Sports Coach*, 27(3): 14-16.

GROVES, R.M.; FOWLER, F.J.; COUPER, M.P.; LEPKOWSKI, J.M.; SINGER, E. & TOURANGEAU, R. (2004). *Survey methodology*. Hoboken, NJ: John Wiley & Sons.

HANTON, S.; FLETCHER, D. & COUGHLAN, G. (2005). Stress in elite sport performers: A comparative study of competitive and organizational stressors. *Journal of Sports Sciences*, 23(10): 1129-1141.

HARRIS, J. & ELBOURN, J. (2002). Cooling down theory. *Sports Coach*, 25(3): 23-25.

HAWLEY, J. & BURKE, L. (1998). *Peak performance: Training and nutritional strategies for sport*. St Leonard, NSW: Allen & Unwin.

HICKS, R.A. & PELLEGRINI, R.J. (1991). The changing sleep habits of college students. *Perceptual and Motor Skills*, 72: 1106.

HOLEY, E. & COOK, E. (2003). *Evidence-based therapeutic massage: A practical guide for therapists*. London: Churchill Livingstone.

JEUKENDRUP, A. & GLEESON, M. (2004). *Sport nutrition: an introduction to energy production and performance.* Champaign, IL: Human Kinetics.

JOHNSON, S.K. & BLANCHARD, A. (2006). Alternative medicine and herbal use among university students. *Journal of the American College of Health*, 55(3): 163-169.

JONES, K. (2003). *Health and human behavior*. South Melbourne, Victoria: Oxford University Press.

KAWADA, T. & SUZUKI, S. (1995). Instantaneous change in sleep stage with noise of a passing truck. *Perceptual and Motor Skills*, 80: 1031-1040.

KELLMANN, M. (2009). Is recovery important? [Abstract]. *Journal of Science and Medicine in Sport*, 12S: S21.

KELLMANN, M. & KALLUS, K. W. (2001). *Recovery-Stress Questionnaire for Athletes: user manual*. Champaign, IL: Human Kinetics.

KENTTÄ, G. & HASSMÉN, P. (2002). Underrecovery and overtraining: A conceptual model. In M. Kellmann (Ed.), *Enhancing recovery: Preventing underperformance in athletes* (57-77). Champaign, IL: Human Kinetics.

LAMBERT, M. & BORRESEN, J. (2006). A theoretical basis of monitoring fatigue: A practical approach for coaches. *International Journal of Sports Science and Coaching*, 1(4): 371-388.

LEE, K.A. (1997). An overview of sleep and common sleep problems. *ANNA Journal*, 24(6): 614-625.

MACLENNAN, A.H.; MYERS, S.P. & TAYLOR, A.W. (2006). The continuing use of complimentary and alternative medicine in South Australia: Costs and beliefs in 2004. *Medical Journal of Australia*, 184(1): 27-32.

MAUGHAN, R.J.; GREENHAFF, P.L.; LEIPER, J.B.; BALL, D.; LAMBERT, C.P. & GLEESON, M. (1997). Diet composition and the performance of high-intensity exercise. *Journal of Sports Sciences*, 15: 265-275.

NATIONAL SLEEP FOUNDATION, WASHINGTON, DC. *2005 Sleep in America Poll*. Available on line at [http://www.sleepfoundation.org/2005poll.cfm]. Accessed 28 March 2006.

NOAKES, T. (2003). *Lore of running* (4th ed.). Champaign, IL: Human Kinetics.

ÖHRSTRÖM, E. & SKÅNBERG, A. (2004). Sleep disturbances from road traffic and ventilation noise-laboratory and field experiments. *Journal of Sound and Vibration*, 271(1-2): 279-296.

PETERSON, K. (2005). Overtraining: balancing practice and performance. In S. Murphy (Ed.), *The sport psych handbook* (49-70). Champaign, IL: Human Kinetics.

PICKETT, G.F. & MORRIS, A.F. (1975). Effects of acute sleep and food deprivation on total body response time and cardiovascular performance. *Journal of Sports Medicine*, 15: 49-54.

PLAATJIE, M.R. (2006). A comparison of coping strategies of ethnically diverse football players.

Unpublished PhD dissertation. Stellenbosch: Stellenbosch University.

POSTOLACHE, T.T. & OREN, D.A. (2005). Circadian phase shifting, alerting, and antidepressant effects of bright light treatment. *Clinics in Sports Medicine*, 24(2): 381-413.

REILLY, T. & EKBLOM, B. (2005). The use of recovery methods post-exercise. *Journal of Sports Sciences*, 23(6): 619-627.

RIDNOUR, H. & HAMMERMEISTER, J. (2008). Spiritual well-being and its influence on athletic coping profiles. *Journal of Sport Behavior*, 31(1): 81-92.

RUSHALL, B.S. & PYKE, F.S. (1990). *Training for sport and fitness*. Melbourne, Australia: MacMillan.

SIERRA, J.C.; JIMENEZ-NAVARRO, C. & MARTIN-ORTIZ, J.D. (2002). Quality of sleep in university students: The importance of sleep hygiene [Abstract; electronic version]. *Salud Mental*, 25(6): 35-43.

SIFF, M.C. & VERKHOSHANSKY, Y.V. (1993). *Supertraining*. Johannesburg: School of Mechanical Engineering, University of the Witwatersrand.

SIMJANOVIC, M.; HOOPER, S.; LEVERITT, M.; KELLMANN, M. & RYNNE, S. (2009). The use and perceived effectiveness of recovery modalities and monitoring techniques in elite sport [Abstract]. *Journal of Science and Medicine in Sport*, 12S: S22.

TODD, M. & BROWN, C. (2003). Characteristics associated with superstitious behavior in track and field athletes: Are there NCAA Divisional level differences? *Journal of Sport Behavior*, 26(2): 168-188.

VAN DONGEN, H.P.A.; PRICE, N.J.; MULLINGTON, J.M.; SZUBA, M.P.; KAPOOR, S.C. & DINGES, D.F. (2001). Caffeine eliminates psychomotor vigilance deficits from sleep inertia. *Sleep*, 24(7): 813-819.

WHITE, J. (1998). Alternative sports medicine. *The Physician and Sportsmedicine*, 26(6): 92-98.

WHITEHEAD, K.A. & BASSON, C.J. (2005). Sport-related differences in type and amount of mental imagery use by athletes. *South African Journal for Research in Sport, Physical Education and Recreation*, 27(2): 159-174.

WILLIAMS, C. (2007). Carbohydrate as an energy source for sport and exercise. In D. MacLaren (Ed.), *Nutrition and sport* (41-71). Philadelphia, PA: Churchill Livingstone.

