DOCTOR OF PHILOSOPHY

The effect of active brain-breaks on in-school physical activity, fundamental movement skills and executive functioning in Grade One children

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The effect of active brain-breaks on in-school physical activity, fundamental movement skills and executive functioning in Grade One children

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Declaration

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own original work; that I am the sole author thereof, save to the extent explicitly otherwise stated; that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously submitted it, in its entirety or in part, for obtaining any qualification. This dissertation has also been presented at Coventry University in terms of a joint-degree agreement. This thesis includes four articles, which have been submitted for publication in international peer-reviewed journals. All the writing of the articles was the responsibility of the PhD student, Odelia van Stryp. The co-authors of all four articles that form part of this thesis, Dr Eileen Africa (supervisor) and Prof Michael Duncan (Co-supervisor), hereby give permission for the candidate, Odelia van Stryp, to include the four articles as part of a PhD thesis. The advice, contribution and support of the co-authors were kept within reasonable limits, thereby enabling the student to submit this thesis for examination purposes. Therefore, this thesis is being submitted in fulfilment of the requirements for a PhD degree in Sport Science at Stellenbosch and Coventry University.

March/April 2021

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SUMMARY

According to the World Health Organization (WHO), children should take part in 60minutes of moderate-to-vigorous physical activity (MVPA) per day. Worldwide, children are becoming more sedentary, and therefore more attention should be given to children's in-school physical activity (PA) patterns, physical fitness and fundamental movement skills (FMS). Children between four to seven years of age go through rapid growth in their motor and cognitive development, and it is therefore vital to establish healthy PA patterns, physical fitness levels and proficiency in their FMS. Getting children more active in the school environment, where they spend majority of their time during the day, and implementing active brain-breaks, which consist of short bouts of PA, can potentially enhance their in-school PA patterns, contribute to the daily recommended MVPA and also improve cognitive function.

The purpose of the current study was to investigate the effect of a 10-minute intervention in the form of active brain-breaks during a school day on Grade One children's (mean age of 6.1 ± 0.36; mean BMI of 15.7) in-school PA patterns, as well as FMS and executive functioning (EF). The study consisted of four articles. Article one and two was based on a descriptive study design, included multiple assessments in order to gain a better understanding of the children's FMS, physical fitness and EF. The children were assessed using *The Test of Gross Motor Development (TGMD-2), the Head Toes Knees and Shoulder (HTKS) task, a modified EUROFIT version, and anthropometrical measurements were obtained.* Article three was based on a quasi-experimental study design, and article four was based on a Comparative Effectiveness Research (CER) as well as a descriptive study design. The children's PA patterns were monitored with Actigraphs and they participated in a 6-week active brain-breaks intervention.

Two schools participated in the study. All the children participated in the assessments during phase one. Each school had three Grade one classes. During the intervention (phase two), two classes from each school made up the experimental group and one class was the control group. The initial sample size recruited was N=191, however, incomplete data due to absenteeism were excluded, and thus the total sample size in each article differed. The children were assessed before and after the intervention, using the TGMD-2 and the HTKS task. The active brain-breaks were self-designed by the researcher and based on integrated neuromuscular training (INT) programmes. The intervention focused on a variety of FMS. All summary statistics were expressed as means, standard deviations, frequency counts and percentages. Comparisons between variables were done by using cross tabulations, Chi-square tests and ANOVA's.

The results of this study indicated that over a third of the participants mastered their FMS and almost a third remained in the 'poor' category. The physical fitness results indicated that the participants demonstrated high fitness levels and that boys performed overall better than girls, and the participants had a normal weight status. The active brain-breaks intervention had no statistically significant improvement on the overall FMS, however a significant positive effect was shown in object control skills subtests ($p<0.05$). During the intervention, the children spent less time being sedentary and more time in vigorous PA. There was also an improvement in their EF. This study contributes to the South African literature base, as to the researcher's knowledge no other study has implemented an active brain-breaks intervention focusing on FMS. This intervention has demonstrated that active brain-breaks can be executed in a school environment and that these contribute to children's in-school PA patterns. It also provides an opportunity to practice FMS during school days.

Keywords:

Grade One, Physical activity patterns, Fundamental movement skills, Fitness, Active brain-breaks, School.

OPSOMMING

Die Wêreld Gesondheidsorganisasie (WGO) beveel aan dat jong kinders daagliks vir ten minste 60 minute aan matig tot strawwe fisieke aktiwiteit (MSFA) moet deelneem. Kinders se leefstyle het wêreldwyd meer sedentêr geword en daarom moet fisieke aktiwiteit (FA), fiksheid en fundamentele bewegingsvaardighede (FBV) beklemtoon word. Die motoriese en kognitiewe ontwikkeling van kinders tussen die ouderdom van vier en sewe jaar oud ondergaan 'n versnelde groeitempo wat die vestiging van gesonde FA patrone, fisieke fiksheidsvlakke en bedrewenheid in FBV tydens hierdie tydperk, noodsaak. Daagliks spandeer kinders die meeste van hulle tyd by die skool wat die ideale omgewing bied om hulle fisiek meer aktief te kry. Die implementering van aktiewe brein breke tydens klastyd, wat kort FA sessies behels, kan moontlik FA patrone verhoog, bydra tot die daaglikse aanbevole MISFA en verbetering van kognitiewe funksies.

Die doel van die huidige studie was om die effek van 10-minuut aktiewe brein breke intervensies gedurende 'n skooldag op Graad 1 leerders (gemiddelde ouderdom 6.1 ± 0.36; gemiddelde BMI van 15.7) se in-skool FA patrone, FBV en uitvoerende funksionering (UF), te bepaal. Die studie het uit vier artikels bestaan. Artikel een en twee was 'n beskrywende studie ontwerp, en dit het meervoudige assesserings uitgevoer om 'n beter begrip te verkry van die leerders se FBV, fiksheid en UF. Die assessering het die *Test of Gross Motor Development (TGMD-2)*, die *Pictorial Scale of Perceived Movement Competence (PMSC)*, die *Head Toes Knees and Shoulder (HTKS)* taak, 'n aangepaste *EUROFIT* weergawe en antropometriese metings ingesluit. Artikel drie was 'n kwasi-eksperimentele studie ontwerp en artikel vier was 'n Vergelykende Effektiwiteitsondersoek sowel as 'n beskrywende studie ontwerp. Die leerders het aan 'n 6-week aktiewe brein breke intervensie deelgeneem waartydens FA patrone deur *Actigraphs* gemonitor is.

Twee skole het vrywillig aangebied om aan die studie deel te neem. Elke skool het drie Graad 1 klasse gehad en al die leerders het tydens fase een aan die assesserings deelgeneem. Tydens die intervensie (fase 2) het twee klasse van elke skool die eksperimentele groep gevorm en een klas die kontrole groep. Die aanvanklike gewerfde steekproef grootte was N=191, as gevolg van afwesigheid was onvolledige data stelle uitgesluit, en daarom verskil

die totale steekproef grootte van elke artikel. Die leerders is pre- en post-intervensie met die *TGMD-2* en die *HTKS* taak geassesseer. Die aktiewe brein breke, gebaseer op geïntegreerde neuro-muskulêre inoefeningsprogramme, is deur die navorser ontwerp. Die fokus van die intervensie was op 'n verskeidenheid FBV. Al die opsommende statistiek is as gemiddeldes, mediane, standaard afwykings, frekwensies en persentasies uitgedruk. Kruis tabulasie, Chi-kwadraat toetse en ANOVA's is gebruik om vergelykings tussen veranderlikes te tref.

Die resultate van die huidige studie toon dat meer as 'n derde van die leerders hulle FBV bemeester het, en amper 'n derde dit nog nie bemeester het nie. Die fisieke fiksheid resultate het aangedui dat die leerders hoë fiksheidsvlakke toon, en dat seuns beter gevorder het as die meisies. Die leerders het normale gewig status. Die aktiewe brein breke intervensies het geen statistiese beduidende resultate getoon oor die algehele FBV nie, alhoewel daar 'n betekenisvolle positiewe effek ($p<0.05$) op die leerders se objekbeheer vaardighede was. Gedurende die intervensie was die leerders minder sedentêr en meer betrokke by strawwe FA. Daar was ook 'n verbetering in die leerders se UF. Hierdie studie dra by tot die poel van Suid-Afrikaanse literatuur oor hierdie onderwerp. Volgens die navorser se kennis het geen ander studies aktiewe brein breke intervensies wat op FBV fokus, onderneem nie. Die huidige studie toon dat aktiewe brein breke in 'n skoolomgewing uitgevoer kan word en kan tot leerders se in-skool FA patrone bydra. Dit kan ook geleenthede skep om aan FBV gedurende skooldae deel te neem.

Sleutelwoorde:

Graad 1, FA patrone, FBV, Fiksheid, Aktiewe brein breke intervensies, Skole.

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“If we want our children to move mountains, we first have to let them get out of their chairs.” ~ Nicolette Sowder

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LIST OF ABBREVIATIONS

PA	Physical activity
FMS	Fundamental movement skills
EF	Executive function
MVPA	Moderate-to-vigorous physical activity
WHO	World Health Organization
PE	Physical Education
TGMD	Test for Gross Motor Development
HTKS	Head Toes Knees Shoulder task
REC	Research Ethics Committee
WCED	Wester Cape Education Department
HAKSA	Healthy Active Kids South Africa
SA	South Africa
GMS	Gross motor skills
LPA	Light physical activity
MPA	Moderate physical activity

Chapter 1

Problem Statement

INTRODUCTION

The World Health Organisation (WHO) recommends that children should participate in moderate-to-vigorous physical activity (MVPA) on a daily basis (Willumsen & Bull, 2020). It is a concern, globally, that children are not meeting these guidelines and are becoming more sedentary. During early childhood, physical and cognitive development take place at a fast pace and it is vital to establish good physical activity (PA) patterns, behaviours and routines (Willumsen & Bull, 2020). In order for children to adopt good PA patterns, behaviours and health benefits, they need to be physically active. According to Donnelly *et al.* (2016), by being physically active, children's cognitive functioning is increased and they are likely to have better body composition, musculoskeletal health as well as enhanced cardiovascular fitness (Janssen & Leblanc, 2010).

When children participate in PA, they are using their gross motor skills (GMS) that involve the large muscles and coordination of the whole body. During PA, children are also executing fundamental movement skills (FMS) (Bremer & Cairney, 2018). FMS are basic movement skills and they include locomotor (running, hopping, galloping, slide, jumping and leaping), object control (striking, catching, throwing, kicking, rolling and dribbling) and stability (balancing and twisting) skills (Bremer & Cairney, 2018). According to Gallahue & Ozmun (2006) FMS are the basic building blocks that children need to participate in more complex movements and activities (Lubans *et al.,* 2010). The hourglass model of Gallahue and Ozmun, (2006) recommend that boys and girls should be able to master their FMS between the ages of five and seven years. However, these skills do not appear naturally; they need to be learned and practiced continuously (Bolger *et al.,* 2018).

Children spend a significant amount of their day at school, and therefore, the school environment creates the ideal setting for children to be physically active and to practice their FMS (Dobbins *et al.,* 2013). Moreover, at school there are a variety of opportunities for children to decrease their sedentary time and increase PA and this can potentially contribute to the MVPA (Mazzoli *et al.,* 2019). Classroom-based active brain-breaks have been explored by researchers as an effective and practical way of getting children more active (Colella *et al.,* 2020). Active brain-breaks are short bouts of PA (10-15 minutes) that consist of a variety of PA and FMS (Egger *et al.,* 2019). It has been concluded that active brain-breaks can potentially enhance children's PA patterns during a school day, improve their on-task attention and cognitive function, and give them a short break from academic work (Egger *et al.,* 2019). By exploring the PA patterns of children, the amount of time they spend being sedentary and active, frequency and distribution need to be investigated (Simaityté *et al.,* 2019). In the current study, children's PA patterns were determined by wearing accelerometers and the counts per minute (c/pm) were captured which was converted to sedentary behaviour and MVPA.

Therefore, the current study explored the effect of an active brain-breaks intervention during a school day on the in-school PA patterns, FMS and executive functioning (EF) of Grade One children in Cape Town, South Africa.

PROBLEM STATEMENT

It is evident that children (between four and seven years old) are not active enough during school hours and tend to be sedentary for too long in the classroom (Pate *et al.,* 2015; Mazzoli *et al.,* 2019). By being sedentary for too long periods during the day on a regular basis can start to lead to physical inactivity, obesity and other health-related risk behaviours (Draper *et al.,* 2018). Children spend approximately 70% of their day at school being sedentary (Mazzoli *et al.,* 2019). Research has shown classroom-based activities (such as an active brain-breaks) can decrease sedentary time, improve children's PA levels, and enhance their attention and academic achievement

(Erwin *et al.,* 2012; Ma *et al.,* 2015; Watson *et al.,* 2017). The novelty of this study addresses a gap in the South African literature where this type of research has not been done yet. This is the first study in South Africa, specifically Cape Town that implemented an active brain-breaks intervention focusing on FMS and EF. This study also used Actigraphs as an objective measurement for PA to collect children's in-school PA patterns. Although Actigraphs has been used in previous South African studies, this is the first research with Actigraphs within this specific age in the Cape Town region. This could potentially help to give a better understanding of PA patterns of Grade One children, and assist researchers in planning interventions for these children. South Africa is a developing country, and thus data collection is more challenging. Data collection using Actigraphs were influenced by, logistics of how schools worked, how far children had travel to school, conditions of the schools as well as cultural and social factors, and the possibility of losing the Actigraphs.

Therefore, the main aim of the current study was to implement a 10-minute classroom-based active brain-breaks intervention in order to increase the in-school PA patterns, FMS and EF of Grade One (6-8 years old) children during school time.

PRIMARY AND SECONDARY AIMS

Primary Aim

The primary aim of this study was to determine the effect of active brain-breaks during school time of Grade One children on i) the in-school PA patterns before and during the intervention and ii) on FMS and EF before and after the intervention.

Secondary Aim

The secondary aim of this study was to determine any differences between boys' and girls' in-school PA patterns, FMS, physical fitness and BMI profiles. An additional secondary aim was to described Grade One children's EF.

The aims and secondary aims are further outlined in accordance with the articles (Chapter Four, Five, Six and Seven):

Research article one (Chapter Four):

To determine the fundamental movement skills proficiency of the Grade One children, as well as the differences between boys and girls;

Research article two (Chapter Five):

To investigate the physical fitness levels and weight status of Grade One children as well as the differences between boys and girls;

Research article three (Chapter Six):

To evaluate Grade One children's fundamental movement skills and executive functioning pre- and post- intervention;

Research article four (Chapter Seven):

To investigate the impact of classroom PA active brain-breaks on the in-school activity levels of Grade One children by comparing baseline results to the intervention PA patterns of the participants.

ASSUMPTIONS

It can be assumed that a 10-minute active brain-breaks intervention during a school day will have a beneficial effect on Grade One children's in-school PA patterns, FMS and EF.

HYPOTHESIS

Research hypothesis (H1): The 10-minute active brain-breaks during a school day will have a statistically significant effect on the Grade One children's in-school PA patterns, FMS and EF.

Null Hypothesis (H0): The 10-minute active brain-breaks during a school day had no statistically significant effect on the Grade One children's in-school PA patterns, FMS and EF.

RESEARCH QUESTION

Will a 10-minute active brain-breaks intervention during a school day have a statistically significant effect on the Grade One children's in-school PA patterns, FMS and EF?

METHODOLOGY

Research design

The current study was based on a quantitative research strategy, using a descriptive, quasi-experimental and Comparative Effectiveness Research (CER) design. Data collected in phase one (this will be explained in detail in chapter three) was reported in a descriptive manner and in phase two the quantitative data was collected before, during and after the intervention. The in-school PA patterns were only monitored before and during the intervention and the FMS and EF were evaluated before and after the intervention. In order to determine the effects of the intervention, the classes of each school were randomly divided into a control and experimental group. Only the experimental group participated in the intervention.