ZARCONE, V.P. (1989). Sleep hygiene. In M.H. Kryger, T. Roth & W.C. Dement (Eds.), *Principles and practice of sleep medicine* (490-494). Philadelphia, PA: WB Saunders.

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THE IMPACT OF A 10-WEEK PHYSICAL ACTIVITY INTERVENTION PROGRAMME ON SELECTIVE METABOLIC SYNDROME MARKERS IN BLACK ADOLESCENTS

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ABSTRACT

The purpose of this study was to determine the effects of a 10-week physical activity (PA) intervention on selective metabolic syndrome markers in black adolescents. All available adolescents (194 subjects), boys and girls, in the grade 9 class (15-19 years) attending a secondary school were recruited for the experimental group. A control group consisting of 57 adolescents from grade 9 of another secondary school in the same area was also recruited. The experimental group participated in a 10-week PA intervention. Body mass index (BMI), fasting insulin, fasting glucose, homeostasis model assessment of insulin resistance (HOMA-IR), systolic blood pressure (SBP), diastolic blood pressure (DBP), Windkessel arterial compliance (C_w), total peripheral resistance (TPR) and waist circumference were measured. After the 10-week PA intervention, adolescents from the control group had a significantly lower DBP compared to the intervention group ($p=0.00005$) and adolescents from the intervention group had a significantly lower SBP compared to the control group ($p=0.000061$). There was also a tendency towards a higher C_w and lower HOMA-IR in the intervention group compared to the control group. The findings of this study suggest that black adolescents had significantly lower SBP and a trend of lower HOMA-IR after a 10-week PA intervention.

Key words: Physical activity; Metabolic syndrome; Adolescents.

INTRODUCTION

Adolescents are no longer as physically active as a few decades ago (Deckelbaum & Williams, 2001; Dwyer *et al*., 2009). Low levels of physical activity (PA) are widely assumed to be involved in the etiology of obesity and underlie public health messages globally (Must & Tybor, 2005). In South Africa the occurrence of obesity is two to three times higher in the black population than in the white population (Punyadeera *et al*., 2000). This significantly higher rate of obesity in the black population is of serious concern, because the metabolic syndrome (MS) is high among obese children and adolescents (Weiss *et al*., 2004). The MS is defined by the clustering of metabolic abnormalities, primarily overweight and more specifically central obesity, insulin resistance, dyslipidaemia and hypertension (Klein-Platat *et al*., 2005; Jennings *et al*., 2009). The MS affects a great number of adolescents (Jessup & Harrell, 2005; Day *et al*., 2009) and is related to cardiovascular risk

(Klein-Platat *et al*., 2005; Day *et al*., 2009; Leite *et al*., 2009). However, studies designed to explore the influence of a PA intervention on the components of the MS in black South African adolescents are lacking. This is a significant shortcoming in the study of the MS in South Africa, especially as previous studies in the US have found that black children, as compared to their white counterparts, have a higher prevalence of obesity (Schuster *et al*., 1998; Deckelbaum & Williams; 2001), are more insulin resistant (Schuster *et al*., 1998) and have higher blood pressure, independent of adiposity (Cruz *et al*., 2002).

Adolescents require monitoring, as risk-related behaviour patterns for coronary heart disease have their origin in childhood and adolescence (Day *et al*., 2009). Adolescents need to partake in PA on a regular basis to reduce their risk of developing Type 2 diabetes and cardiovascular diseases like hypertension (Ritenbaugh *et al.,* 2003). The benefits of regular PA are substantial as it plays a crucial role in the regulation and maintenance of an adolescent's body weight by decreasing the percentage body fat (ACSM, 2006). Regular PA also increases insulin sensitivity (Schmitz *et al.,* 2002), slows down the normal loss of elasticity and compliance in the human cardiovascular system and can reverse some of the age-related declines in arterial stiffness (Tanaka *et al.,* 2000). PA also has a significant negative relationship with blood lipids and blood pressure (McMurray *et al*., 2002; Ritenbaugh *et al*., 2003; Nassis *et al.,* 2005; Nemet *et al.,* 2005).

Studies of PA interventions on American adolescents have indicated a positive effect on MS markers (McMurray *et al*., 2002; Ritenbaugh *et al*., 2003; Nassis *et al.,* 2005; Nemet *et al.,* 2005), but no such study has been conducted on black adolescents in a South African setting. This exploratory study will seek to address this gap by analysing the effects of a 10-week PA intervention on selective markers of the MS in black boys and girls aged 15 to 19 years.

METHODS

Sample and Study design

The PhysicaL Activity in the Young (PLAY) study was a pre-test, intervention, post-test study design that included an experimental group and a control group. The experimental group was subjected to a PA intervention programme while the control group received health information only on a single health promotion day at the school. The setting and design of the study were described by Mamabolo *et al*. (2007) and Swanepoel *et al*. (2007). All available adolescents, boys and girls, in the grade 9 class (15-19 years) attending a secondary school in the low socio-economic status (SES) area of Ikageng township (North-West Province, South Africa) were recruited for the experimental group. A total of 194 adolescents were in the experimental group (96 boys and 98 girls). Another 57 adolescents (16 boys and 41 girls) from grade 9 of a secondary school in the same low SES area were recruited for the control group. These schools were selected from a total of five high schools in the low socio-economic township, because they were attended only by adolescents from the surrounding neighbourhoods. The adolescents' status were similar with regard to growth phase, SES, diet and PA profiles.

Ethical considerations

The PLAY study was approved by the Ethics Committee of the North-West University, Potchefstroom Campus (no. 04M01) as well as the school principals. Consent was obtained from the adolescents' parents and from the adolescents for participation in the study and the collection of blood samples.

Measurements

The adolescents were transported to the university in groups of 20-30 per day for baseline- and end measurements before and after the PA intervention programme. Data were collected over a period of one week at baseline and after the intervention, respectively. The measuring sequence was as follows: Fasting blood samples were taken upon arrival in the morning. The participants were then taken to the remaining workstations, namely air displacement plethysmography (BOD-POD), blood pressure and anthropometry workstations. The participants were provided light refreshments before being guided to the demographic, PA and Tanner-stage questionnaire workstations.

Body composition

Body composition was compiled by determining the body mass index (BMI), waist-hip ratio (WHR) and percentage body fat. BMI was determined from the height (cm) by a vertical stadiometer using the stretch-method (Marfell-Jones *et al.,* 2006) to the nearest 0.1 cm and body mass by means of a calibrated electronic scale (Precision, A&D Company, Saitama, Japan) to the nearest 0.1 kg. The circumferences were measured with a flexible steel tape (Lufkin, Cooper Tools, Apex, NC) to the nearest 0.1 cm. The measures of the abdomen (across the smallest or leanest area of the abdomen) and the hips (across the broadest part over the buttocks) were recorded. Body fat percentage was measured by means of air displacement plethysmography (BOD-POD, Life Measurement Inc, Concord, CA) according to standard guidelines (Fields *et al*., 2000). Body mass was measured by means of a calibrated digital scale. When the body density is known, relative ratios of fat-containing and fat-free mass can be calculated. This technique is based on Boyle's law of pressure-volume ratios (Fields *et al*., 2000).

Biochemical analysis

The participants fasted overnight (12 hours). A fasting sample of 20 ml blood was taken from each participant for all biochemical analyses of the study. Blood samples for plasma were collected in ethylenediamine tetra-acetate-(EDTA)-coated venepuncture tubes. The plasma and serum were immediately separated and stored in Eppendorff tubes at –80°C until the analyses were performed. Fasting serum insulin was measured according to the ELISA method by means of the Immulite 2000 Analyzer. Insulin resistance was calculated according to the formula used by Matthews *et al.* (1985). For blood glucose concentrations blood was sampled in tubes with sodium fluoride and calcium oxalate. A total of 4.5 ml blood was mixed with the calcium oxalate and sodium fluoride (glucolite inhibitor) by turning the tube around carefully (not shaking). It was then placed on ice and centrifuged within 15 minutes. Plasma was immediately deposited into plastic micro tubes for analysis of glucose and frozen on dry ice. Plasma glucose was measured by means of Vitros DT60 II Chemistry Analyser

(Ortho-Clinical Diagnostics, Rochester, NY, USA) with VITROS reagents (catalogue number 1532316) and control (catalogue numbers 8420317, 1448042).

Blood pressure

A continuous blood pressure measurement was recorded for a period of at least five minutes by means of the Finometer apparatus (FMS, The Netherlands). The Finometer computed all cardiovascular variables online, the Beatscope 1.1 software programme integrated the subject's gender, age, height and weight and this information was further integrated to obtain systolic blood pressure (SBP) (mmHg), diastolic blood pressure (DBP) (mm Hg), total peripheral resistance (TPR) (mmHg/ml) and Windkessel arterial compliance (C_w) (ml/mmHg). The mean values of all the cardiovascular function variables were estimated in the last two minutes of the five minutes measuring time. The vascular unloading technique of Penáz together with the Physiocal criteria of Wesseling provided reliable, non-invasive and continuous estimations of the cardiovascular function variables (Schutte *et al*., 2004).

Tanner

The Tanner-stage questionnaires were used to determine the level of physical maturity in boys and girls and were administered by trained individuals in private rooms. Classification for Tanner 1 was PH1 (no pubic hair) to PH5 (adult stage). Classification for Tanner 2 is MA1 (no breasts) to MA5 (adult stage). Genital development in boys is classified from level 1 (no enlargement) to level 5 (adult stage). A sketch with descriptions of the five stages of development in boys and girls was shown to respondents, who then indicated their own development level (Tanner & Whitehouse, 1982).

The Previous Day Physical Activity Recall (PDPAR)

Trained field workers were employed to collect information from respondents regarding their level of PA on one given weekday and one given weekend day. This method of classifying PA, called the PDPAR, developed by Trost *et al*. (1999), uses a 24 hour recall list to classify respondents PA levels as low (1), moderate (2) or high (3). According to this method respondents were asked to list their PA of a given day in 30 minute time frames, on an activity list. Using a difficulty factor, the type as well as intensity of activity was classified as high, medium or low. The metabolic equivalent (MET) values of PA were taken from *The Compendium of physical activities,* and the energy usage list was taken from the PDPAR (Ainsworth *et al*., 1993; Weston *et al*., 1997). The number of 30-minute periods with a MET value of 3 METs or more, as well as 30-minute periods with a MET value of 6 METs or more, was aggregated. Respondents were classified as vigorously active if two or more 30-minute periods had been coded as more than 6 METs, moderately active if two or more 30-minute periods had been coded as 3 to 6 METS, and inactive if a respondent failed to meet the criteria for high or medium PA (Pate *et al*., 1997). This questionnaire has been validated and used in the assessment of PA of children and adolescents from various ethnic groups (Weston *et al*., 1997).

Physical activity intervention and compliance

The intervention programme was performed three days a week for ten weeks and presented by 12 post-graduate Human Movement Science students. No activity periods were scheduled during school hours, therefore the programme had to be done directly after school hours. Although the adolescents were encouraged to participate in the programme their participation was voluntary. The 10-week period was selected to conform to a school term, the assumption being that adolescents will be more willing to partake in the intervention at school on school days than at school during a holiday. Each intervention session lasted one hour, consisting of

aerobic activity (aerobic exercises, dancing, kata boxing) for 20 minutes, sport-specific activity (mini-soccer, ball skills) lasting 20 minutes, and strength and flexibility exercises (push-ups, lunges, stretching exercises) for 20 minutes. Compliance with exercise intensity was performed by determining the heart rates of the adolescents manually at random by the post-graduate Human Movement Science students. Heart rates between 136 and 155 (beats per minute) were the required intensity for this population as determined according to their age (Lamb, 1984). The intensity of this intervention was also monitored through accelerometers (Actical, Minimitter, Bend, Oregon), where learners were selected according to group lists to wear them at every session. The mean duration of the activity sessions was 69 minutes. Girls spent a mean of 28 minutes in vigorous activity and boys spent a mean of 29.5 minutes in vigorous activity. The frequency of participation was monitored through the use of an attendance register.

Statistical analysis

The Statistica Computer Processor Programme for Statsoft, Inc. STATISTICA (data analysis software system, version 7, 2004) was used for processing the documented data. The SAS programme was used individually for each adolescent to calculate height-for-age z-scores, according to the Centres for Disease Control (CDC) database (CDC, 2000). Descriptive statistics and the Mann-Whitney U-test were used to compare groups. Analysis of covariance (ANCOVA) was used to compare the data of the groups after the intervention (Thomas & Nelson, 2001).

RESULTS

Baseline characteristics of the adolescents

Baseline characteristics of participants by gender and group are presented in table 1. It should be noted that although the control and the intervention groups included participants from the same grade (Grade 9), the boys in the intervention group were significantly older than the boys from the control group. The majority of all the subjects in both the intervention and control groups reported to be in Tanner-stage 4 of physical development. The baseline data indicate that the boys of the intervention group had a higher mean muscle mass, than the boys of the control group. In subsequent statistical analyses age, body fat percentage and muscle mass, as well as the baseline variable corresponding to the dependent variable were included as covariates. The habitual PA levels in the intervention- and control groups are presented in Figure 1. The girls' PA levels were on average low when compared to the boys.