Sample

A convenience sample was applied in this study. The schools were selected from the Bellville and Stellenbosch regions in the Western Cape, South Africa. Both schools are public schools and follow the same curriculum and activities. The groups in each school were selected according to homogenous purposive sampling. Both schools had three Grade one classes available to participate in the study. The classes were randomly assigned to the experimental and control groups. The sample size for all the articles were as follow: (Article one [N=178], article two [N=184], article three [N=157] and article four [N=48]). Only the experimental group participated in the intervention, while the control group continued with their normal school programme. The control group will have the opportunity to take part in the intervention after the completion of the study. The researcher will share the content of the intervention programme with the teachers of the specific schools.

Assessments

Standardized tests and assessments were used to collect data from the participants. During the first month of the data collection, the children were assessed using the Test for Gross Motor Development (TGMD-2nd edition) (Ulrich, 1985), Head Toes Knees Shoulders (HTKS) Test (Ponitz *et al.,* 2008) and a modified EUROFIT (Adam, 1988). After the active brain-breaks intervention, the children were post-tested using the TGMD-2 and the HTKS. The research assistants were blind testers during all the assessments. Due to logistical reasons, only one school was monitored with Actigraphs to measure their PA patterns.

Intervention

The six-week active brain-break intervention took place at both schools. The intervention was planned and designed by the researcher, who is a qualified Kinderkineticist (01/014/06/1415/005), registered at the South African Professional Institute for Kinderkinetics (SAPIK). A Kinderkineticist focuses on the optimal growth and development of children between the ages of 0 and 13 years by designing and implementing science-based programmes to develop and enhance their gross motor skills. The intervention focused on FMS (locomotor and object control skills) and the activities were based on integrated neuromuscular training (INT) programmes. INT programmes are established on various essential gross motor skills, such as locomotor and object manipulation, which improve and strengthen children's FMS and fitness levels (Duncan *et al.,* 2017). The active brain-breaks took place in the classroom and were presented by the researcher and four trained assistants. The same assistants helped with the same classes to ensure consistency throughout the intervention. The children participated in 24 10-minute active brain-break sessions (twice a week, two per day). The first active brain-break was done early in the morning and the second one later in the morning. A detailed description of the intervention programme is provided in appendix C.

Statistical analysis

All the data of the study was analysed with the assistance of Professor Martin Kidd, from the Statistical Consultation Centre at Stellenbosch University. Statistica version 13.5 was used. Data were analysed by Excel (Microsoft®), Statistica version 13.5 (TIBCO Software Inc., Palo Alto, California, USA).

Ethical considerations

Ethical clearance for the study was obtained from the Research Ethical Committee of Stellenbosch University (REC-2019-8456) as well as Coventry University (P94100) (Appendix E). Thereafter, permission was received from the Western Cape Education Department (Appendix D). The researcher received consent from the parents/guardians (Appendix A) as well as assent from the children (Appendix B). All the data was managed confidentially and was stored and kept safe on the researcher and supervisors' computers as well as external hard drives. The computers were all password-protected and the hard copies and documentation were safely stored at the Department of Sport Science, Stellenbosch University. Children's information remained anonymous at all times.

STRUCTURE OF THE THESIS

This study is presented in a research article format. The four research articles presented in Chapter Four, Five, Six and Seven, were written in compliance with specific journal guidelines and therefore the referencing style used in the thesis will differ.

Chapter One: Problem statement

This chapter provides a short introduction, the problem statement, aims and objectives and a short methodology. The adapted Harvard reference style was used in this chapter according to the guidelines set out by the Department of Sport Science, Stellenbosch University.

Chapter Two: Literature Review

In this chapter a review of literature relating to the current study is provided, including PA, PA patterns, FMS, physical fitness and weight status, EF and active brain-break interventions. The adapted Harvard reference style was used in this chapter according to the guidelines set out by the Department of Sport Science, Stellenbosch University.

Chapter Three: Methodology

This chapter provides a detailed explanation on the methodology of the study. The research design, sample, assessments, intervention, intervention theory, timeline and data analysis are discussed. The adapted Harvard reference style was used in this chapter according to the guidelines set out by the Department of Sport Science, Stellenbosch University.

Chapter Four: Research Article 1

The title of research article 1 is: *Fundamental movement skills proficiency amongst neurotypical Grade one children in Cape Town, South Africa: A Descriptive study.* This article is written according to the journal guidelines for the Sport Sciences for Health Journal. The reference style of The American Psychological Association (APA) was used. This article is a descriptive study design. This article has been *submitted* to the journal for publication and the researcher is awaiting feedback.

Chapter Five: Research Article 2

The title of research article 2 is: *Physical fitness and weight status of Grade one children in Cape Town, South Africa.* This article is written according to the journal guidelines of The Journal of Physical Therapy in Sport. The American Medical Association reference style format was used. This article is a descriptive study design. This article has been <u>*submitted*</u> to the journal for publication and the researcher is awaiting feedback.

Chapter Six: Research Article 3

The title of research article 3 is: *The effect of active brain-breaks on the fundamental movement skills and executive functioning of Grade One children in Cape Town, South Africa.* This article is written according to the journal guidelines for the European Physical Education Review. The reference style of SAGE Harvard was used. This article is a quasi-experimental study design. This article has been <u>*submitted*</u> to the journal for publication and the researcher is awaiting feedback.

Chapter Seven: Research Article 4

The title of the research article 4 is: *The effect of active brain-breaks during a typical school day on the in-school physical activity patterns of South African Grade One children.* This article is written according to the journal guidelines for the Journal of Sport and Health Science. The American Medical Association reference style format was used. This article is a CER and descriptive study design. This article has been <u>*submitted*</u> to the journal for publication and the researcher is awaiting feedback.

Chapter Eight: Conclusions, Recommendations & Limitations

The final chapter concludes all the important findings relevant to the current study, recommendations for future studies, as well as limitations. The adapted Harvard reference style was used in this chapter according to the guidelines set out by the Department of Sport Science, Stellenbosch University.

Summary

In this chapter, the importance of the effect of an active brain-break intervention on Grade One children's FMS, PA patterns and EF were briefly discussed. The main and secondary aim as well as the sub-aims of each research article of the current study were presented to form a hypothesis to determine whether an active brain-break intervention was effective in improving children's in-school PA patterns, FMS and EF.

REFERENCES

ADAMS, J. & WHITE, M. 2003. Are activity promotion interventions based on the transtheoretical model effective? A critical review. *British Journal of Sports Medicine*. 37:106–114.

BARNETT, L.M., RIDGERS, N.D., ZASK, A. & SALMON, J. 2015. Journal of Science and Medicine in Sport Face validity and reliability of a pictorial instrument for assessing fundamental movement skill perceived competence in young children. *Journal of Science and Medicine in Sport*. 18(1):98–102.

BOLGER, L.E., BOLGER, L.A., O'NEILL, C. & COUGHLAN, E. 2018. Age and Sex Differences in Fundamental Movement Skills Among a Cohort of Irish School Children. *Journal of Motor Learning and Development.* 6: 81-100.

BREMER, E. & CAIRNEY, J. 2018. Fundamental Movement Skills and Health-Related Outcomes: A Narrative Review of Longitudinal and Intervention Studies Taregting Typically Developing Children. *American Journal of Lifestyle Medicine.* 12(2): 148-159.

COLELLA, D., MONACIS, D. & LIMONE, P. 2020. Active Breaks and Motor Competencies Development in Primary School: A Systematic Review. *Advances in Physical Education.* 10: 233-250.

DONNELLY, J.E., HILLMAN, C.H., CASTELLI, D., ETNIER, J.L., LEE, S., TOMPOROWSKI, P., LAMBOURNE, K. & SZABO-REED, A.N. 2016. Physical activity, fitness, cognitive function, and academic achievement in children: a systematic review. *Medicine & Science In Sports & Exercise.* 48(6): 1197-1222.

DOBBINS, M., HUSSON, H., DECORBY, K. & LAROCCA, R.L. 2013. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database Systematic Review.* 2.

DUNCAN, M.J., EYRE, E.L.J. & OXFORD, S.W. 2017. The effects of 10 weeks Integrated Neuromuscular Training on fundamental movement skills and physical self-efficacy. *Journal of Strength and Conditioning*. 1–32.

EGGER, F., BENZING, V., CONZELMANN, A. & SCHMIDT, M. 2019. Boost your brain, while having a break! The effects of long-term cognitively engaging physical activity breaks on children's executive functions and academic achievement. *Public Library of Science.* 14(3): 1-20.

ERWIN, H., FEDEWA, A., BEIGHLE, A. & AHN, S. 2012. A quantitative review of physical activity, health, and learning outcomes associated with classroom-based physical activity interventions. *Journal of Applied School Psychology.* 28(1): 14-36.

GALLAHUE, D.L. & OZMUN, J.C. 2006. Understanding motor development: Infants, children, adolescents, adults (6^{th} ed.) New York, NY: McGraw-Hill.

JANSSEN, I. & LEBLANC, A.G. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity.* 7(40): 1-16.

LUBANS, D.R., MORGAN, P.J., CLIFF, D.P., BARNETT, L.M. & OKELY, A.D. 2010. Fundamental movement skills in children and adolescents: review of associated health benefits. *Sports Medicine.* 40: 1019-1035.

MAZZOLI, E., KOORTS, H., SALMON, J., PESCE, C., MAY, T., TEO, W. & BARNETT, L.M. 2019. Feasibility of breaking up sitting time in mainstream and special schools with a cognitively challenging motor task. *Journal of Sport and Health Science.* 8: 137-148.

MA, J.K., LE MARE, L. & GURD, B.J. 2015. Four minutes of in-class high-intensity interval activity improves selective attention in 9- to 11-year old's. *Applied Physiology, Nutrition and Metabolism.* 40: 238-244.

PATE, R., MCIVER, K., DOWDA, M., BROWN, W.H. 2008. Directly Observed Physical Activity Levels in Preschool Children. *Journal of School Health*. 78(8):438–444.

PONITZ, C., McCLELLAND, M. 2009 & MORRISON, J. A Structured Observation of Behavioral Self-Regulation and Its Contribution to Kindergarten Outcomes. *Developmental Psychology.* 45(3): 605-619.

SIMAITYTE, M., PETRENAS, A., KRAVCENKO, J., KALDOUDI, E. & MAROZAS, V. 2019. Objective evaluation of physical activity pattern using smart devices. *Scientific Reports.* 9(2006): 1-9.

ULRICH, D.A. (1985). Test of Gross Motor Development (2nd ed.). Austin, Texas: Pro-ed.

WATSON, A., TIMPERIO, A., BROWN, H., BEST, K. & HESKETH, K.D. 2017. Effect of classroom-based physical activity interventions on academic and physical activity outcomes: a systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity.* 14: 114-138.

WILLUMSEN, J. & BULL, F. 2020. Development of WHO guidelines on physical activity, sedentary behaviour and sleep for children less than 5 years of age. *Journal of Physical Activity and Health.* 17(1): 96-100.

Chapter 2

Literature Review

INTRODUCTION

Fundamental movement skills

Being physically active is important for children and therefore they need to be able to execute fundamental movement skills (FMS) (Hesketh *et al.,* 2017). Physical literacy can be seen as an umbrella term that consist of a few components, such as motivation and confidence, physical competence, knowledge and understanding and engagement in physical activities. By developing and enhancing children's FMS, they will be more confident and motivated to partake in any form of physical activities, free play and sport specific sports. Overall, FMS links with physical literacy as they both are intertwined (Jurbala, 2015). Therefore, factors such as encouragement and motivation to partake in FMS plays a role as well as the exposure that children get to practice the skills. This study only explored children's FMS, as it is a crucial time for them to master their FMS skills in order to partake in other sport specific activities. FMS consists of foundational skills that are necessary for children to participate in physical activities and different sports and they include locomotor, object control and stability skills. Locomotor skills involve the ability to move one's body from one place to another in space, such as running, jumping, leaping, jumping, sliding and hopping. Object control skills involve the manipulation of objects such as striking, dribbling, throwing, catching, kicking and rolling a ball (Stodden *et al.,* 2008). Stability skills involve the ability to maintain one's balance in a static or dynamic position, such as standing on one leg (Gallahue and Ozmun, 2006). FMS form the foundation for PA and they are the building blocks for more complex movements as well as equipping children to become physical literate (Lubans *et al.,* 2010; Hulteen *et al.,* 2018). It is necessary to develop FMS and reach proficiency in these skills in order to be able to participate in organized and non-organized physical activities (Pienaar *et al.,* 2016; Lubans *et al.,* 2010). FMS gives children the opportunity to engage and explore their environment (Siahkouhian *et al.,* 2011).

Phases of development

According to Gallahue and Ozmun (2006), children's FMS develop between the ages of four and six years old. Between the ages of six and seven years, a child must be proficient in the majority of the FMS and preferably at the mature phase level when executing the skills (Kahts *et al.,* 2017). Being able to master FMS contributes to multiple health benefits as well as a balanced Body Mass Index (BMI) (Kahts *et al.,* 2018). FMS consists of three phases (Gallahue & Ozmun, 2006; O'Brien *et al.,* 2016). During the initial phase (between two and three years old), children tend to execute movements in an uncoordinated and slightly unfinished or unskilful manner. During the second phase, which is the elementary phase (between four and five years old), children start to show more coordination, control and rhythm. The mature phase (between six and seven years old), is when children are able to execute the skills fluently, in a well-coordinated and mechanically correct manner. For children to execute their FMS at mature phase level, they need to practice the skills, and also receive encouragement, correct feedback and instructions (Gallahue & Ozmun, 2006). Therefore, it is extremely important for children under the age of six to get exposure to FMS and to achieve mastery before taking part in specific sports at a competitive level (Cliff *et al.,* 2012). In the early childhood development period, numerous developmental phases take place, such as physical, cognitive and emotional development and mastery of FMS contributes to these domains (Pang & Fong, 2009; Lubans *et al.,* 2010; Pienaar *et al.,* 2016).

During early childhood, children's neurological pathways develop at a fast pace and therefore they can learn skills at a much faster rate (Rushton, 2011). At the age of 6 years and younger, they have not learned any bad habits and they are not terrified to try out new skills in front of their peers (Mukherjee *et al.,* 2017). In the pre-school phase, between two to six years of age, children's movement patterns are not well established yet, and this is the optimal time to introduce FMS (Hardy *et al.,* 2010). Recently, more studies are looking at the impact of PA on the cognitive function of individuals and how it can benefit everyday activities and academic work of children (Carson *et al.,* 2016; Donnelly *et al.,* 2016; Bidzan-Bluma & Lipowska, 2018). According to Bolger *et al.* (2018), there is a positive association between FMS proficiency, effective cognitive function and academic work.

Proficiency in fundamental movement skills

According to Bryant *et al.* (2014) and Bolger *et al.* (2018), sex plays a role in the PA levels and FMS of children. Various studies have reported that boys are better at object control skills and girls at locomotor skills (Bardid *et al.,* 2016; O'Brien *et al.,* 2016; Duncan *et al.,* 2019). A possible reason for this can be because boys tend to engage more in activities and games where a ball is involved and girls are more likely to engage in activities where they use their bodies like swimming, gymnastics and dancing (Bryant *et al.,* 2014). Barnett *et al.* (2015) reported that girls had poorer object control skills, and they also perceived their object control skills as being lower compared to boys. Pienaar *et al.* (2016) investigated the FMS competence and sex differences of 6-year old children (N=72) in the North-West Province in South Africa. They classified the FMS competence of the children in five different categories, namely; initial, initial elementary, elementary, elementary mature and mature. 70.4% of the group showed mature mastery of object control skills and there was a 9.5% difference between boys and girls, with boys showing the highest percentage of mastery. The most difficult object control skill was throwing a ball; 71% of the children in the group were still in the elementary stage for throwing. The reason that throwing is such a difficult skill to master, is because it requires upper and lower body coordination as well as bilateral movement (rotation of the hips and shoulders) (Pienaar *et al.,* 2016).