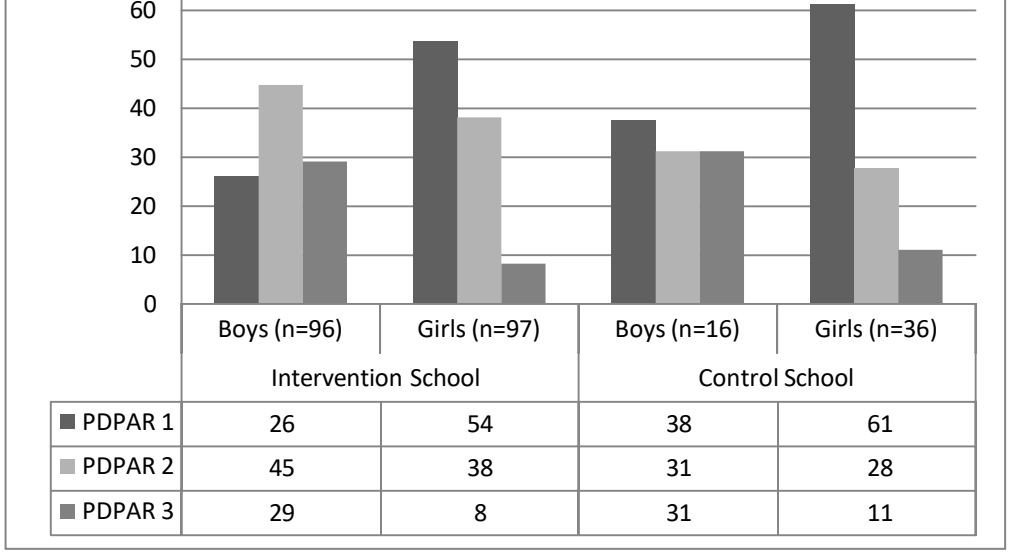
TABLE 1: **BASELINE CHARACTERISTICS (MEAN ± SD, OR MEDIAN [INTERQUARTILE RANGE]) OF THE BOYS AND GIRLS OF THE INTERVENTION AND CONTROL GROUPS**

Characteristic	Intervention group (n=194)		Control group (n=57)	
	Mean ± SD		Mean ± SD	
	Boys (n=96)	Girls (n=98)	Boys (n=16)	Girls (n=41)

Age (years)	15.8 ± 1.2[a]	15.5 ± 1.1[a]	14.7 ± 0.8[a]	14.8 ± 1.0[a]
Tanner stage: 1	0	0	0	1 (2.4%)
Tanner stage: 2	10 (10.4%)	7 (7.1%)	0	3 (7.1%)
Tanner stage: 3	17 (17.7%)	36 (36.7%)	7 (43.8%)	19 (45.2%)
Tanner stage: 4	53 (55.2%)	45 (45.9%)	9 (56.2%)	15 (35.7%)
Tanner stage: 5	16 (16.7%)	10 (10.1%)	0	4 (9.4%)
Body fat percentage (%)	18.1 ± 6.0[b]	29.1 ± 6.2	21.4 ± 9.2[b]	29.4 ± 7.5
Muscle mass (kg)	40.5 ± 8.2[c]	34.4 ± 4.4	34.0 ± 5.7[c]	33.8 ± 6.8
BMI (kg/m^2)	18.9 ± 2.6	20.3 ± 3.0	18.0 ± 1.5	20.7 ± 3.2
Height-for-age z-score	-1.26 ± 0.9	-1.12 ± 0.9	-1.29 ± 1.1	-0.89 ± 1.1
Waist circumference (cm)	66.3 ± 5.5	64.3 ± 5.5	64.0 ± 3.3	64.3 ± 6.0
Fasting plasma glucose (mmol/dL)	5.3 ± 0.6	5.0 ± 0.4	5.0 ± 0.4	4.8 ± 0.4
Systolic blood pressure (mm Hg)	105.8 ± 12.0	105.8 ± 10.8	102.8 ± 7.0	110.8 ± 13.3
Diastolic blood pressure (mm Hg)	72.7 ± 7.5	70.8 ± 6.7	68.7 ± 6.6	68.9 ± 9.3
Total Peripheral Resistance (TPR)	1.52 ± 0.37	1.72 ± 0.3	1.57 ± 0.23	1.39 ± 0.25
Windkessel arterial compliance (C_w)	1.70 ± 0.34	1.39 ± 0.2	1.55 ± 0.16	1.30 ± 0.09
Fasting plasma insulin (µU/ml) (median, 25%, 75%)	6.4 [4.8,10.2]	8.8 [6.3,12.6]	5.1 [4.7,6.6]	8.0 [6.1,12.6]
[1]Homeostasis Model Assessment insulin resistance (HOMA-IR)	1.56 [1.1,2.8]	1.94 [1.3,2.9]	1.64 [1.0,1.4]	1.75 [1.2,2.8]

[1] HOMA-IR = [(fasting insulin (µU/ml)) x (fasting venous glucose (mmol/L))/22.5]

[a-c] Similar letters indicate significant differences between variables for intervention and control groups, $p < 0.05$; t-test and Mann-Whitney U-test



	Intervention School		Control School	
	Boys (n=96)	Girls (n=97)	Boys (n=16)	Girls (n=36)
PDPAR 1	26	54	38	61
PDPAR 2	45	38	31	28
PDPAR 3	29	8	31	11

FIGURE 1: **HABITUAL PHYSICAL ACTIVITY LEVELS IN THE INTERVENTION AND CONTROL GROUP AT BASELINE AS MEASURED WITH PREVIOUS DAY PHYSICAL ACTIVITY RECALL**

Adolescents identified with markers of the metabolic syndrome

Six (two girls, four boys) out of the 156 subjects who consented to blood samples had a fasting blood glucose > 6.1mmol/L. Not one of the six above-mentioned subjects had high blood pressure, although only one had a waist circumference > 95th percentile of the British reference (McCarthy *et al*., 2001). Both girls had a body fat percentage > 25% and both were inactive (PDPAR = 1). The four boys had a body fat percentage > 20% and were moderately active (PDPAR = 2). All six adolescents had a HOMA-IR reading above 2.8 (75th percentile in the present study).

Ten (six girls, four boys) out of the 214 adolescents measured had a waist circumference above the 95th percentile of the British reference (McCarthy *et al*., 2001). Only one of the 10 subjects had high blood pressure and one had high fasting plasma glucose. All 10 had a body fat percentage > 25% for girls and > 20% for boys. Six were inactive and four moderately active. Six out of these 10 adolescents consented to blood samples and four had a HOMA-IR reading > 2.8.

Twenty-two (nine girls, 13 boys) out of the 216 measured, had blood pressure > 90th percentile (Jessup & Harrell, 2005). None of the 22 subjects had high fasting glucose, but one had a waist circumference > 95th percentile. Eleven subjects out of the 22 were inactive and

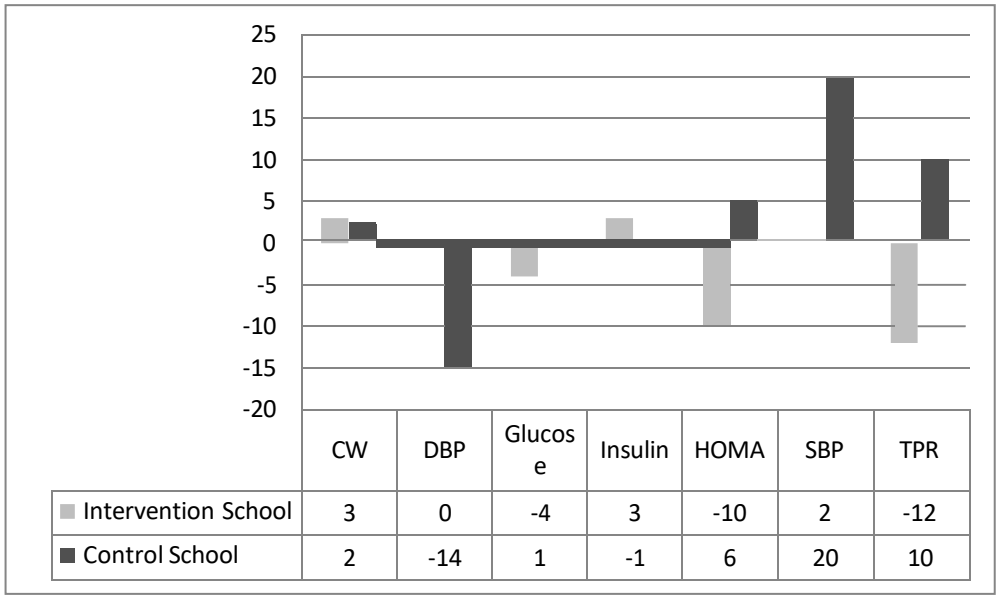
11 moderately active. Eleven had a body fat percentage > 25% (for girls) and > 20% (for boys). Fifteen out of 22 consented to blood samples and three had a HOMA-IR reading > 2.8.

Triacylglycerol and HDL-cholesterol were not determined in this study, therefore only blood pressure larger than the 90th percentile based on US age and sex reference curves (National High Blood Pressure Education Program, 2005), glucose concentrations >6.1 mmol/L and waist circumference > 95th percentile based on British reference curves (McCarthy *et al*., 2001) were used as markers of the MS. The British reference was used because there is currently no reference curve or cut-off point for waist circumference of South African adolescents. In this study there was no participant that met all three the criteria for the MS, as defined in this study. Only two subjects met two of the three MS criteria (McCarthy *et al*., 2001).

Compliance with the physical activity intervention

Only 31.4% of the adolescents attended 40% or more of the physical activity sessions. The most important reasons for not attending were household chores and living far from school. Attendance ranged between 0-100 % with only five adolescents attending no sessions and the rest of the group attending some sessions. The low compliance adolescents were not excluded from this study.

Figure 2 presents the percentage change from baseline to end for different variables of the intervention- and control groups after the PA intervention as a percentage change of median variables. In the intervention group there was an increase in the percentage change in C_w (3%), fasting plasma insulin (3%) and SBP (2%). There was also a decrease in the subjects' glucose (-4%), HOMA (-10%) and TPR (-12%). No difference in the subjects' DBP was found. The control group show increases in the percentage change in C_w (2%), fasting plasma glucose (1%), HOMA (6%), SBP (20%), and TPR (10%). There was also a decrease in their fasting plasma insulin (-1%) and DBP (-14%).



	CW	DBP	Glucose	Insulin	HOMA	SBP	TPR
Intervention School	3	0	-4	3	-10	2	-12
Control School	2	-14	1	-1	6	20	10

FIGURE 2: **UNADJUSTED PERCENTAGE CHANGE FROM BASELINE TO END FOR DIFFERENT VARIABLES IN THE INTERVENTION- AND CONTROL GROUPS AFTER THE PA INTERVENTION (% CHANGE OF MEDIAN VARIABLES)**

Changes in metabolic markers after the physical activity intervention

Table 2 gives the least squares means, 95% confidence intervals and level of significance for the difference in metabolic markers between the intervention group and the control group (ANCOVA with adjustment for age, gender, Tanner-stage, habitual PA, body fat percentage, muscle mass and baseline values of the relevant variable). Significant differences were found between diastolic- and systolic blood pressure, respectively of the two groups. Adolescents

from the control group had a lower DBP compared to the intervention group and adolescents from the intervention group had a lower SBP compared to adolescents from the control group.

TABLE 2: **LEAST SQUARES MEANS, 95% CONFIDENCE INTERVALS AND LEVEL OF SIGNIFICANCE FOR THE DIFFERENCE IN METABOLIC MARKERS BETWEEN THE INTERVENTION GROUP AND THE CONTROL GROUP**

Variable	Level of significance	n	Intervention Group	n	Control Group
Model 1*					
Fasting plasma glucose (mmol/dL)	NS	50	4.84 [4.7, 4.9]	11	5.0 [4.7, 5.3]
Homeostasis Model Assessment insulin resistance (HOMA-IR)	NS	48	0.61 [0.43, 0.78]	11	0.74 [0.35, 1.13]
Systolic blood pressure (mm Hg)	p=0.00061	59	100 [97, 102]	20	110 [105, 114]
Diastolic blood pressure (mm Hg)	p=0.00005	59	63 [61, 66]	20	52 [48, 57]
Total Peripheral Resistance (TPR)	NS	53	1.54 [1.45, 1.63]	11	1.54 [1.33, 1.75]
Windkessel arterial compliance ($C_{w)}$	NS	53	1.51 [1.47, 1.55]	11	1.50 [1.41, 1.59]
Model 2**					
Fasting plasma glucose (mmol/dL)	NS	50	4.81 [4.7, 4.9]	11	5.1 [4.7, 5.5]
Homeostasis Model Assessment insulin resistance (HOMA-IR)	NS	48	0.55 [0.35, 0.75]	11	0.99 [0.41, 1.58]
Systolic blood pressure (mm Hg)	p=0.00061	59	100 [96, 103]	20	110 [101, 118]
Diastolic blood pressure (mm Hg)	p=0.00005	59	63 [60, 66]	20	53 [46, 60]
Total Peripheral Resistance (TPR)	NS	53	1.57 [1.47, 1.67]	11	1.39 [1.08, 1.71]
Windkessel arterial compliance (C_w)	NS	53	1.51 [1.46, 1.55])	11	1.49 [1.35, 1.63]