According to Pienaar *et al.* (2016), there are no sex differences in the throwing subtest for 6-year old children. Differences can only be seen at a later age when boys are able to throw further and when there is an improvement in hip rotation (Pienaar *et al.,* 2016). Of all the object control skills, catching had the highest percentage of mastery (83%). The largest sex difference was seen in kicking a stationary ball, where 88.6% of the boys were in the mature phase in comparison to only 70% of the girls (Pienaar *et al.,* 2016). When examining the locomotor skills evaluated with the TGMD-2, girls tend to perform better than boys (O'Brien *et al.,* 2016; Duncan *et al.,* 2019). Researchers have noted that children in South Africa do not meet the mastery requirements of FMS at the ages of 6 and 7years; however, the majority of those studies were conducted in the North-West Province and there is a need for more similar studies to be conducted in other provinces of South Africa (Kahts *et al.,* 2017). In an Irish study, the researchers evaluated 6 to 10 year (N=203) old children using the TGMD-2 (Bolger *et al.,* 2018). They concluded that running was the simplest locomotor skill to master and jumping the most difficult; kicking was the object control skill that the children were most proficient in and rolling was the one they were least proficient in (Bolger *et al.,* 2018). Overall, children perform better in object control than locomotor skills, and boys are superior in object control (Bolger *et al.,* 2018). Some studies have reported no differences between the FMS of boys and girls (Hardy *et al.,* 2010; Kordi *et al.,* 2012). The sex differences observed in prior work can be attributed to individual and biological characteristics such as body type, body composition, strength and limb lengths, and some researchers have argued that sex differences before puberty are more likely to be associated with socio-cultural factors (Bardid *et al.,* 2016; Forthofer *et al.,* 2017).

There are some factors that can be investigated when looking at the possible reasons for low proficiency scores in South African children. According to Bronfenbrenner's bio-ecological model, the environment, especially the immediate environment, can have a large impact (Kahts *et al.,* 2017). This immediate environment refers to the learning environment that children are exposed to as well as access to the necessary infrastructure, equipment and professional assistance. Moreover, it is vital that children get the exposure to PA and FMS on a regular basis in order for their motor proficiency to develop as well as their cognitive, social and emotional well-being.

Physical fitness

The term physical fitness can be defined in relation to numerous health-related components that are essential in our everyday lives. It involves body functions that are vital for daily activities (Weston *et al.,* 2019). Health-related components consist of cardiorespiratory endurance, muscular strength and endurance, body composition and flexibility (Amusa *et al.,* 2011; Weston *et al.,* 2019). Paschaleri *et al.* (2016) suggested that various chronic diseases and obesity that are prominent in adolescents most probably occur as a result of physical inactivity during their childhood years. Paying attention to health-related components from early childhood can potentially decrease and prevent diseases, and endorse a healthy body composition (Paschaleri *et al.,* 2016). According to Amusa *et al.* (2011), during the early childhood phase, numerous physiological and psychological characteristics develop, where a child can acquire a healthy or unhealthy lifestyle that can carry on into their adolescent years. Low levels of physical fitness can lead to the development of more body fat, abdominal adiposity, cardiovascular diseases and hypertension (De Moraes *et al.,* 2019). Therefore, being physically fit and active is important through implementing appropriate interventions. There are other positive characteristics associated with physical fitness such as children showing a confident attitude towards their bodies, having good self-awareness and being motivated to be fitter and more active.

Amusa and colleagues conducted a study in Tshannda, South Africa in 2011, where they measured the physical fitness of N=409 primary school children using the

EUROFIT physical fitness test. They concluded that boys had significantly better results in muscular strength, muscular endurance and cardiorespiratory fitness and girls performed better in flexibility and agility tests (Amusa *et al.,* 2011). Armstrong *et al.* (2011) investigated the baseline physical fitness of South African children between the ages of 6 and 13, as well as differences between ethnic groups. The data was collected in the Western Cape, Gauteng, Eastern Cape, Free State and KwaZulu-Natal provinces with N=10 295 participants. The results indicated that Caucasian boys and girls were taller and heavier. Significant sex differences were observed, where girls performed better in the flexibility test and boys performed better in muscular strength and endurance tests (Armstrong *et al.,* 2011). Being conscious of the importance of children's physical fitness and body composition is necessary, as well as the effect it has on the health status and overall well-being of an individual (Monyeki *et al.,* 2005).

Anthropometry

Body composition can be defined as the relationship between lean body mass and fat body mass (Kemp *et al.,* 2013). Across the world the prevalence of overweight and obesity is increasing drastically and becoming a definite problem (Monyeki *et al.,* 2008; Rossouw *et al.,* 2012; Klingberg *et al.,* 2019). There are numerous risk factors associated with obesity, including chronic diseases such as: coronary heart disease, diabetes mellitus and hypertension (Monyeki *et al.,* 2008; Rossouw *et al.,* 2012; Pretorius *et al.,* 2019). It is evident that these risk factors are starting to become more prominent in childhood obesity, and the chances of obese children growing up to be obese adults are much higher (Siahkouhian *et al.,* 2011; Kim & Lee, 2016; Dukhi *et al.,* 2020). The earlier the risk factors are identified, the earlier an intervention can be implemented and preventative measurements can be put in place (Dukhi *et al.,* 2020). Evidence has shown a tremendous decline in the PA levels of children worldwide and sedentary behaviors are increasing every year (Katzmarzyk *et al.,* 2016; Hesketh *et* *al.,* 2017; Dukhi *et al.,* 2020). Sedentary behaviours among children are on the increase and this contributes to increased body fat percentages and changes in body compositions (Kemp *et al.,* 2013).

When children are overweight or obese, they are less likely to participate in PA and sports and tend to engage in more sedentary activities (Rossouw *et al.,* 2012). This contributes to an inactive lifestyle that can potentially be detrimental to children's overall health and well-being (Siahkouhian *et al.,* 2011; Wu *et al.,* 2017). It could negatively affect their FMS and physical fitness levels and possibly lead to movement difficulties, especially in cases where children have to project themselves through space (Monyeki *et al.,* 2005; Kemp *et al.,* 2013). Children who are overweight and obese carry more body mass and find it difficult to execute movements. This could potentially hinder them from taking part in FMS. Wrotniak *et al.* (2006) concluded that children who are lacking in their motor and physical fitness competence, show a greater decline in their PA levels. Logan *et al.* (2011) also concluded that children with a low FMS proficiency are less physically active, which leads to the children being overweight, which in turn leads to a low FMS proficiency. A study by Kim & Lee (2016) found no relationship between FMS and BMI in five to six-year-old South Korean children (N=216) and recommended that researchers should also investigate other factors such as exercise intensity and nutrition of children.

Moreover, it is essential that researchers should not depend solely on BMI as it can be misleading and not necessarily give an accurate indication of body fat and lean body mass (Musalek *et al.,* 2017). Cattuzzo *et al.* (2016) suggested that children who have a higher motor competence or FMS proficiency and a balanced weight status, with increased musculoskeletal and cardiorespiratory fitness, are more active. Two main reasons for the high overweight and obesity prevalence rates are a decline in PA and diets which are rich in fat, oils and carbohydrates (Rossouw *et al.,* 2012). According to

Armstrong *et al.* (2011), the prevalence of overweight and obesity among South African children is similar to that of developed countries. Du Toit *et al.* (2011) measured the physical fitness and anthropometry of primary school children in the North-West province (South Africa). They found that girls had a higher body fat percentage than boys. Kemp & Pienaar (2013) investigated the relationship between body composition, motor and physical fitness competencies of Grade One (N=880) learners in the North-West Province (South Africa). They concluded that 1 in every 10 learners are overweight or obese. These findings are in line with those of Armstrong *et al.* (2011). Kemp & Pienaar's (2013) findings also suggested that girls are more overweight than boys, and that overweight and obese children have lower physical fitness abilities, poor balance and poor body control, which can negatively affect their everyday tasks. Musalek *et al.* (2017), conducted a study in the Czech Republic and investigated if obese preschool children have poorer FMS proficiency than normal weight preschool children. Their results demonstrated poorer FMS proficiency in obese children and they also presented a three times higher risk of severe motor deficits in comparison with normal weight children (Musalek *et al.,* 2017).

There are multiple reasons that lead to physical inactivity among children. There is enormous diversity in South Africa between different economic and social classes as well as ethnic groups and cultures (Armstrong *et al.,* 2011). As mentioned in the literature above, there is a strong relationship between PA and physical fitness, inactivity and BMI. Children spend numerous hours and a big part of their day at school and therefore, it is the ideal environment to implement PA interventions. Most schools already have a well-established infrastructure where PA interventions can be implemented and can be seen as a safe environment for children to be physically active (Watson *et al.,* 2017). Although not all schools have access to equipment, classroom-based PA interventions may present a practical, low-cost and effective solution for such schools (Watson *et al.,* 2017; Konijnenberg & Fredriksen, 2018; Egger *et al.,* 2019).

Executive functions

Increasing children's PA during the day decreases sedentary activity and thus promotes health benefits. PA provides multiple advantages for executive functioning (EF) and cognitive enhancement of children that is important for school success (de Greeff *et al.,* 2018 & Konijnenberg & Fredriksen, 2018). Stewart *et al.* (2004) provided evidence that teachers can assist children to be more active in the classroom. Implementing PA in the classroom will potentially increase children's concentration, mental cognition and academic performance (Mahar *et al.,* 2006; de Greeff *et al.,* 2018). MVPA leads to improved cognitive activity and this is mostly seen in EF (de Greeff *et al.,* 2018).

EF refers to a set of cognitive functions that helps one to carry out tasks and that is critical for attention, focus and concentration (Mulvey *et al.,* 2018; Egger *et al.,* 2019). The executive process develops from childhood through to adolescence, and forms a key aspect of a child's cognitive function, behaviour, emotional regulation as well as social communication (Anderson, 2002). The prefrontal cortex of the brain plays a fundamental role in EF (Verburgh *et al.,* 2014). There are three main aspects of executive function: Cognitive flexibility or *shifting* is the ability to shift between different tasks without getting distracted; working memory or *updating* is the ability to remember directions in order to plan tasks; and inhibitory control or *inhibition*, is the capability to stop or avoid a response in order to do something else (McClelland *et al.,* 2014). According to Kvalø *et al.* (2017), these three aspects have been found to be more important for school readiness and academic achievement than a child's IQ or reading and math level. High levels of EF can predict school readiness in preschool children. The development of all the EF components takes place between the ages of 7 and 12 years and contributes considerably to the emotional growth of a child (Bidzan-Bluma *et al.,* 2018). The brain develops at a very fast pace between the ages of 7 and 12 years and therefore, the cognitive and PA exposure children receive is crucial as the brain's plasticity allows the child to develop new skills (Bidzan-Bluma *et al.,* 2018). In children, the inhibitory control or inhibition is the first EF component that fully develops and cognitive flexibility or shifting, the last (Egger *et al.,* 2019). However, a delayed development or late maturation in the prefrontal cortex can result in late development in EF (Verburgh *et al.,* 2014).

Most of the time, the enrichment of cognitive function is due to increased PA that is mostly seen in EF and attention. However, physical activities with a moderately high cognitive engagement, where children need to concentrate, strategically focus and plan, are believed to have a better effect in EF compared to activities with a low cognitive engagement (de Greeff *et al.,* 2018). Scudder *et al.* (2014) & van der Niet *et al.* (2015) found that children who participate in PA exhibited better EF functions in their inhibition and planning abilities than children who did not participate in PA. Improvement of EF can be achieved through physical and cognitive exercises (computer training, games or aerobics). Erickson and Kramer (2009) concluded that aerobic activities have the most substantial impact on EF, which helps to regulate other cognitive functions. Konijnenberg and Fredriksen (2018) also concluded that PA has good responsive effects on EF and that it is seen as a fundamental skill. Thus, being able to integrate, implement and improve children's EF in a school setting can possibly help them to plan, organize and problem-solve easier on a daily basis (McClelland *et al.,* 2014).

Active brain-breaks

The school setting is a critical environment where children can adopt healthy habits and initiate change (Whitt-Glover *et al.,* 2011; Käll *et al.,* 2015). Recently, more researchers are investigating the effects of classroom-based PA, as it serves as an alternative to Physical Education (PE) periods (Käll *et al.,* 2015; Kvalø *et al.,* 2017; Konijnenberg & Fredriksen, 2018). Implementing PA in an effective way in the classroom could possibly give children the opportunity to get regular exposure to PA on a daily basis and contribute to the recommended 60-minutes of MVPA per day (Kolimechkov *et al.,* 2017). Fairclough *et al.* (2012) discovered that PA interventions during school time could possibly contribute to up to 50% of the recommended MVPA per day. It could assist children to get active breaks in between academic work to eliminate sedentary behaviour for long periods of time.

There are a few ways to implement classroom-based PA; it can either be integrated into academic lessons (physically active/focused lessons) or outside of academic lessons (active breaks) (Egger *et al.,* 2019). Overall, the meta-analysis done by Watson *et al.* (2017) concluded that PA has significant effects on school engagement and that active-breaks interventions showed the most effective results. Numerous researchers have explored the relationship between PA and cognitive function and found noteworthy results (Donnelly *et al.,* 2016; de Greeff *et al.,* 2018; Egger *et al.,* 2019). Watson *et al.* (2017) defined active breaks as short bouts of PA that can be implemented as a break from academic work. The implementation of active breaks can have a positive impact on children's PA levels, classroom behaviour, cognitive function (e.g. EF) and academic achievement (Watson *et al.,* 2017; Egger *et al.,* 2019). According to de Greeff *et al.* (2018), a single bout of PA can potentially promote the child's level of physiological arousal, which leads to an escalation in attention. Intensive active breaks can vary from 4 minutes of vigorous-intensity physical activity (VPA) to 20 minutes of MVPA, twice per day (Verburgh *et al.,* 2014; Altenburg *et al.,* 2016). The meta-analysis done by Watson *et al.* (2017) reported that studies that implemented active breaks showed a 2 to 16% increase in MVPA of children.

The International Life Sciences Institute Centre for Health Promotion in the United States developed a programme called ‘TAKE 10!’. Children took part in 10-minutes (12-week intervention) of classroom-based physical activities during school time to promote their PA levels (Stewart *et al.,* 2004). The programme was developed to integrate PA in the academic curriculum and teachers were trained to present the programme. China developed a similar programme called Happy 10 that took place once a week over two semesters (Liu *et al.,* 2007). Both of these programmes showed an effective improvement in children’s PA levels and increased exercise intensity during school time. The researchers who designed both of these programmes concluded that 10-minutes of PA during school time is feasible to implement and has shown long lasting results at various schools (Stewart *et al.,* 2004). Mulvey *et al.* (2018) implemented a slightly longer (30 minutes) evidence-based gross motor intervention (6-weeks) called SKIP! (Successful Kinesthetic Instruction for Preschoolers). The programme consisted of a variety of cognitively demanding gross motor skills (GMS) and FMS that required focused attention, concentration and working memory skills. The researchers concluded that the experimental group that took part in the SKIP! programme demonstrated significantly better GMS and EF performance from pre- to post-testing (Mulvey *et al.,* 2018). Wilson *et al.* (2015) implemented their intervention in Australia on 11-year old boys. The aim was to evaluate the impact of 10-minute activity breaks on three weekdays over a 4-week period. The activity breaks took place during academic work and the results concluded that active breaks contributed to the daily activity of the boys and did not interrupt their classwork (Wilson *et al.,* 2015). Van den Berg *et al.* (2016) did a study on 10 to 13-year olds in the Netherlands by investigating the effect of a 12-minute classroom-based active break on cognitive tasks and secondly the effects of different types of exercises such as aerobics, coordination and strength. The study found no significant results that physical exercises improved cognitive performance or that different types of exercises have different effects. This is inconsistent with what other researchers have found. There are a few reasons that could have led them to different results, including the possibility that the active breaks were conducted at a low intensity or the timing of the cognitive tests that were done on the participants (van der Berg *et al.,* 2016). The Instant Recess programme was implemented by Whitt-Glover *et al.* (2011) in California at eight elementary schools. The aim of the programme was to provide opportunities for children to take part in 10-minute bouts of PA during an 8-week intervention. The active breaks consisted of a variety of aerobic, dance and sport movements and they resulted in an increase in classroom PA as well as on-task behaviour.

The SKIP! programme was evaluated with the TGMD-2 as most of the intervention consisted of FMS, and the working memory skills with the Head Toes Knees and Shoulders (HTKS) test. According to Anderson (2002), in order to assess EF, the evaluation tool needs to be novel and complex and must include the integration of the information. However, an evaluation can be easy for one person and complex for the next. Some researchers also propose that all cognitive evaluations involve EF (Anderson, 2002). Different evaluation tools can be used for EF; however the current study also made use of the HTKS evaluation as it evaluates children's inhibitory control, working memory and attention focusing (Ponitz *et al.,* 2008). As far as the researcher is aware, there is no study other than the one conducted by Mulvey *et al.* (2018) that has used the TGMD-2 and the HTKS to evaluate children before and after an active break intervention and certainly not in South Africa.

Physical activity levels of children

Children's participation in PA has a significant effect on the development of FMS and the engagement of physical activities (Barnett *et al.,* 2015). If children cannot execute these skills proficiently, they might have limited opportunities when they engage in PA and different sports. Stodden *et al.* (2008) designed a conceptual model stating that the development of a child's motor competence skills is extremely important when looking at the development of health-related physical fitness, PA and the prevention of obesity (Bryant *et al.,* 2014; Hulteen *et al.,* 2018). Worldwide, there is a concern about PA levels of children and the reality that they are not partaking in the daily 60-minute moderate- to vigorous-intensity of physical activity (MVPA) as recommended by the World Health Organization (WHO) (Flaes *et al.,* 2016; Reimers & Knapp, 2017; Frank *et al.,* 2018). According to various researchers, there is a significant correlation between children's PA levels and a positive perception of FMS (Chan *et al.,* 2018; Bolger *et al.,* 2019; Moulton *et al.,* 2019).

Physical activity patterns

By investigating the PA patterns of young children, it is evident that the prevalence of physical inactivity around the world is growing at a tremendous rate (van Biljon *et al.,* 2018). Low levels of PA are one of the factors leading to obesity, which is currently one of the top four leading risk factors contributing to global mortality (van Biljon *et al.,* 2018). South Africa is showing a high prevalence of overweight and obesity in young children, fluctuating from 11% to 14% in 6-year olds (Prioreschi *et al.,* 2017). Studies have indicated that South African children and adolescents show a low volume and intensity of PA (Craig *et al.,* 2013). According to Draper *et al.* (2018) the HAKSA (Healthy Active Kids South Africa) stated in 2016 that only 50% of the children meet the daily recommendations for PA. This is in line with international findings (Uys *et al.,* 2016). It is also a concern that screen time and sedentary behaviour is increasing (Draper *et al.,* 2018). Janssen *et al.* (2016) stated that childhood is a critical period for the development of sedentary behaviour habits and that there is a strong possibility that the older children get, the more sedentary they become. The study of van Ekris *et al.* (2020) examined the total sedentary time on a day-to-day basis of a large international sample, data were obtained from the International Children's Accelerometry Database (ICAD). The results concluded that the children's total sedentary time increased with age and already became accustomed during childhood (van Ekris *et al.,* 2020). Therefore, the current study focusses on the 6-8 year age range as children from 5 years of age PA starts to decrease progressively over time. Examining and measuring children's PA patterns and levels will provide researchers with substantial information on how active children are during the day.

PA patterns and levels can be measured subjectively via questionnaires or objectively via accelerometers. Marques *et al.* (2017) found that there can be inconsistent results between subjective and objective measurements, where self-reported measurements can overestimate PA. This should be considered when looking at the results. One commonly-used and objective measurement method that researchers make use of is an accelerometer device, which is mostly seen as a "gold standard" and is a non-invasive method that eliminates the possibility of any self-reported bias (Balaban, 2017).

Accelerometers

The Actigraph GT3X accelerometer is one of the most commonly used accelerometers. It is a very small and discreet monitor that can be attached with an elastic belt or strap to the wrist, hip or ankle (Johnstone *et al.,* 2019). Studies have shown that the Actigraph shows high validity and reliability and low reactivity in children (Craig *et al.,* 2013). Accelerometers have numerous benefits, but they are not free of limitations. They can measure PA patterns for a short period of time, but they do not fully represent the typical PA patterns of children (Marques *et al.,* 2017). Therefore, one cannot be certain what type of activities children executed.

The monitor is comfortable for children to wear during the day. It needs to be initialized to collect at a present frequency in hertz and this gets summed over into a sampling interval called an epoch. This ensures that raw PA data gets collected and converted to a total volume of PA counts (counts per minute – cpm) and time spent in sedentary and in MVPA by using different cut points (Kim *et al.,* 2012; Johnstone *et al.,* 2019). Thus, the monitor measures frequency, intensity and duration of children's MVPA and sedentary time (Kim *et al.,* 2012). The epochs need to be converted into the time that was spent in various PA intensity levels, like sedentary, moderate and vigorous and this is determined by a 'cut-point'. There are various 'cut-points' to choose from that have been established and validated by calibration studies. The calibration studies need to take the following aspects into consideration: they need to use appropriate biological standards, include a wide variety of activities, make use of epoch lengths less than 60 seconds and have a sample size of a minimum of 10 participants per age group. Kim *et al.* (2012) concluded that although there are numerous 'cut-points' developed by calibration studies, there are no definite 'cut-points' agreed on by researchers to categorize MVPA of children and youth it is therefore necessary to look at why a researcher chose a specific 'cut-point'. The Evenson *et al.* (2008), Crouter *et al.* (2013) and Freedson *et al.* (2005) 'cut-points' are the most recent and recommended 'cut-points' to use for children between 6 and 10 years old, as both of them have similarities in identifying PA intensity levels, the Crouter *et al.* (2013) 'cut-points' are also recommended for wearing on the dominant wrist. According to Freedson *et al.* (2005) the intensity levels of PA are divided into different categories namely: sedentary PA (0-149 counts/min), light PA (150-499 counts/min), moderate PA (500-3999 counts/min), vigorous PA (4000-7599 counts/min) and very vigorous PA (4000-7599 counts/min).

Studies exploring physical activity patterns of children

A study conducted by van Biljon *et al.* (2018) investigated the PA levels of 8-14-year-old (N=7348) children across seven provinces in South Africa. Data was collected subjectively with The Physical Activity Questionnaire for Older Children (PAQ-C). Significant differences were found between boys and girls and between older and younger children. Boys had higher PA levels than the girls, and the younger children were more active than the older ones. The study also established that children do take part in an adequate amount of PA; however there are inconsistencies between ethnic groups and socio-economic environments and more attention should be given to this (van Biljon *et al.,* 2018). Another South African study was conducted by Micklesfield *et al.* (2014) and it examined the PA patterns of children aged between 7 and 15 years (N=3511) by using a PA questionnaire that was developed and validated for South African children. The results indicated that children spent an average of 25 minutes per day in MVPA and 1.5 hours in informal PA. Only 26% of the children met the recommended guidelines of 60 minutes MVPA per day. The increase in sedentary behaviour is a big concern as it leads to overweight and obesity, especially in girls. There was a difference between the PA levels of boys and girls; boys spent an average of 196 minutes per day in PA and girls 154 minutes per day; boys also spent more time in vigorous activities (Micklesfield *et al.,* 2014). A study done by McVeigh and Meiring (2014) also explored the PA patterns of 5-18-year-old South African children (N=767) using the PAQ-C and concluded that boys participated in more MVPA than girls, and that physical inactivity increased as the children got older. Another global self-reported assessment is the IPAQ (International Physical Activity Questionnaire). A study done by Mielgo-Ayuso *et al.* (2016) described the PA behaviours of children by using the IPAQ. The results indicated that boys were more active in the MVPA than girls.

A study conducted by Minnaar *et al.* (2016) in South Africa measured the PA levels of boys and girls between 5-6, 9-11 and 12-14 years old (N=78) using a pedometer that was worn for seven consecutive days. It was found that children between 9-11 years old were more active. Craig *et al.* (2013) conducted an objectively measured study by testing children (N=89) aged 7, 11, and 15 years-old PA levels using the Actigraph GT3X, which was worn for seven consecutive days. The study concluded that the children presented high volumes of PA but at a low intensity and only a minority (8.3% of the 7-year-olds, 6.3% of the 11 year olds and 3.7% at 15 year olds) of the participants met the recommended guidelines for MVPA (Craig *et al.,* 2013).

Balaban (2017) in Czech Republic measured 8-11-year-old children's (N=201) PA patterns using the Actigraph GT3X, as well as their FMS using the TGMD-2. The results indicated that the children spent 60% of their time in sedentary PA (SPA) and only 13% in MVPA. It was also evident that boys engaged in more PA than girls. According to Colley *et al.* (2012) 12, 000 steps are equivalent to approximately 60 minutes of MVPA per day. Balaban (2017) indicated that only 56% of the children in their study were able to reach 12, 000 steps. Van Hecke *et al.* (2017) conducted a literature review on the PA levels of children and adolescents in Europe and showed that boys generally had higher PA levels than the girls. A study conducted by Ruiz *et al.* (2018) explored the PA intensity and patterns of preschool children in America using Actigraphs and found that the children spent about 50% of their time in sedentary behaviour. The results showed that children achieved an average of 90-minutes in MVPA per day, with boys spending 13 minutes longer in MVPA per day than girls. There are numerous health benefits for children participating in more PA and also spending more time in MVPA. Assessing children's PA patterns and intensity would most certainly give a better understanding of where children can improve their PA levels in order to reach the recommended levels and be generally more active.

Summary

In this chapter the researcher conducted an in-depth literature review on the FMS and proficiency of children. The physical fitness and anthropometry of children in South Africa. As well as the PA patterns of children, executive function and a variety of active-brain breaks and what they consist of.

REFERENCES

ALTENBURG, T.M., CHINAPAW, M.J.M. & SINGH, A.S. 2016. Effects of one versus two bouts of moderate intensity physical activity on selective attention during a school morning in Dutch primary schoolchildren: a randomized controlled trial. *Journal of Science and Medicine in Sport.* 19(10): 820-824.

AMUSA, L.O., GOON, D.T., AMEY, A.K. & TORIOLA, A.L. 2011. Health-related physical fitness among rural primary school children in Tshannda, South Africa. *Scientific Research and Essays.* 6(22): 4665-4680.

ANDERSON, P. 2002. Assessment and Development of Executive Function (EF) During Childhood. *Child Neuropsychology.* 8(2): 71-82.

ARMSTRONG, M.E.G., LAMBERT, E.V. & LAMBERT, M.I. 2011. Physical fitness of South African primary school children, 6 to 13 years of age: Discovery vitality health of the Nation study. *Perceptual and Motor Skills.* 113(3): 999-1016.

BALABAN, V. 2017. The Relationship between Objectively Measured Physical Activity and Fundamental Motor Skills in 8 to 11 Years Old Children from the Czech Republic. *Journal of Sport Science & Medicine.* 2: 1-6.

BARDID, F., HUYBEN, F., LENOIR, M., SEGHERS, J., DE MARTELAER, K., GOODWAY, J.D. & DECONINCK, F.J.A. 2016. Assessing fundamental motor skills in Belgian children aged 3-8 years highlights differences to US reference sample. *Acta Paediatrica*. 105:281-290.

BARDID, F., DE MEESTER, A., TALLIR, I., CARDON, G., LENOIR, M. & HAERENS, L. 2016. Configurations of actual and perceived motor competence among children: Associations with motivation for sports and global self-worth. 50: 1-9.

BARNETT, L.M., VAZOU, S., ABBOTT, G., BOWE, S.J., ROBINSON, L.E., RIDGERS, N.D. & SALMON, J. 2016. Construct validity of the pictorial scale of Perceived Movement Skill Competence. *Psychology of Sport and Exercise.* 22: 294-302.

BIDZAN-BLUMA, I. & LIPOWSKA, M. 2018. Physical Activity and Cognitive Functioning of Children: A Systematic Review. *International Journal of Environmental Health Research and Public Health.* 15(800): 1-13.

BOLGER, L.E., BOLGER, L.A., O'NEILL, C. & COUGHLAN, E. 2018. Age and Sex Differences in Fundamental Movement Skills Among a Cohort of Irish School Children. *Journal of Motor Learning and Development.* 6:81-100.

BOLGER, L.E., BOLGER, L.A., O'NEILL, C., COUGHLAN, E., O'BRIEN, W., LACEY, S. & BURNS, C. 2019. Accuracy of Children's Perceived Skill Competence and its Association with Physical Activity. *Journal of Physical Activity and Health.* 16: 29-36.

BRYANT, E.S., DUNCAN, M.J. & BIRCH, S.L. 2013. Fundamental movement skills and weight status in British primary school children. *European Journal of Sport Science.* 14(7):730-736.

CARSON, V., HUNTER, S., KUZIK, N., WIEBE, S.A., SPENCE, J.C., FRIEDMAN, A., TREMBLAY, M.S., SLATER, L. & HINKLEY, T. 2015. Systematic review of physical activity and cognitive development in early childhood. 1-6.

CATTUZZO, M.T., HENRIQUE, R., RE, A.H.N., DE OLIVEIRA, I.S., MELO, B.M., DE SOUSA MOURA, M., DE ARAUJO, R.C. & STODDEN, D. 2016. Motor competence and health related physical fitness in youth: A systematic review. *Journal of Science and Medicine in Sport.* 19:123-129.

CHAN, C.H.S., HA, A.S.C., NG, J.Y.Y. & LUBANS, D.R. 2018. Associations between fundamental movement skill competence, physical activity and psycho-social determinants in Hong Kong Chinese children. *Journal of Sports Sciences.* 37(2): 229-236.

CLIFF, D.P., OKELY, A.D., MORGAN, P.J., JONES, R.A., STEELE, J.R. & BAUR, L.A. 2011. Proficiency Deficiency: Mastery of Fundamental Movement Skills and Skill Components in Overweight and Obese Children. *Obesity Journal*. 20(5): 1024-1033.

COLLEY, R.C., JANSSEN, I. & TREMBLAY, M.S. 2012. Daily step target to measure adherence to physical activity guidelines in children. *Medicine and Science in Sports Exercise.* 44(5): 977-982.

CRAIG, E., BLAND, R. & REILLY, J. 2013. Objectively measured physical activity levels of children and adolescents in rural South Africa: High volume of physical activity at low intensity. *Applied Physiology, Nutrition and Metabolism.* 38: 81-84.

DELANEY, T., JACKSON, J.K., JONES, J., HALL, A., DIVES, A., WEDESWEILER, T., CAMPBELL, L., NATHAN, N., ROMITI, M., TROST, S.G., LUM, M., COLLIVER, Y., HERMANDEZ, L. & YOONG, S.L. 2019. *International Journal of Environmental Research and Public Health.* 16: 1-14.

DE GREEFF, J.W., BOSKER, R.J., OOSTERLAAN, J., VISSCHER, C. & HARTMAN, E. 2018. Effects of physical activity on executive functions, attention and academic performance in preadolescent children: a meta-analysis. *Journal of Science and Medicine in Sport.* 21: 501-507.

DE MORAES, A.C.F., VILANOVA-CAMPELO, R.C., TORRES-LEAL, F.L. & CARVALHO, H.B. 2019. Is Self-Reported Physical Fitness Useful for Estimating Fitness Levels in Children and Adolescents? A Reliability and Validity Study. *Medicina.* 55(286): 1-14.

DE ONIS, M., BLOSSNER, M. & BORGHI, E. 2010. Global prevalence and trends of overweight and obesity among preschool children. *American Journal of Clinical Nutrition.* 92: 1257-1264.

DONNELLY, J.E., HILLMAN, C.H., CASTELLI, D., ETNIER, J.L., LEE, S., TOMPOROWSKI, P., LAMBOURNE, K. & SZABO-REED, A.N. 2016. Physical Activity, Fitness, Cognitive Function, and Academic Achievement in Children: A Systematic Review. *Journal of Medical Science and Sports Exercise.* 48(6): 1197-1222.

DRAPER, C.E., TOMAZ, S.A., BASSETT, S.H., HARBRON, J., KRUGER, H.S., MICKLESFIELD, L.K., MONYEKI, A. & LAMBERT, E.V. 2018. Results from the Healthy Active Kids South Africa 2018 Report Card. *The South African Journal of Child Health.* 13(3): 130-136.

DUKHI, N., SARTORIUS, B. & TAYLOR, M. 2020. A Behavioral change in intervention study for the prevention of childhood obesity in South Africa: protocol for randomized controlled trial. *BMC Public Health.* 20: 179-190.