* Ancova with adjustment for gender, tanner-stage, habitual PA, body fat percentage, muscle mass and baseline values of the relevant variable

** Model 1 + percentage attendance in the PA intervention

As noted in Table 2, after an additional adjustment for percentage attendance in the PA intervention (model 2), there were still significant differences between DBP- and SBP of adolescents from the two groups. There was also a trend of a difference between HOMA-IR of the two groups.

DISCUSSION

The purpose of this study was to determine the effects of a 10-week PA intervention on selective markers of the MS in black adolescents. One of the main reasons for conducting a PA intervention was that atherosclerosis has been found in children and young adults and is associated with CVD risk factors such as obesity, abnormal plasma lipoprotein levels, elevated blood pressure, insulin resistance (Day *et al*., 2009) and diabetes mellitus type 2 due to a lack of PA (Ritenbaugh *et al*., 2003). The reason for this inactivity can in turn be attributed to a range of factors: urbanisation, lack of interest in PA, technology, unsafe neighbourhoods and schools that cannot afford hosting physical activities (Bar-or *et al*., 1998; WHO, 1998).

There was a significant difference in PA participation between black and white adolescents in the USA (Kimm *et al.,* 2002), and it became more apparent with an increase in age (Jago *et al*., 2008). In South Africa, significantly more males (57.1% [95%CI 54.6–59.6]) participated in vigorous- and moderate physical activities than females (34.7% [95% CI 31.7–37.6]), and a decrease in participation was apparent with an increase in age. Significantly more black females than black males were inactive, or showed low PA participation levels (MRC, 2002). The same tendency is seen in this study (figure 1) as the girls from both the intervention and control group's habitual PA levels were on average low when compared to the boys (PDPAR 1: Girls intervention = 54%, Girls control = 61%). On average, the boys were classified as being more moderately- and vigorously active, compared to the girls (figure 1). In this study only 31.4% of the adolescents attended 40% or more of the PA sessions. Despite their low level of PA, none of the study participants presented with all three of the MS markers.

Insulin resistance and consequently fasting plasma insulin of the adolescents from the intervention group did not show a significant improvement after the 10-week PA intervention. As presented in figure 2, the intervention group had a small increase in the percentage change in fasting insulin (3%) but a decrease in HOMA-IR (-10%). Changes in fasting plasma insulin were, however small in both groups. Insulin resistance increases during puberty, as insulin sensitivity is reduced in both non-diabetic and diabetic children, and therefore the body produces more insulin (Jessup & Harrell, 2005). This increased insulin secretion may be caused by an increased amount of circulating growth hormones and changes in body composition (Jessup & Harrell, 2005). African Americans' fasting insulin and acute insulin responses are significantly higher than in white children (Deckelbaum & Williams, 2001; Gower *et al.,* 2001; Cruz *et al*., 2002), and it can be explained by black adolescents' altered rates of hepatic insulin extraction when compared to white adolescents, which contribute significantly to their peripheral hyperinsulinemia (Schuster *et al*., 1998).

After the 10-week PA intervention, adolescents from the control group had a significantly lower DBP compared to the intervention group (p=0.00005) and adolescents from the intervention group had a significantly lower SBP compared to the control group

(p=0.000061). The higher DBP encountered in the intervention group is attributed to the higher vascular resistance (TPR) found in the adolescents from the intervention group. Even after an additional adjustment for percentage attendance in the PA intervention, there were still significant differences between DBP- and SBP when the adolescents from the two groups were compared. As presented in figure 2, the intervention group had a small increase in SBP (2%), but no change in DBP. The control group showed an increase in SBP (20%) and a decrease in DBP (-14%). These results can be due to the increase in muscle mass in the intervention group which in turn may possibly elevate resting blood pressure (AAOP 1997). While some studies indicated that decreased blood pressure levels are associated with increased levels of PA (Ewart *et al.*, 1998; McMurray *et al.*, 2002), a study by De Visser *et al*. (1994) indicated a non-significant relationship between blood pressure and PA in adolescents. In a study by Fu and Hao (2002) on Hong Kong adolescents, SBP and DBP were related to sexual maturation, and increased with age. Insulin sensitivity did not improve significantly in this study.

Insulin resistance and hyperinsulinemia alter blood pressure through several mechanisms, including the insulin-mediated effects on the sympathetic nervous system and renal sodium reabsorption (Cruz *et al*., 2002). In a study by Cruz *et al*. (2002), it was found that insulin resistance was a more important determinant of SBP in children than body fat. Furthermore it was found that black ethnicity and decreased insulin sensitivity were independently related to elevated blood pressure even at an early age.

After the PA intervention, the intervention group had an increase in the percentage change in C_w (3%) and a decrease in TPR (-12%) (figure 2). In a study by Otsuki *et al*. (2007) it was suggested that endurance training in school-age youths decreases arterial stiffness or increase C_w and continued endurance training would maintain this decrease. Because arterial pressure is determined by cardiac output and TPR, reductions in arterial pressure after endurance exercise training must be mediated by decreases in one or both of these variables. Reductions in resting cardiac output do not typically occur after chronic exercise; thus, decreased TPR appears to be the primary mechanism by which resting BP is reduced after exercise training.

LIMITATIONS

This study has several limitations. This study is firstly limited by the relatively small number of participants who consented to blood sampling pre- and post test. This small sample size makes it difficult to detect statistically significant changes with a great deal of accuracy. It is important to note that participants enrolled in this study voluntarily, which could also lead to potential bias. The second limitation was the duration of the study. School terms are, however, relatively short and it is almost impossible to maintain school-based interventions over school holidays. The third limitation was that triacylglycerol and HDL-cholesterol were not measured due to budget constraints. However, this study has provided valuable information for future studies on South African adolescents.