DUNCAN, M.J., ROSCOE, C.M.P., NOON, M., CLARK, C.C.T., O'BRIEN, W. & EYRE, E.L.J. 2019. Run, jump, throw and catch: How proficient are children attending English schools at the fundamental motor skills identified as key within the school curriculum? *European Physical Education Review.* 1-13.3

DU TOIT, D., PIENAAR, A.E. & TRUTER, L. 2011. Relationship between physical fitness and academic performance in South African children. *South African Journal for Research in Sport, Physical Education and Recreation.* 33(3): 23-35.

EGGER, F., BENZING, V., CONZELMANN, A. & SCHMIDT, M. 2019. Boost your brain, while having a break! The effects of long-term cognitively engaging physical activity breaks on children's executive functions and academic achievement. *Public Library of Science.* 14(3):1-20.

ENGEL, A.C., BRODERICK, C.R., VAN DOORN, N., HARDY, L.L. & PARMENTER, B.J. Exploring the relationship between Fundamental Motor Skill Interventions and Physical Activity Levels in Children: A Systematic Review and Meta-analysis. *Journal of Sports Medicine.* 48: 1845-1857.

ERICKSON, K.I. & KRAMER, A.F. 2009. Aerobic exercise effects on cognitive and neural plasticity in older adults. *British Journal of Sports Medicine.* 43: 22-24.

EVENSON, K.R., CATELLIER, D.J., GILL, K., ONDRAK, K.S. & McMURRAY, R.G. 2008. Calibration of two objective measures of physical activity for children. *Journal of Sport Sciences.* 26(14): 629-633.

FAIRCLOUGH, S.J., BEIGHLE, A., ERWIN, H. & RIDGERS, N.D. 2012. School day segmented physical activity patterns of high and low active children. *BMC Public Health Journal.* 12: 406-418.

FARMER, O., BELTON, S. & O'BRIEN, W. 2017. The Relationship between Actual Fundamental Movement Skill Proficiency, Perceived Motor Skill Confidence and Competence, and Physical Activity in 8-12-Year-Old Irish Female Youth. *Journal of Sports.* 5(74): 1-13.

FLAES, S.A.M.B., CHINAPAW, M.J.M., KOOLHAAS, C.M., VAN MECHELEN, W. & VERHAGEN, E.A.L.M. 2016. More children more active: Tailored playgrounds positively affect physical activity levels amongst youth. *Journal of Science and Medicine in Sport.* 19(3): 250-254.

FORTHOFER, M., DOWDA, M., O'NEILL, J.R., ADDY, C.L., MCDONALD, S., REID, L. & PATE, R.R. 2017. Effect of Child Gender and Psychosocial Factors on Physical Activity from Fifth to Sixth Grade. *Journal of Physical Activity and Health.* 14: 953-958.

FRANK, M.L., FLYNN, A., FARNELL, G, S. & BARKLEY, J.E. 2018. The differences in physical activity levels in preschool children during free play recess and structured play recess. *Journal of Exercise Science & Fitness.* 16: 37-42.

FREEDSON, P., POBER, D. & JANZ, K.F. 2005. Calibration of accelerometer output for children. *Medicine & Science in Sports & Exercise.* 37: 523-530.

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

HARDY, L.L., KING, L., FARRELL, L., MACNIVEN, R. & HOWLETT, S. 2009. Fundamental movement skills among Australian preschool children. *Journal of Science and Medicine in Sport*. 13: 503-508.

HARTER, S. 1982. The Perceived Competence Scale for Children. Child Development. Wiley. Vol.53. No.1. pp. 87-97.

HESKETH, K.R., O'MALLEY, C., PAES, V.M., MOORE, H., SUMMERBELL, C., ONG, K.K., LAKSHMAN, R. & VAN SLUIJS, E. 2017. Determinants of Change in Physical Activity in Children 0-6 years of Age: A Systematic Review of Quantitative Literature. *Journal of Sports Medicine.* 47: 1349-1374.

HULTEEN, R.M., MORGAN, P.J., BARNETT, L.M., STODDEN, D.F.& LUBANS, D.R. 2018. Development of Foundational Movement Skills: A Conceptual Model for Physical Activity Across the Lifespan. *Journal of Sports Medicine*. 48: 1533-1540.

JANSSEN, X., MANN, K.D., BASTERFIELD, L., PARKINSON, K.N., PEARCE, M.S., REILLY, J.K., ADAMSON, A.J. & REILLY, J.J. 2016. Development of sedentary behaviour across childhood and adolescence: longitudinal analysis of the Gateshead millennium study. *International Journal of Behavioral Nutrition and Physical Activity.* 13(88): 1-10.

JOHNSTONE, A., HUGHES, A.R., BONNAR, L., BOOTH, J.N. & REILLY, J.J. 2019. An active play intervention to improve physical activity and fundamental movement skills in children of low socio-economic status: feasibility cluster randomised controlled trial. *Pilot and Feasibility Studies.* 5: 45-58.

JURBALA, P. 2015. What Is Physical Literacy, Really? *Quest.* 67: 367-383.

KÄLL, L.B., MALMGREN, H., OLSSON, E., LINDÉN, T. & NILSSON, M. 2015. Effects of a Curricular Physical Activity Intervention on Children's School Performance, Wellness, and Brain Development. *Journal of School Health.* 85(10): 704-713.

KAHTS, S.A., DU RANDT, R. & VENTER, D.J.L. 2017. Fundamental movement skills proficiency of South African girls from a lower socio-economic community. *South African Journal for Research in Sport, Physical Education and Recreation.* 39(3): 41-56.

KATZMARZYK, P.T., DENSTEL, K.D., BEALS, K., BOLLING, C., WRIGHT, C., CROUTER, S.E., MCKENZIE, T.L., PATE, R.R., SAELENS, B.E., STAIANO, A.E., STANISH, H.I. & SISSON, S.B. 2016. Results from the United States of America's 2016 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health.* 13(2): 307-313.

KEMP, C. & PIENAAR, A.E. 2013. Relationship between the body composition and motor and physical competence of Grade 1 learners in South Africa. *The Journal of Sports Medicine and Physical Fitness.* 53: 635-43.

KIM, Y., BEETS, M.W. & WELK, G.J. 2012. Everything you wanted to know about selecting the "right" Actigraph accelerometer cut-points for youth, but…: A systematic review. *Journal of Science and Medicine in Sport.* 15: 311-321.

KIM, C. & LEE, K. 2016. The relationship between fundamental movement skills and body mass index in Korean preschool children. *European Early Childhood Education Research Journal.* 1-7.

KLINGBERG, S., DRAPER, C.E., MICKLESFIELD, L.K., BENJAMIN-NEELON, S.E. & VAN SLUIJS, E.M.F. 2019. Childhood Obesity Prevention in Africa: A Systematic Review of Intervention Effectiveness and Implementation. *International Journal of Environmental Research and Public Health.* 16: 1212-1230.

KOLIMECKHOV, S. 2017. European Journal of Physical Education and Sport Science PHYSICAL FITNESS ASSESSMENT IN CHILDREN AND ADOLESCENTS: A

SYSTEMATIC REVIEW. *European Journal of Physical Education and Sport Science*. 3(4):65–79.

KONIJNENBERG, C. & FREDRIKSEN, P.M. 2018. The effects of a school-based physical activity intervention programme on children's executive control: The Health Oriented Pedagogical Project (HOPP). *Scandinavian Journal of Public Health.* 26(21): 82-91.

KORDI, R., NOURIAN, R., GHAYOUR, M., KORDI, M. & YOUNESIAN, A. 2012. Developmental and Evaluation of a Basic Physical and Sports Activity Program for Preschool Children in Nursery Schools in Iran: an Interventional Study. *Iranian Journal of Pediatrics.* 22(3): 357-363.

KVALØ, S.E., BRU, E., BRØNNICK, K. & DYRSTAD, S.M. 2017. Does increased physical activity in school affect children's executive function and aerobic fitness? *Scandinavian Journal of Medical Science and Sports.* 27: 1833-1841.

LEGEAR, M., GREYLING, L., SLOAN, E., BELL, R.I., WILLIAMS, B., NAYLOR, P. & TEMPLE, V.A. 2012. A window of opportunity? Motor skills and perceptions of competence of children in Kindergarten. *International Journal of Behavioral Nutrition and Physical Activity.* 9(29): 1-5.

LIU, A.L., HU, X.Q., MA, G.S., CUI, Z.H., PAN, Y.P., CHANG, S.Y. & ZHAO, W.H. 2007. Report on childhood obesity in China: Evaluation of a classroom-based physical activity promotion program. *Journal of Biomedical and Environmental Sciences.* 20(1): 19-23.

LOGAN, S.W., SCRABIS-FLETCHER, K., MODLESKY, C. & GETCHELL, N. 2011. The Relationship Between Motor Skill Proficiency and Body Mass Index in Preschool Children. *Research Quarterly for Exercise and Sport.* 82(3): 442-448.

LUBANS, D.R., MORGAN, P.J., CLIFF, D.P., BARNETT, L.M. & OKELY, A.D. 2010. Fundamental Movement Skills in Children and Adolescents. *Sports Medicine.* 40(12): 1019-1035.

MAHAR, M.T., MURPHY, S.K., ROWE, D.A., GOLDEN, J., SHIELDS, A.T. & RAEDEKE, T.D. 2006. Effects of a Classroom-Based program on Physical Activity and On-Task Behavior. *Medicine & Science in Sports & Exercise.* 2086-209.

MARQUES, A., SANTOS, D.A., HILLMAN, C.H. & SARDINHA, L.B. 2017. How does academic achievement relate to cardiorespiratory fitness, self-reported physical activity and objectively reported physical activity: a systematic review in children and adolescents aged 6-18 years. *British Journal of Sports Medicine.* 0: 1-11.

McCLELLAND, E., PITT, A. & STEIN, J. 2014. Enhanced academic performance using a novel classroom physical activity intervention to increase awareness, attention and self-control – putting embodied cognition into practice. *Improving schools.* 18(1): 83-100.

MCVEIGH, J. & MEIRING, R. 2014. Physical Activity and Sedentary Behavior in an Ethnically Diverse Group of South African School Children. *Journal of Sports Science and Medicine.* 13: 371-378.

MICKLESFIELD, L.K., PEDRO, T.M., KAHN, K., KINSMAN, J., PETTIFOR, J.M., TOLLMAN, S. & NORRIS, S.A. 2014. Physical activity and sedentary behavior among adolescents in rural South Africa: levels, patterns and correlates. *BMC Public Health.* 14: 40-50.

MIELGO-AYUSO, J., APARICIO-UGARRIZA, R., CASTILLO, A., RUIZ, E., ÁVILA, J.M., ARANCETA-BATRINA, J., GIL, A., ORTEGA, R.M., SERRA-MAJEM, L., VARELA-MOREIRAS, G. & GONZÁLEZ-GROSS, M. 2016. Physical Activity Patterns of the Spanish Population Are Mostly Determine by Sex and Age: Findings in the ANIBES Study. *Public Library of Science.* 11(2): 1-22.

MINNAAR, E., GRANT, C.C. & FLETCHER, L. 2016. Physical activity of children from a small rural town, South Africa. *South African Family Practice.* 58(2): 68-73.

MONYEKI, M.A., KOPPES, L.L.J., KEMPER, H.C.G., MONYEKI, K.D., TORIOLA, A.L., PIENAAR, A.E. & TWISK, J.W.R. 2005. Body composition and physical fitness of undernourished South African rural primary school children. *European Journal of Clinical Nutrition.* 59: 877-883.

MONYEKI, K.D., MONYEKI, M.A., BRITS, S.J., KEMPER, H.C.G. & MAKGAE, P.J. 2008. Development and Tracking of Body Mass Index from Preschool Age into Adolescence in Rural South African Children: Ellisras Longitudinal Growth and Health Study. *Journal of Health, Population and Nutrition.* 26(4): 405-417.

MOULTON, J.M., COLE, C., RIDGERS, N.D., PEPIN, G. & BARNETT, L.M. 2019. Measuring movement skill perceptions in preschool children: A face validity and reliability study. *Australian Occupational Therapy Journal.* 66: 13-22.

MULVEY, K.L., TAUNTON, S., PENNELL, A. & BRIAN, A. 2018. Head, Toes, Knees, SKIP! Improving Preschool Children's Executive Function Through a Motor Competence Intervention. *Journal of Sport and Exercise Psychology.* 40: 233-239.

MUSALEK, M., KOKSTEJN, J., PAPEZ, P., SCHEFFLER, C., MUMM, R., CZERNITZKI, A. & KOZIEL, S. 2017. Impact of normal weight obesity on fundamental motor skills in pre-school children aged 3 to 6 years. *Journal of Biological and Clinical Anthropology.* 74(3): 203-212.

O'BRIEN, W., BELTON, S. & ISSARTEL, J. 2016. Fundamental movement skill proficiency amongst adolescent youth. *Physical Education and Sport Pedagogy.* 21(6): 557-571.

PANG, A.W. & FONG, D.T. 2009. Fundamental Motor Skill Proficiency of Hong Kong Children Aged 6-9 Years. *Research in Sports Medicine.* 17:125-144.

PASCHALERI, Z., ARABATZI, F., PAPITSA, A., GIAGAZOGLOU, P. & KELLIS, E. 2016. Physical Activity, Physical Fitness and Overweight in Early Schoolchildren. *Journal of Sports Medicine & Doping Studies.* 6(2): 1-6.

PIENAAR, A.E. & KEMP, C. 2014. Motor proficiency profile of Grade 1 learners in the North West Province of South Africa: NW-child study. *South African Journal of Research in Sport, Physical Education and Recreation.* 36(1): 167-182.

PIENAAR, A.E., VAN REENEN, I. & WEBER, A.M. 2016. Sex differences in fundamental movement skills of a selected group of 6-year-old South African children. *Early Child Development and Care*. 186(12): 1994-2008.

PONITZ, C., McCLELLAND, M. 2009 & MORRISON, J. A Structured Observation of Behavioral Self-Regulation and Its Contribution to Kindergarten Outcomes. *Developmental Psychology.* 45(3): 605-619.

PRETORIUS, S.S., NEOPHYTOU, N. & WATSON, E.D. 2019. Anthropometric profiles of 8–11-year-old children from a low-income setting in South Africa. *BMC Public Health.* 19: 314-320.

PRIORESCHI, A., BRAGE, S., HESKETH, K.D., HNATIUK, J., WESTGATE, K. & MICKLESFIELD, L.K. 2017. Describing objectively measured physical activity levels, patterns, and correlates in cross sectional sample of infants and toddlers from South Africa. *International Journal of Behavioral Nutrition and Physical Activity.* 14: 176-190.

REIMERS, A.K. & KNAPP, G. 2017. Playground usage and physical activity levels of children based on playground spatial features. *Journal of Public Health.* 25: 661-669.

ROSSOUW, H.A., GRANT, C.C. & VILJOEN, M. 2012. Overweight and Obesity in children and adolescents: The South African problem. *South African Journal of Science.* 108(5-6): 1-6.

RUIZ, R.M., SOMMER, E.C., TRACY, D., BANDA, J.A., ECONOMOS, C.D., JAKA, M.M., EVENSON, K.R., BUCOWSKI, M.S. & BARKIN, S.L. 2018. Novel patterns of physical activity in a large sample of preschool-aged children. *BMC Public Health.* 18: 242-250.

RUSHTON, S. 2011. Neuroscience, Early Childhood Education and Play: We are Doing it Right! *Early Childhood Education Journal.* 39:89-94.

SCUDDER, M.R., LAMBOURNE, K., DROLLETTE, E.S., HERMANN, S.D., WASHBURN, R.A., DONNELLY, J.E. & HILLMAN, C.H. 2014. Aerobic capacity and cognitive control in elementary school-age children. *Journal of Medical Science and Sports Exercise.* 46: 1025-1035.

SIAHKOUHIAN, M., MAHMOODI, H. & SALEHI, M. 2011. Relationship between fundamental movement skills and body mass index in 7-to-8 year-old children. *World Applied Sciences Journal.* 15(9): 1354-1360.

SPESSATO, B.C., GABBARD, C. & VALENTINI, N.C. 2013. The Role of Motor Competence and Body Mass Index in Children's Activity Levels in Physical Education Classes. *Journal of Teaching in Physical Education.* 32: 118-130.