CONCLUSION

The findings of this study suggest that a 10-week PA intervention showed a significant decrease in SBP (p=0.000061), trends of decreased HOMA-IR and increased C_w in black

adolescents. The implications of the results are that adolescents should be encouraged to increase their PA levels, which may result in significant improvements in selective markers of the MS. The present study is, however, limited by the small subject sample size and the small number of adolescents who gave consent for blood sampling after the intervention.

REFERENCES

AMERICAN ACADEMY OF PEDIATRICS (AAOP) (1997). Athletic participation by children and adolescents who have systemic hypertension. *Pediatrics*, 99(4): 637-638.

AMERICAN COLLEGE OF SPORTS MEDICINE (ACSM) (2006). *ACSM's guidelines for exercise testing and prescription* (7th ed.). Philadelphia, PA: Lippincott Williams & Wilkens.

AINSWORTH, B.E.; HASKELL, W.L.; LEON, A.S.; JACOBS, D.R.; MONTOYE, H.J.; SALLIS, J.F. & PAFFENBARGER, R.S. (1993). Compendium of physical activities: classification of energy costs of human physical activities. *Medicine and Science in Sports and Exercise*, 25(1): 71-80.

BAR-OR, O.; FOREYT, J.; BOUCHARD, C.; BROWNELL, K.D.; DIETZ, W.H.; RAVUSSIN, E.; SALBE, A.D.; SCHWENGER, S.; JEOR, S. & TORUN, B. (1998). Physical activity, genetic, and nutritional considerations in childhood weight management. *Official Journal of the American College of Sports Medicine*, 30(1):2-10.

CENTRES FOR DISEASE CONTROL (CDC) (2000). "Growth charts SAS codes". Hyperlink [http://www.cdc.gov/nccdphp/dnpa/growthcharts/sas.htm]. Retrieved 20 October 2008.

CRUZ, M.L.; HUANG, T.T.K.; JOHNSON, M.S.; GOWER, B.A. & GORAN, M.I. (2002). Insulin sensitivity and blood pressure in black and white children. *Hypertension*, 40: 18-22.

DAY, R.S.; FULTON, J.E.; DAI, S.; MIHALOPOULOS, N.L. & BARRADAS, D.T. (2009). Nutrient intake, physical activity, and CVD risk factors in children project HeartBeat. *American Journal of Preventive Medicine*, 37(1S): S25–S33.

DECKELBAUM, R.J. & WILLIAMS, C.L. (2001). Childhood obesity: The health issue. *Obesity Research*, 9(4): 239S-243S.

DE VISSER, D.C.; VAN HOOFT, I.M.S.; VAN DOORNEN, L.J.P.; HOFMAN, A.; ORLEBEKE, J.F. & GROBBEE, D.E. (1994). Anthropometric measures, fitness and habitual physical activity in offspring of hypertensive parents. *The American Journal of Hypertension*, 7: 242-248.

DWYER, T.; MAGNUSSEN, C.G.; SCHMIDT, M.D.; UKOUMUNNE, O.C.; PONSONBY, A.; RAITAKARI, O.T.; ZIMMET, P.Z.; BLAIR, S.N.; THOMSON, R.; CLELAND, V.J. & VENN, A. (2009). Decline in physical fitness from childhood to adulthood associated with increased obesity and insulin resistance in adults. *Diabetes Care*, 32: 683-687.

EWART, C.K.; YOUNG, D.R. & HAGBERG, J.M. (1998). Effects of school-based aerobic exercise on blood pressure in adolescent girls at risk for hypertension. *American Journal of Public Health*, 88(6): 949-951.

FIELDS, D.A.; HUNTER, G.R. & GORAN, M.I. (2000). Validation of the BOD POD with hydrostatic weighing: Influence of body clothing. *International Journal of Obesity*, 24: 200-205.

FU, F.H. & HAO, X. (2002). Physical development and lifestyle of Hong Kong secondary school students. *Preventive Medicine*, 35: 499-505.

GOWER, B.A.; HERD, S.L. & GORAN, M.I. (2001). Anti-lipolytic effects of insulin in African American and white prepubertal boys. *Obesity Research*, 9(3): 224-228.

JAGO, R.; WEDDERKOPP, N.; KRISTENSEN, P.L.; MØLLER, N.C.; ANDERSEN, L.B.; COOPER, A.R. & FROBERG, K. (2008). Six-year change in youth physical activity and effect on fasting insulin and HOMA-IR. *American Journal of Preventive Medicine*, 35(6): 554-560.

JENNINGS, C.L.; LAMBERT, E.V.; COLLINS, M.; LEVITT, N.S. & GOEDECKE, J.H. (2009). The atypical presentation of the metabolic syndrome components in black African women: the relationship with insulin resistance and the influence of regional adipose tissue distribution.

Metabolism-Clinical and Experimental, 58:149-157.

JESSUP, A. & HARRELL, J.S. (2005). The metabolic syndrome: Look for it in children and adolescents too. *Clinical Diabetes*, 23(1): 26-32.

KIMM, S.Y.S.; GLYNN, N.W.; KRISKA, A.M.; BARTON, B.A.; KRONSBERG, S.S.; DANIELS, M.S.S.R.; CRAWFORD, P.B.; SABRY, Z.I. & LIU, K. (2002). Decline in physical activity in black girls and white girls during adolescence. *The New England Journal of Medicine*, 347(10): 709-715.

KLEIN-PLATAT, C.; DRAI, J.; OUJAA, M.; SCHLIENGER, J.L. & SIMON, C. (2005). Plasma fatty acid composition is associated with the metabolic syndrome and low-grade inflammation in overweight adolescents. *American Journal of Clinical Nutrition*, 82: 1178-1184.

LAMB, D.R. (1984). *Physiology of exercise: Responses and adaptations* (2nd ed.). New York, NY: Macmillan.

LEITE, N.; MILANO, G.E.; CIESLAK, F.; LOPES, W.A.; RODACKI, A. & RADOMINSKI, R.B. (2009). Effects of physical exercise and nutritional guidance on metabolic syndrome in obese adolescents. *Revista Brasileira de Fisioterapia*, 13(1): 73-81.

MAMABOLO, R.; KRUGER, H.S.; LENNOX, A.; MONYEKI, M.A.; PIENAAR, A.; UNDERHAY, C. & CZLAPKA-MATYASIK, M. (2007). Habitual physical activity and body composition of black township adolescents residing in the North West Province, South Africa. *Public Health Nutrition*, 10: 1047-1056.

MARFELL-JONES, M.; OLDS, T.; STEWART, A. & CARTER, L. (2006). *International standards for anthropometric assessment*. ISAK: Potchefstroom, South Africa

MATTHEWS, D.R.; HOSKER, J.P.; RUDENSKI, A.S.; NAYLOR, B.A.; TREACHER, D.F. & TURNER, R.C. (1985). Homeostasis model assessment: insulin resistance and b-cell function from fasting plasma glucose and insulin concentration. *Diabetologia*, 28: 412-419.