STEWART, J.A., DENNISON, D.A., KOHL, H.W. & DOYLE, J.A. 2004. Exercise level and energy expenditure in the TAKE 10! in-class physical activity program. *Journal of School Health.* 74(10): 397-400.

STODDEN, D.F., GOODWAY, J.D., LANGENDORFER, S.J., ROBERTON, M., RUDISILL, M.E., GARCIA, C. & GARCIA, L.E. 2008. A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship. *Journal of Motor Competence and Physical Activity.* 60: 290-306.

UYS, M., BASSETT, S., DRAPER, C.E., MICKLESFIELD, L., MONYEKI, A., DE VILLIERS, A. & LAMBERT, E.V. 2016. Results from South Africa's 2016 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health.* 13(2): 265-273.

VAN BILJON, A., McKUNE, A.J., DuBOSE, K.D., KOLANISI, U. & SEMPLE, S.J. 2018. Physical activity levels in urban-based South African learners: A cross-sectional study of 7348 participants. *South African Medical Journal.* 108(2): 126-131.

VAN DEN BERG, V., SALIASI, E., DE GROOT, R.H.M., JOLLES, J., CHINAPAW, M.J.M. & SINGH, A.S. 2016. Physical Activity in the School Setting: Cognitive Performance Is Not Affected by Three Different Types of Acute Exercise. *Frontiers in Psychology.* 7: 723-732.

VAN DER NIET, A.G., SMITH, J., SCHERDER, E.J.A., OOSTERLAAN, J., HARTMAN, E. & VISSCHER, C. 2015. Associations between daily physical activity and executive functioning in primary school-aged children. *Journal of Science and Medicine in Sport.* 18: 673-677.

VAN EKRIS, E., WIJNDAELE, K., ALTENBURG, T.M., ATKIN, A.J., TWISK, J., ANDERSEN, L.B., JANZ, K.F., FROBERG, K., NORTHSTONE, K., PAGE, A.S., SARDINHA, L.B., VAN SLUIJS, E.M.F., CHINAPAW, M. & INTERNATIONAL CHILDREN'S ACCELEROMETRY DATABASE (ICAD) COLLABORATORS. Tracking of total sedentary time and sedentary patterns in youth: a pooled analysis using the International Children's Accelerometry Database (ICAD). *International Journal of Behavioral Nutrition and Physical Activity.* 17(65): 1-10.

VAN HECKE, L., LOYEN, A., VERLOINGE, M., VAN DER PLOEG, H.P., LAKERVELD, J., BRUG, J., DE BOURDEAUDHUIJ, I., EKELUND, U., DONNELLY, A., HENDRIKSEN, I. & DEFORCHE, B. 2016. Variation in population levels of physical activity in European children and adolescents according to cross-European studies: a systematic literature review within DEDIPAC. *International Journal of Behavioral Nutrition and Physical Activity.* 13(70): 1-22.

VERBURGH, L., KÖNIGS, M., SCHERDER, E.J.A. & OOSTERLAAN, J. 2014. Physical exercise and executive functions in young preadolescent children, adolescents and young adults: a meta-analysis. *British Journal of Sports Medicine.* 48:973-979.

WATSON, A., TIMPERIO, A., BROWN, H., BEST, K. & HESKETH, K.D. 2017. Effect of classroom-based physical activity interventions on academic and physical activity outcomes: a systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity.* 14: 114-137.

WESTON, K.L., PASECINIC, N. & BASTERFIELD, L. 2019. A Preliminary Study of Physical Fitness in 8- to 10-Year Old Primary School Children from North East England in Comparison with National and International Data. *Journal of Pediatric Exercise Science.* 31: 229-237.

WILLIAMS, H.G., PFEIFFER, K.A., O'NEILL, J.R., DOWDA, M., McIVER, K.L., BROWN, W.H. & PATE, R.R. 2008. Motor Skill Performance and Physical Activity in Preschool Children. *Obesity Journal*. 16(6): 1421-1426.

WILSON, A.N., OLDS, T., LUSHINGTON, K., PETKOV, J. & DOLLMAN, J. 2015. The impact of 10-minute activity breaks outside the classroom on male students' on-task behaviour and sustained attention: a randomised crossover design. *Acta Paediatrica.* 1-7.

WHITT-GLOVER, M.C., HAM, S.A. & YANCEY, A.K. 2011. Instant Recess: A Practical Tool for increasing Physical Activity During the School Day. *The John Hopkins University Press.* 5(3): 289-297.

WROTNIAK, B., EPSTEIN, L.H., DORN, J.M., JONES, K.E. & KONDILIS, V.A. 2006. The Relationship between Motor Proficiency and Physical Activity in Children. *Pediatrics.* 118(6): 1758-1765.

WU, X.Y., HAN, L.H., ZHANG, J.H., LUO, S., HU, J.W. & SUN, K. 2017. The influence of physical activity, sedentary behavior on health-related quality of life among the general population of children and adolescents: A systematic review. *Public Library of Science.* 12(11): 1-29.

ZENG, N., AYYUB, M., SUN, H., WEN, X., XIANG, P. & GAO, Z. 2017. Effects of Physical Activity on Motor Skills and Cognitive Development in Early Childhood: A Systematic Review. 1-13.

Chapter 3

Methodology

INTRODUCTION

Physical activity (PA) is defined as any bodily movement executed with skeletal muscles that requires a certain amount of energy expenditure (Kolimechkov *et al.,* 2017). The awareness and implementation of PA in children and youth is a very big concern worldwide as sedentary behaviour among children is on the increase (Micklesfield *et al.,* 2014). Sedentary activities include watching television and playing video games (Bidzan-Bluma & Lipowska, 2018). A lack of PA on a daily basis can potentially be harmful to children and can result in numerous risk factors such as: problems with posture, overweight and obesity, heart conditions, diabetes and circulation problems (Bidzan-Bluma & Lipowska, 2018). It is, therefore, vital to create opportunities and encourage children to partake in activities that develop fundamental movement skills (FMS) (Myer *et al.,* 2015). Health-related physical fitness components consist of flexibility, cardiorespiratory endurance and body composition, where skill-related physical fitness components consist of agility, balance, coordination, power, reaction time and speed (Amusa *et al.,* 2011; Cattuzo *et al.,* 2016).

The World Health Organization (WHO) stated that children between the ages of 5 and 17 years old should participate in at least 60 minutes of moderate- to vigorous- intensity physical activity (MVPA) per day, as well as strengthening exercises, two to three times per week (Willumsen & Bull, 2020). After an investigation by Uys *et al.* (2016) on the PA levels and patterns of South African children, they concluded that 50% of South African children do not meet the PA daily recommendations as suggested by the WHO (Uys *et al.,* 2016). Special efforts are needed in South Africa (SA) to promote PA and ensure that children are more physically active and lead healthier lifestyles, as children are becoming more sedentary (Micklesfield *et al.,* 2014). Implementing PA interventions in early childhood would not only promote PA and increase health benefits, but also enhance and develop children's FMS and contribute to their cognitive, physical and emotional well-being. Moreover, PA provides multiple advantages for executive functioning (EF) and cognitive enhancement of children, which can most probably contribute to their academic achievement (Kvalo *et al.,* 2017).

Problem statement

It is evident that children between four and seven years old are not active enough during school hours and tend to be sedentary for long periods in the classroom (Pate *et al.,* 2015 & Katzmarzyk *et al.,* 2016). This can result to children becoming more physical inactive leading to obesity as well as other health-related risk behaviours (Draper *et al.,* 2018). Therefore, the main aim of the current study was to determine the effect of active brain-breaks during school time of Grade One children on i) the in-school PA patterns, before and during the intervention and ii) on FMS and EF before and after the intervention. The secondary aim of the study was to determine if there any differences between boys' and girls' in-school PA patterns, FMS, physical fitness and BMI profiles. An additional secondary aim was to described Grade One children's EF.

The aims and secondary aims are further outlined in accordance with the articles:

Phase 1

Article 1: Fundamental movement skills proficiency amongst neurotypical Grade One children in Cape Town, South Africa: A Descriptive study

Aim:

To determine the FMS proficiency of the Grade One children

Objective:

- To examine the difference between boys and girls.

Article 2: Physical fitness and weight status of Grade One children in Cape Town, South Africa

Aim:

To determine the physical fitness levels and weight status of Grade One children

Objective:

- To examine the differences between boys and girls.

Phase 2

Article 3: The effect of active brain-breaks on the fundamental movement skills and executive functioning of Grade One children in Cape Town, South Africa

Aim:

To assess the children's FMS and EF before and after a 10-minute active brain-break intervention

Objective:

To determine the change in FMS and EF of the children after the intervention

Article 4: The effect of active brain-breaks on the in-school physical activity patterns of Grade One children in the Bellville region, Cape Town, South Africa

Aim:

The aim of the current study was to investigate the impact of classroom PA active brain-breaks on the in-school activity levels of Grade 1 (6- to 8-years-old) learners (N=48) by comparing baseline results to the intervention PA patterns of the participants.

Objectives:

- To determine the in-school physical activity patterns of the children during a traditional school day (5 consecutive days);
- To determine the in-school physical activity patterns of the children during the 10-minute active brain-breaks intervention;

RESEARCH METHODOLODY

Research design

The current study employed a quantitative research strategy and it consisted of two phases. Data from phase one (article one and two) was reported in a descriptive format. Phase two was based on quasi-experimental research design (article three) to allow the researcher to manipulate or determine the influence of the variables, specifically a pre- and post- test two treatment group design, as well as a CER and descriptive study design (article four). In this design researchers cannot be sure if the changes between the groups at pre- and post- testing occurred without any treatment or intervention. This design is helpful to investigate comparisons or intervention effects (Flannelly *et al.,* 2018). A sample of convenience was used and therefore, the researcher could not control the influence of the uncontrollable variables (Grimshaw *et al.,* 2000 & Joubert *et al.,* 2016). In phase one all the children participated in the evaluations and in phase two there was an experimental and a control group. Both groups participated in the evaluations but only the experimental group was involved in the intervention.

Sample

This study was based on a convenience sampling technique, where the schools were practically and logistically accessible to the researcher. A convenience sample is a nonprobability sample, where the sample are conveniently available. Although the selected schools were not representative of all schools in Cape Town, it demonstrated what is commonly expected in a Cape Town school. The researcher approached all the Grade One learners to partake in the study. Grade One learners (N=184) were selected from two schools in Cape Town, South Africa (see figure 3.1). All the evaluations took place in the school halls at the specific schools, and the intervention took place in the classrooms. School W had three classes and school B, four classes. Each class had a minimum of n=26 and a maximum of n=29 children per class.

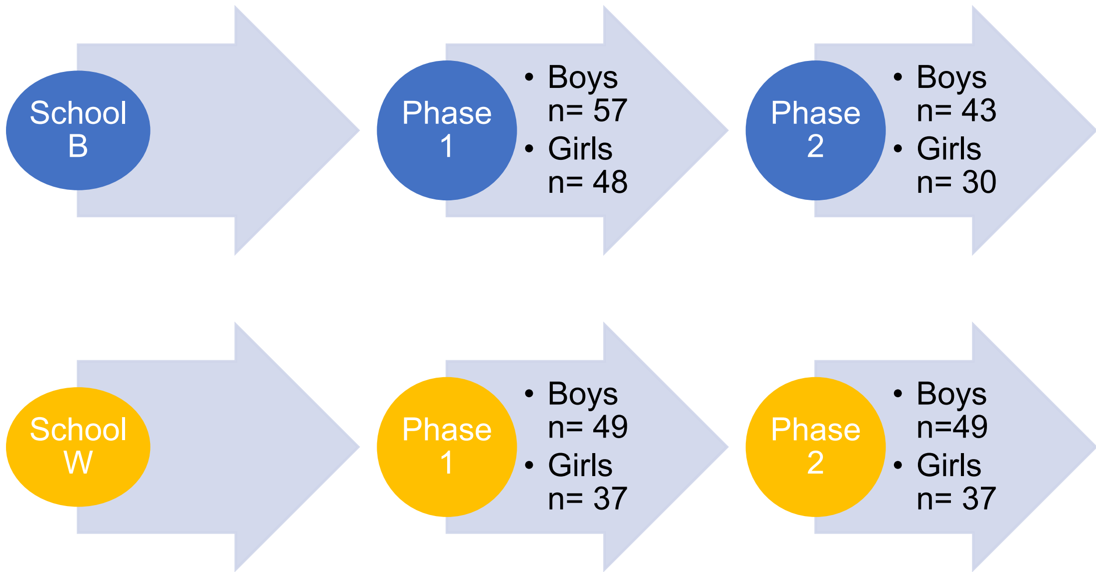

Figure 3.1. Participants

All the Grade One classes took part in phase one. At School B there was an extra fourth class (N=30) that took part in phase one, but not in phase two. This decision was based on a random allocation. Only three classes from each school took part in phase two. The main reason for this was because school W only had three classes and the researcher wanted the same number of classes to take part in this phase for consistency during the intervention. All three classes at both schools took part in the assessments conducted in phase two. Two classes at each school formed the experimental group and the other class the control group. The children were motivated by the researcher and teacher to participate; however, they willingly participated in this study. All the children in the study were free from any neuromuscular disorder, cognitive impairment and learning difficulties.

Inclusion criteria

Participants were included if:

- They were in Grade one.

- They attended the selected schools.
- Their parents completed the informed consent form.
- Children signed the assent form.

Exclusion criteria

Participants were excluded if:

- They had a hearing or sight impairment.
- They were unwilling to participate in the measurements, evaluations and/or the intervention programme activities.
- They had severe medical conditions, for example, heart or ear defect.
- They were unable to run or jump.
- They missed more than 30% or 4 sessions of the intervention programme (*phase two only*).

Research assistants

The researcher had four research assistants who assisted voluntarily from the beginning to the end of the study. The assistants were Kinderkinetics honours students from the Department of Sport Science at Stellenbosch University, who were registered at SAPIK (South African Professional Institute of Kinderkinetics). The assistants had all done a First Aid level 1 course and had undergone police clearance. Phase one and two (discussed below in the procedures), as well as the expectations of the study, were thoroughly discussed with the assistants beforehand.

The students assisted with both phases, including all of the assessments as well as the intervention. They were trained in the assessments and the test battery before the data collection commenced. The assistants were blind-testers throughout the study. The intervention programme and the importance of consistency between the two schools were clearly explained to them. Whatever was done at school W had to be executed in exactly the same manner at school B. The assistants received the intervention programme a week in advance to ensure that they understood the activities. The assistants had to attend all the intervention sessions and assisted with the presentation of the intervention programme at both schools. The assistants were responsible to assist the researcher with the demonstration of the activities and ensuring that the children cooperated. However, in a school setting the teachers will not need any assistance as they will be familiar with their school and class environment, they will be familiar with the children and know them well, and the activities of the intervention will be thoroughly explained to the teachers. They also supported the children where necessary with the execution of the activities. The intervention will be explained in more detail later in this chapter.

Procedures

The study consisted of two phases. In phase one, the children were assessed using multiple evaluation tools to determine their PA profiles. In phase two, children's in-school PA patterns were monitored using accelerometers (ActiGraphs) and an active brain-breaks intervention was implemented over a period of six-weeks. The children's in-school PA patterns were monitored the week before the intervention as well as during the intervention on random days. Part of phase two the children were evaluated with the TGMD-2 and HTKS task before and after the six-week intervention.

In phase one, the children were assessed using the following (see Figure 3.2):

1. The Test for Gross Motor Development (TGMD-2) assessed proficiency in two motor-area composites, namely: locomotor and object control (Ulrich, 1985).
2. The Head Toes Knees Shoulder (HTKS) test evaluated inhibitory control, working memory and attention focus (Ponitz *et al.,* 2008).
3. Modified EUROFIT physical fitness test assessed muscular strength/explosiveness, agility, flexibility, hand-eye coordination and endurance (Adam, 1988).
4. Anthropometry measurements such as height and mass were also conducted.

The data was used to determine the PA profiles and in-school PA patterns of the children, as well as the effect the intervention had on the children's in-school PA levels, FMS and EF.