McCARTHY, H.D.; JARRETT, K.V. & CRAWLEY, H.F. (2001). The development of waist circumference percentiles in British children aged 5.0-16.9y. *European Journal of Clinical Nutrition*, 55: 902-907.

McMURRAY, R.G.; HARRELL, J.S.; BANGDIWALA, S.I.; BRADLEY, C.B.; DENG, S. & LEVINE, A. (2002). A school-based intervention can reduce body fat and blood pressure in young adolescents. *Journal of Adolescent Health*, 31: 125-132.

MEDICAL RESEARCH COUNCIL (MRC) (2002). "Umthente uhlaba usamila: the 1st South African National Youth Risk Behaviour Survey". Pretoria, Department of Health. Hyperlink [http://www.mrc.ac.za/healthpromotion/healthpromotion.html]. Retrieved 19 March 2008.

MUST, A. & TYBOR, D.J. (2005). Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. *International Journal of Obesity*, 29: S84-S96.

NASSIS, G.P.; PAPANTAKOU, K.; SKENDERI, K.; TRIANDAFILLOPOULOU, M.; KAVOURAS, S.A.; YANNAKOULIA, M.; CHROUSOS, G.P. & SIDOSSIS, L.S. (2005). Aerobic exercise training improves insulin sensitivity without changes in body weight, body fat, adiponectin, and inflammatory markers in overweight and obese girls. *Metabolism*, 54(11): 1472-1479.

NATIONAL HIGH BLOOD PRESSURE EDUCATION PROGRAM. National Institutes for Health (2005). National high blood pressure education program working group on hypertension control in children and adolescents (1996). Update on the 1987 task force report on high blood pressure in children and adolescents: A working group report from the National High Blood Pressure Education Program. *Pediatrics*, 98: 649-658.

NEMET, D.; BARKAN, S.; EPSTEIN, Y.; FRIEDLAND, O.; KOWEN, G. & ELIAKIM, A. (2005). Short- and long-term beneficial effects of a combined dietary–behavioral–physical activity intervention for the treatment of childhood obesity. *Pediatrics*, 115: e443-e449.

OTSUKI, T.; MAEDA, S.; IEMITSU, M.; SAITO, Y.; TANIMURA, Y.; AJISAKA, R. & MIYAUCHI, T. (2007). Relationship between arterial stiffness and athletic training programs in young adult

men. *American Journal of Hypertension*, 20(9): 967-973.

PATE, R.P.; TROST, S.G.; FELTON, G.M.; WARD, D.S.; DOWDA, M. & SAUNDERS, R. (1997). Correlates of physical activity behaviour in rural youth. *Research Quarterly for Exercise and Sport*, 68(3): 241-248.

PUNYADEERA, C.; CROWTHER, N.J.; VAN DER MERWE, M.T.; GALPIN, J. & GRAY, I.P. (2000). Comparison of glucose metabolism in South African obese and diabetic women. (Abstract). *The Journal of Endocrinology, Metabolism and Diabetes of South Africa*, 5(2): 42.

RITENBAUGH, C.; TEUFEL-SHONE, N.I.; AICKIN, M.G.; JOE, J.R.; POIRIER, S.; DILLINGHAM, D.C.; JOHNSON, D.; HENNING, S.; COLE, S.M. & COCKERHAM, D. (2003). A lifestyle intervention improves plasma insulin levels among Native American high school youth. *Preventative Medicine*, 36: 310-318.

SCHMITZ, K.H.; JACOBS, D.R.; HONG, C.P.; STEINBERGER, J.; MORAN, A. & SINAIKO, A.R. (2002). Association of physical activity with insulin sensitivity in children. *International Journal of Obesity*, 26: 1310-1316.

SCHUSTER, D.P.; KIEN, C.L. & OSEI, K. (1998). Differential impact of obesity on glucose metabolism in black and white American adolescents. *The American Journal of the Medical Sciences*, 316(6): 361-367.

SCHUTTE, A.E.; HUISMAN, H.W.; VAN ROOYEN, J.M.; MALAN, N.T. & SCHUTTE, R. (2004). Validation of the Finometer device for measurement of blood pressure in black women. *Journal of Human Hypertension*, 18: 79-84.

STATSOFT (2004). Statistica (data analysis software system), version 7. Hyperlink [www.statsoft.com]. Retrieved 16 September 2009.

SWANEPOEL, M.; MOSS, H.; KRUGER, S. & SCHUTTE A. (2007). Die verband tussen leptien, liggaamsamestelling en fisieke fiksheid in swart adolessente: Die PLAY-studie. *South African Journal for Research in Sport, Physical Education and Recreation*, 29(2): 109-119.

TANAKA, H.; DINENNO, F.A.; MONAHAN, K.D.; CLEVENGER, C.M.; DESOUZA, C.A. & SEALS, D.R. (2000). Aging, habitual exercise, and dynamic arterial compliance. *Circulation*, 102: 1270-1275.

TANNER, J.M. & WHITEHOUSE, R.H. (1982). Variations of growth and development at puberty. In A.D. Lascari (Ed.), *Atlas of children's growth, normal variation and growth disorders* (122-127). New York, NY: Academic Press.

THOMAS, J.R. & NELSON, J.K. (2001). *Research methods in physical activity* (4th ed.). Champaign, IL: Human Kinetics.

TROST, S.G.; PATE, R.R.; WARD, D.S.; SAUNDERS, R. & RINER, W. (1999). Determinants of physical activity in active and low active, sixth grade African-American youth. *Journal of School Health*, 69(1): 29-34.

WEISS, R.; DZIURA, J.; BURGERT, T.S.; TAMBORLANE, W.V.; TAKSALI, S.E.; YECKEL, C.W.; ALLEN, K.; LOPES, M.; SAVOYE, M.; MORRISON, J.; SHERWIN, R.S. & CAPRIO, S. (2004). Obesity and the metabolic syndrome in children and adolescents. *The New England Journal of Medicine*, 350(23): 2362-2374.

WESTON, A.T.; PETOSA, R. & PATE, R.R. (1997). Validation of an instrument for measurement of physical activity in youth. *Medicine and Science in Sports and Exercise*, 29: 138-143.

WORLD HEALTH ORGANIZATION (WHO) (1998). *Obesity: preventing and managing the global epidemic. Report of a WHO consultation of obesity.* Geneva: WHO.

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