The pre- and post-tests took place in each school's hall. Phase one assessments took place over a month. Phase two took place during one school term. Participants' PA patterns were monitored for one week prior to the intervention, as well as on four random days during the intervention, thereafter followed the a six-week intervention. The children were also evaluated with the TGMD-2 and HTKS task before and after the intervention. The two phases will be explained in detail below.

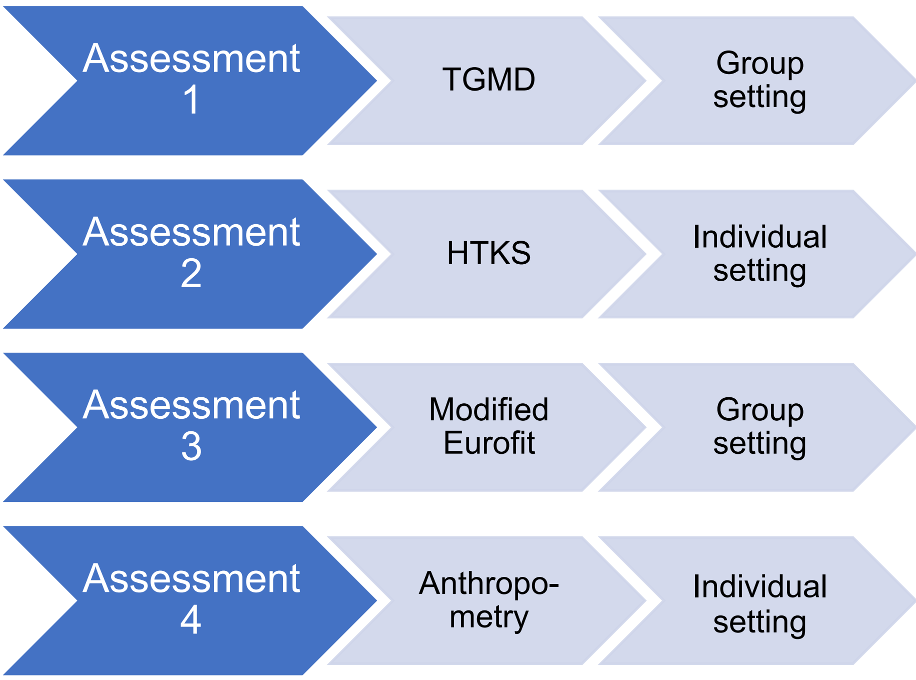

Figure 3.2. Assessments in phase one

Phase one

Phase one took place during the first term of 2019 (February to March), where all the participants underwent multiple assessments (see Figure 3.2). Various stations were allocated in the hall and the assessments took place in a group setting. Participants rotated between the various stations (eight children per station) and as soon as they were done with a station, they moved on to the next one. At each station there were two research assistants who demonstrated the activities to the participants. For the individual assessments, the researcher took the children one by one to the hall to complete the test. By assigning participants to a station, the researcher ensured that they were effectively busy the whole time until they completed the assessments and returned to the classroom. The five phase one assessments (Figure 3.2) will be discussed in more detail below:

Test for Gross Motor Development (TGMD-2nd edition) (Ulrich, D.A. 1985)

The TGMD assesses proficiency in two motor-area composites, namely: locomotor and object control. The TGMD-2 consists of 12 subtests, and each subtest is composed of six skills. The locomotor skills consist of running, hopping, jumping, leaping, galloping and sliding. Object control consists of striking, dribbling, catching, throwing, kicking and rolling. The test takes approximately 15 to 20 minutes to complete and is easy to administer. There are other methods that could be used to assess motor competency and FMS such as the CHAMPS or KTK. The CHAMPS test focuses specifically on pre-schoolers (3-5 years old) and the current study on 6-7-year-old children. The sensitivity tool (gross motor composite) for the TGMD-2 was appropriate for this study, and it specifically measures locomotor and object control skills and was correct for the age group. The internal consistency reliability coefficients for the Locomotor subtest ranged from 0.79 to 0.90, with a mean of 0.85, which is relatively high. The Object control subtest ranged from 0.67 to 0.93, with a mean of 0.78. This suggests that the overall reliability of this test is very consistent and it is a good assessment to use for locomotor and object control skills '(Ulrich, 1985)'. As part of the study, the researcher did the inter-rater reliability for the TGMD-2. Two qualified Kinderkineticists who have experience with the TGMD-2 received 10 participants' videos and scored both the locomotor and object control skills trials. Thereafter, the intra-class correlations (ICC) agreement was done. The final locomotor score was 0.82 and the final object control score was 0.65.

The researcher used the TGMD-2 to evaluate the participants in Phase one and two. The researcher and research assistants verbally explained and gave an accurate demonstration of every test item. A practice trial was given to each participant to ensure that they understood what was expected of them. If they did not understand, the researcher gave an additional demonstration. Thereafter, two test trials were given and a raw skill score between 0 and 10 for each skill was given to each participant, depending on the scoring rubric of the TGMD-2. During the assessments, live videos were taken of the participants with a Samsung tablet. The video was recorded while they executed the test in order to score them accurately afterwards. Permission was granted to take videos of the participants. There was a locomotor and object control station. One assistant was responsible to record the video and the other assistant demonstrated the assessment. The researcher explained to the assistants how to record the children in order to get accurate video material. After the assessments, the videos were transferred from the tablets to a memory stick. This way the researcher was able to score each video and examine each technique accurately. After the study had been finalized, the researcher discarded the videos.

Locomotor subtest

All of the gross motor skills in this subtest required fluid body movements as the child moved from one place to another (Ulrich, 1985:3). The following skills were measured:

- Running – A 15 meter running space was marked out. Participants had to run from the one line to other line on the researcher’s cue.
- Galloping – In a marked-out distance of 7.5 meters, participants had to gallop from the one line to the other line.

- Hopping– In a marked-out space of 4.5 meters, the participants hopped from the one line to the other line.
- Leaping – In a marked-out space of 6 meters**,** participants leaped from the one side to the other side. A beanbag was placed between the two lines to provide a brief period during which both feet were off the ground.
- Horizontal jumping – In a marked-out space of 3 meters, the participants had to stand behind the line and jump as far as possible. They had to bend both knees and extend arms behind the body.
- Sliding – In a marked-out 7.6 meters, the participants had to slide from one line to the other.

Object Control subtest

All of the gross motor skills in this subtest required efficient throwing, striking and catching movements (Ulrich, 1985:3). The following skills were measured:

- Striking a stationary ball – A plastic bat, big plastic cone and a 10-centimetre plastic or sponge ball were used for this subtest.
- Stationary dribble – For this subtest a basketball was used. The child had to dribble the ball up to their waist level four consecutive times.
- Catch – In a marked-out area of 4.5 meters, the participant had to stand on one line and the tosser on the other line. A 20-25-centimetre softball was used for this test.
- Kick – A marked-out space of 9 meters was used and on the 3 meter mark a beanbag was placed with a soccer ball (20-25 centimetre) on top of it. The child had to run up from the starting line to the ball.
- Overhand throw – A clearly marked-out space of 6 meters and a tennis ball were used. The participant stood behind the line and threw the ball at a target on the wall with their preferred hand.

- Underhand roll – A clearly marked-out space of 7.6 meters, two small cones and a tennis ball were used. The preferred rolling arm had to be extended backwards and in a forceful motion the participant had to roll the ball forward (Ulrich, 1985:19).

For each skill, the participant was able to score from a minimum to maximum score depending on the performance criteria that are needed to master each subtest. For the locomotor skills: For running, galloping, horizontal jumping and sliding ranges from 0 to 8 were recorded, hopping ranged from 0 to 10 and leaping ranged from 0 to 6. For the object control skills: Striking ranged from 0 to 10, dribbling, kicking, throwing and rolling from 0 to 8 and catch from 0 to 6. The total for locomotor and object control ranged from 0 to 48 raw points. The raw scores were used. After the evaluation the Gross Motor Quotient (GMQ) (Ulrich, 1985) was determined by combining the standard scores of the locomotor and object control subtests. The GMQ and raw scores was used in the study because it is the most appropriate method when no norm values have been established. Standardized scores would only be appropriate when you would want to compare one group with another group. The best measurement of the individual's overall gross motor ability was taken.

Head Toes Knees Shoulders (HTKS) Test (Ponitz *et al.,* 2008)

The Head Toes Knees Shoulders (HTKS) is a behavioural self-regulation measurement that can be used in various settings to measure inhibitory control, working memory and attention focus of children between 4 and 8 years old. The HTKS combines different aspects of executive functioning (EF) into a game that can be played with the children. This measurement requires no equipment and needs minimal space to administer. The HTKS was the most appropriate measurement in this study, EF were evaluated, practically and logistically it was possible to do the test at the schools with the time available and necessary tools. Other child specific measurement tools for EF make use of computerized assessments (such as the NIH toybox) and this was inaccessible in the study. Due to the fact that this test looked at the cognitive function of children, the administration took place on a separate day where no PA influenced the evaluation. The evaluation took place as soon as school started in the morning, before academic work started. The HTKS is dependent on the instructions and interaction between the examiner and the child. The examiner gave the children an instruction to touch their heads, but instead of following the command the children were required to do the opposite and touch their toes and vice versa. The HTKS had three sections and four paired behavioural rules. To start off, the children had to respond naturally to the following commands: If the examiner said, “Touch your head”, they had to touch their heads. Then they were instructed to switch rules by doing the opposite of what the examiner commanded. When the examiner said “touch your head”, they had to “touch their toes”. If the children got it right, they moved up to the next section that worked with the knees and shoulders. The exercise got more difficult when the examiner asked the children to touch all four limbs in a mixed order (Ponitz *et al.,* 2008)**.**

The scoring for this test worked as follow: If a child immediately demonstrated the correct response, they received a “2”; if they self-corrected right away, they received a “1”, and if they did not touch the correct part of their body, they received a “0”. Children received four to six practice trials. There was a first and a second set in this test, with practice trials in between. The final score ranged between a minimum of 0 and maximum of 52. The HTKS task takes between 5-7 minutes per child, and have an inter-rater reliability (K = 0.90) (McClelland *et al.,* 2014). The HTKS assessment has been used in previous studies with children (Ponitz *et al.,* 2008 & Ponitz *et al.,* 2009). It has been suggested that when they are doing the HTKS, the children are required to incorporate and integrate EF skills such as: paying careful attention to the examiners instructions; being able to use their working memory to remember and to execute new rules; using inhibitory control, which focuses on the ability to inhibit the dominant response of being able to imitate the examiner; using cognitive flexibility as well as working memory when rules accumulate and change. The HTKS has been associated and compared with other EF assessments. A longitudinal study done by McClelland *et al.* (2014) with young children found that the HTKS have construct validity with measures of attention, inhibitory control, and working memory as well as a high internal consistency reliability.

MODIFIED EUROFIT - Physical Fitness Test

Physical fitness tests have a multidimensional structure and numerous components that can be evaluated (Kolimechkov, 2017). Currently there are multiple health-related physical fitness test batteries to assess physical fitness in children and adolescents. This study used a modified version of the EUROFIT (Council of Europe Committee for the Development of Sport), which was designed and developed in Europe in 1983 and can be used on children from six to 18 years old (Adam, 1988). The test was specifically chosen as it assesses children's standing broad jump, throwing, flexibility, endurance and speed. There are other comparators such as the ALPHA health-related fitness test, which is also an international test, however, the EUROFIT has been done in South Africa, the researcher was more familiar with this test and had the necessary support to collect the data. The test takes approximately 15-20 minutes to complete (Council of Europe, 1983 & Kolimechkov, 2017). EUROFIT is a reliable and valid physical fitness test battery to use with children and it has been used worldwide for more than 30 years. A modified EUROFIT was used in this study because it measures most of the motor ability and health-related skills. Studies conducted by Amusa *et al.* (2011) in Limpopo, South Africa and Armstrong *et al.* (2011) in the Western Cape, South Africa as well as Monyeki *et al.* (2005) in Ellisras, South Africa, all used the

EUROFIT. This inexpensive test (Figure 3.3) was used in this study to evaluate muscular strength, agility, flexibility, hand-eye coordination and endurance. The test consisted of five subtests.

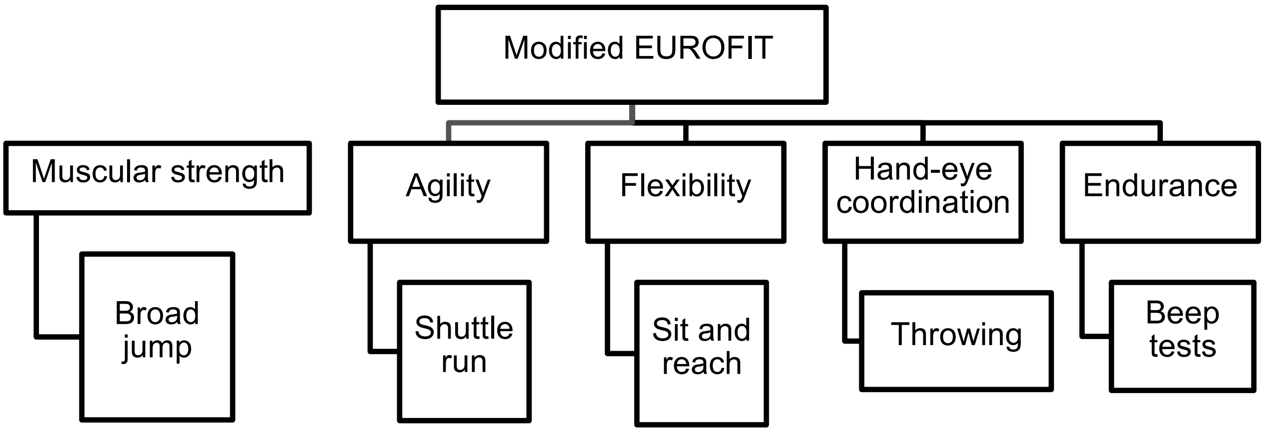

Figure 3.3. Components of a modified EUROFIT

- Muscular strength (broad jump) - A marked-out area was allocated for this test. Performance criteria: The participant stood on the starting line. Feet had to be parallel, knees bent and arms extended behind the body. The participant had to jump as far as possible from the standing position and while they jumped their arms had to swing forward. They had to land simultaneously on both feet and extend their arms above their heads. The examiner demonstrated the test and then each participant was given two attempts. The longest distance was scored in centimetres.
- Agility (5-meter shuttle run) - A distance of 5 meters was marked-out for this test. A cone was placed on one side of the line and another cone was placed on the other side of the line. Performance criteria: The participant had to run as fast as possible from the one cone to the other cone four times without stopping. Each participant received two formal trials. The best result (fastest time) was used.
- Flexibility (sit and reach test) - For this test a specific wooden bench and a ruler were used. Performance criteria: Participants sat on the ground; one leg had to be bent and the other leg had to be in a 90-degree position. The participant was required to

reach/stretch as far as possible to the front by sliding their hands forward on the ruler. Each participant was given two trials and the better result was scored.

- Throwing (left & right hand) - The starting place was marked out with a cone and a tennis ball was used for this test. Performance criteria: The ability to throw the ball overhand as far as possible with the left and right hand. There were three trials on each side and the longest distance was scored.
- Endurance (Beep test) - This test was a progressive shuttle run endurance test. A distance of 20 meters was marked out, indicating the start and finish lines. Performance criteria: The participants ran the 20 meters marked-out distance back and forth in response to a sound signal. Participants were led by a voice (pacemaker/pacesetter) that led the running tempo. Participants had to be in time on the sound signal from the sound system at a certain side of the 20-meter distance. The time was measured from the beginning until the participants were unable to keep up with the tempo.

Anthropometric Evaluation

The anthropometric evaluation measured the height and mass of the children. This evaluation consisted of two subtests and took approximately 5 minutes to complete. The researcher ensured that the boys and girls were separated for this evaluation and that men worked with the boys and women worked with the girls.

The following parameters were measured:

- Body height — barefoot standing heights were measured with arms laterally at the sides and feet parallel (light sport clothes we worn).
- Body mass – was measured with a calibrated Trystom (P375) scale (TPLZ1T46CLNDBI300).

For reliability and validity, all weight measurements were calibrated by weight type (TPLZ1T46CLNDBI300) to assess weight to the nearest 0.1kg. Height was measured with a portable anthropometer (P375) and all measurements were taken to the nearest 0.1cm. Part of the anthropometry evaluations the researcher also determined the children's BMI according to The International Obesity Task Force (IOTF) norms developed by Cole *et al.* (2000) were used to determine the proportion of normal weight, overweight and obese of the children. According to Monasta *et al.* (2010) the IOTF reference and cut-offs are accepted for the identification of underweight, overweight and obesity in children.

Phase two

After the FMS, physical fitness and anthropometry measurements of the participants were determined, the researcher monitored the in-school PA patterns of the participants during school hours from 08:00-13:00 using accelerometers (Actigraph, Pensacola, Florida, USA). Thereafter, a six-week active-brain breaks intervention was implemented. During the intervention the participants wore the accelerometer on four random days. Only School B's children were monitored with the accelerometers. The experimental group (n=48) wore the accelerometers on their dominant wrist for five consecutive school days (this formed part of the baseline testing), before the intervention started. During the consecutive five days of monitoring, on day four the children took part in a PE lesson and therefore the research article in Chapter 7 excluded that day from the data. The monitoring took place during the second week of the third term (July). This gave the researcher a clear indication of the in-school PA patterns of the children and how active they were during a school day.

The Actigraphs were placed on each participant's dominant wrist at 08:00 in the morning and taken off at 13:00 in the afternoon by the researcher. The reason for the specific times was because the researcher only wanted to monitor the PA patterns of the children during school hours. Most South African schools start between 07:30 and 07:45 in the morning and end between 13:00 and 14:30, depending on the Grade.

Monitors were marked with a number, and each child received a number that ensured that the participants wore the same accelerometer for the week. Figure 3.4 illustrates the timeline of Phase two followed by an explanation.

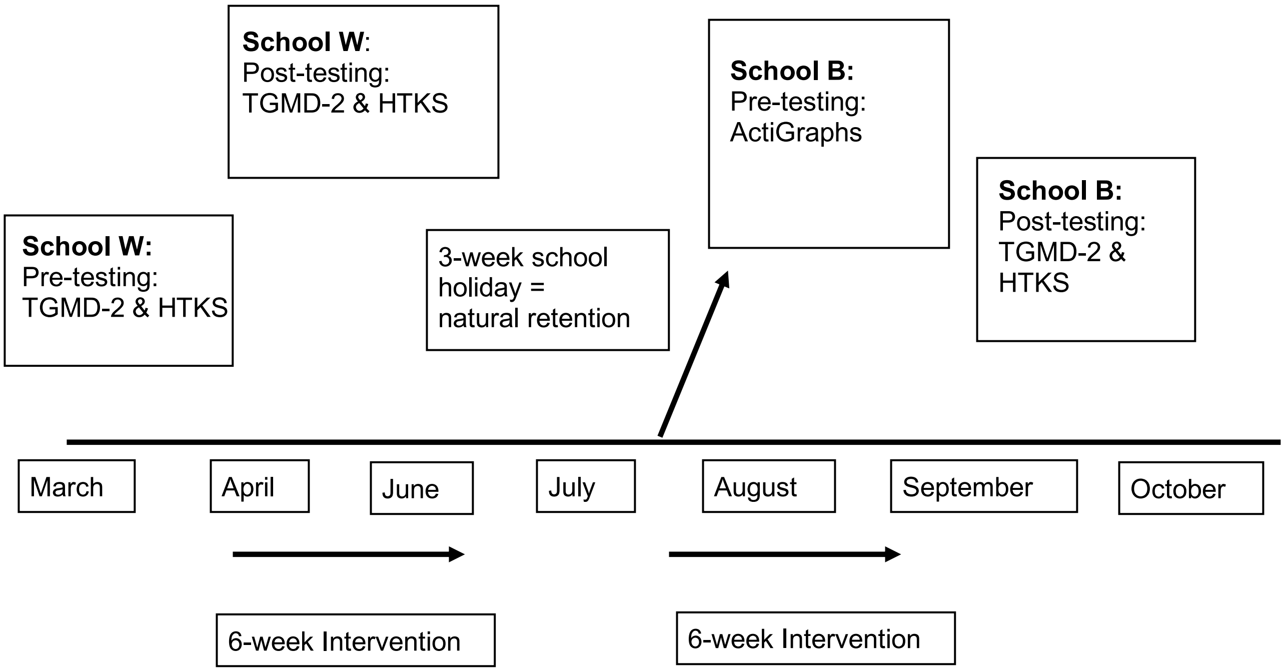

Figure 3.4. Timeline of phase two

School W and School B took part in exactly the same intervention, but at different times. The pre-testing of both schools with the TGMD and HTKS took place in phase one. In the second term (April), School W started with the six-week intervention programme, followed by post-testing. Afterwards, there was a three-week school holiday. As soon as the research team was done with School W's testing, they started with School B. Due to the lack of Actigraph unavailability and strict timeline demands of assessments, participants from school W were not able to wear the Actigraphs. School B did their pre-testing with the Actigraphs, followed by the 6-week intervention programme, during the intervention their in-school PA patterns were monitored on four random days. Thereafter, they did post-testing for the TGMD and HTKS. All the participants (experimental and control group) took part in the evaluations.

Actigraph GT3X

Measuring children's PA patterns by only doing self-reported measurements can be very challenging. The use of accelerometers is a more reliable method of measurement (Migueles *et al.,* 2017). Children take part in short bursts of PA and therefore an accelerometer can collect data in short increments (Pate *et al.,* 2006).

The Actigraph GT3X was used in this study to measure the PA patterns of the participants. The monitor has been used in several studies with children (Puyau *et al.,* 2002; Pate *et al.,* 2004; Murray *et al.,* 2004; Schmitz *et al.,* 2005). The accelerometer is a wearable device that measures the acceleration of the body (Migueles *et al.,* 2017). Amongst the different types of accelerometers available on the market, the Actigraph is the most commonly used by researchers. In 2009, the triaxial GT3X was launched, which measures acceleration in three different planes namely, vertical (VT), anterior-posterior (AP) and medio-lateral (ML) (Kelly *et al.,* 2013). Triaxial accelerometers measure more than one plane and might be able to give more efficient and accurate information regarding PA than uniaxial accelerometers (Kelly *et al.,* 2013). The GT3X is relatively small (3.8 x 3.7 x 1.8 cm), light (27 g) and convenient and comfortable to wear during daily activities (Kelly *et al.,* 2013). Accelerometers give objective information on the frequency, intensity and duration of PA (De Vries *et al.,* 2010). They also measure "free-living" PA of children and provide an average time spent in MVPA that is necessary for this study (Kim *et al.,* 2012). When looking at collecting data with accelerometers, it is important to keep the following in mind (Migueles *et al.,* 2017):

1. Data collection protocols:
    - Device placement - it can either be worn on the hip, wrist or ankle.
    - Sampling frequency
2. Data processing criteria:
    - Filters, epoch lengths, non-wear time, cut-points and algorithms.

Fairclough *et al.* (2016) concluded that better compliance results have been received with wrist-worn versus hip-worn devices for children (McLlellan *et al.,* 2020). Therefore, the children in the current study wore the ActiGraphs on their dominant wrists. The activity counts were filtered with raw accelerations that had to be converted to epochs to determine the level of PA intensity. Epoch lengths vary from 3 to 60 seconds depending on the PA intensity that needs to measured (Migueles *et al.,* 2017). Epochs are the samples that are collected from the accelerometer. These samples are summarized over a specific time interval. The epoch converted the samples to activity 'counts' that were saved on the accelerometers memory (Kim *et al.,* 2012). According to Aibar *et al.* (2014), smaller epoch lengths of 3 to 15 seconds are suggested for children as this increases the resolution of the measure and it takes short bouts of activity. The monitors were initialized to save the data in intervals (epochs) of 5 seconds to identify the spontaneous PA of the children during a school day and the frequency (Hz) was set at 100Hz. Migueles *et al.* (2017) recommended the use of the cut points developed by Crouter *et al.* (2015) for dominant wrists, and this was taken into consideration for the specific population in this study.

In order to verify the PA that was measured with the accelerometers, it was necessary to keep a daily logbook of when the Actigraphs were placed on and taken off, as well as when the active brain-breaks took place. This process ensured that the researcher had a clear understanding of the activity movement of the data. The GT3X has an inter-reliability coefficient (r=0.91) for structured activities (Pate *et al.,* 2006). The GT3X showed a high level of reliability with an intra-class correlation coefficient for activity counts of 0.97 (Cardon *et al.,* 2013; Kelly *et al.,* 2013). The GT3X has good reliability, validity and feasibility when it comes to measuring the PA patterns and energy expenditure of children (Welk *et al.,* 2004; De Vries *et al.,* 2009).

Intervention

During phase two, the researcher implemented 24 active brain-breaks of 10-minutes each over a period of six weeks (at both schools) with the aim of increasing the children's PA patterns and FMS in between academic learning times. The six-week intervention was supported by previous research (Mombarg *et al.,* 2013; Mulvey *et al.,* 2018), and was based on the South African school terms, which is normally 9-weeks and needed to accommodate the pre- and post-testing. The active brain-breaks took place on two separate days during the week and two active brain-breaks were implemented per day. The intervention took place during the second and third term of 2019 and it was implemented in the classrooms of the experimental groups. There were two experimental groups (n=104) and one control group (n=53) at each school. The groups were randomly selected by assigning and selecting numbers. Both groups did the pre- and post-tests, but only the experimental group took part in the intervention. Minimal space and equipment were necessary to execute the intervention. However, in the future teachers will be able to implement the active brain-breaks on their own, as they are automatically comfortable and familiar with their classroom set-up/environment as well as the children in their class. The activities will be explained thoroughly beforehand, the researcher ensured that all the activities are quick and easy to administer and therefore it would be feasible and practically possible for teachers to implement the active brain-breaks. The 10–minute active brain-breaks were self-designed after an in-depth literature review was done on how to improve children's PA and FMS in the classroom. The Consensus on Exercise Reporting Template (CERT) was investigated and a modified version of the CERT was implemented in this study. Out of the assessment form the current took 12 of the 16 points into consideration during the intervention (Slade *et al.,* 2014). Below is the outline of the intervention (Table 3.1).

Table 3.1*.* Intervention Outline

Weeks	Warm-up (2min)	Focus 1 (3min)	Focus 2 (3min)	Cool down (1-2min)
1 Session 1	Cardiovascular: Skipping in a circle & following commands.	**Run** ***Variation 1:*** Run on the spot & follow commands. ***Variation 2:*** Run on the spot behind the chair & on command sit on the chair.	**Catch** ***Variation 1:*** Throw & catch a bean bag. ***Variation 2:*** Throw & catch a beanbag to a friend.	Coordination, strength & balance: March on the spot and follow commands.
1 Session 2	Cardiovascular: Mountain climbers & on command turn on your back.	**Run** ***Variation 1:*** Stand in the block, run as fast as possible & on command jump out of the block & stand on your toes. ***Variation 2:*** Stand behind the block, run & on command jump in the block & touch left knee with the right elbow & vice versa.	**Catch** ***Variation 1:*** Make small groups & throw & catch a small ball (do not trap ball). ***Variation 2****:* In groups, throw & catch a bean bag with one hand.	Coordination, strength & balance: Caterpillar walk
1 Session 3	Cardiovascular: In the crab position lift arms & legs up on the command & turn around on stomach on the command.	**Run** ***Variation 1:*** Stand behind block, run & on command jump in block & touch opposite arm with elbow while running. ***Variation 2:*** Stand behind block & do high knees & on command jump in block & high five your friend.	**Catch** ***Variation 1:*** Cone & beanbag – throw beanbag up & catch with cone. ***Variation 2:*** Do same as above BUT with non-dominant hand.	Coordination, strength & balance: Caterpillar walk & swing arms like a tree.
1 Session 4	Cardiovascular: Stand in pairs & hook in with arms & skip in a circle & on command change direction.	**Run** ***Variation 1:*** Stand behind block and run & on the command jump in the block & just do the arm motion of running.	**Catch** **Variation 1:** In pairs & each with cones & 1 bean bag & throw bean bag with cone & catch it.	Coordination, strength & balance: Caterpillar walk & swing arms like a tree.

		Variation 2: Behind block & do high knees with running arms & on command jump in block & touch toes.	***Variation 2:*** Do the above in pairs with non-dominant hand.	
2 Session 5	Cardiovascular: Hopscotch on the spot & on command stand on one leg.	**Gallop** ***Variation 1:*** In pairs & practice gallop arm motion with a band. ***Variation 2:*** Gallop activity with arrows.	**Throw** ***Variation 1*****:** Step forward with preferred foot, touch back with preferred hand & high five a friend. ***Variation 2:*** Try doing it faster.	Coordination, strength & balance: Core exercise
2 Session 6	Cardiovascular: Feet together & jump side to side & on command swing arms.	**Gallop** ***Variation 1:*** In small groups do a gallop exercise focusing on arm action. ***Variation 2:*** With a block, execute gallop exercise.	**Throw** ***Variation 1:*** Protecting the feet exercise. ***Variation 2:*** Throwing arm exercise with a piece of cotton wool.	Coordination, strength & balance: Stand on toes & reach for the sky & bend down & make a egg.
2 Session 7	Cardiovascular:	**Gallop** ***Variation 1:*** Make a circle & gallop & on command change direction. ***Variation 2:*** Same as above, pick up pace.	**Throw** ***Variation 1:*** Partner up & under arm throw to each other & catch with both hands. ***Variation 2:*** Same as above, but do in a small group.	Coordination, strength & balance: Children sit on haunches, take a deep breath come up & reach for the stars.
2 Session 8	Cardiovascular:	**Gallop** ***Variation 1:*** Gallop over blocks, only one foot allowed per block. **V*ariation 2:*** Same as above, try put the arms with.	**Throw** ***Variation 1****:* Pair up & perform a lunge & underarm throw the bean bag to your partner. ***Variation 2:*** Same as above, just use a ball.	Coordination, strength & balance: Simon says

3 Session 9	Cardiovascular: Each child gets a dot & run around it & on command change direction. Vary with one leg hop.	**Leap** ***Variation 1:*** Practice ski hops. ***Variation 2:*** Stand behind beacon & jump over it & land on one foot.	**Roll** ***Variation 1:*** In pairs, roll tennis ball. ***Variation 2:*** Same as above, focus on arm swing.	Coordination, strength & balance: Rock backwards & forwards while on your back pulling your legs to your chest.
3 Session 10	Cardiovascular: Hook in with a partner & skip & follow commands given.	**Leap** ***Variation 1:*** Alternating hops over a dot. ***Variation 2:*** Increase pace.	**Roll** ***Variation 1:*** Roll ball accurately to a friend with a swing. ***Variation 2:*** Form small groups, roll ball to a friend by calling their name & then roll.	Coordination, strength & balance: Ring-a-rosie
3 Session 11	Cardiovascular: Feet together, rotate a bean bag around your feet.	**Leap** ***Variation 1:*** Leap action exercise over a bean bag starting on one leg. ***Variation 2:*** Leap action exercise over a bean bag starting on both legs.	**Roll** ***Variation 1:*** Lunges for the swing. ***Variation 2:*** More lunges.	Coordination, strength & balance: Simon says
3 Session 12	Cardiovascular: Take bean bag & follow instructors of presenter.	**Leap** ***Variation 1:*** Stand in the block & leap in the instructed direction. ***Variation 2:*** Leap over a cone.	**Roll** ***Variation 1:*** Lunge & in lunge position pick up the bean bag & switch it to the other hand. ***Variation 2:*** Same as above just switch legs & hands.	Coordination, strength & balance: Trace the outline of your body with a bean bag.
4 Session 13	Cardiovascular: Each child received a dot & followed the instructions.	**Slide** ***Variation 1:*** Sequence jumps (one & two leg jumps)	**Strike** ***Variation 1:*** Stand behind a block, step in with preferred leg & practice strike	Coordination, strength & balance:

		Variation 2: Stepping in & out a block.	***Variation 2:*** Pick up pace	Sit & place a bean bag on your head & lift arms up & feet off the floor.
4 Session 14	Cardiovascular: Move around with a bean bag on your head & on command jump up & down.	**Slide** ***Variation 1:*** Slide in the direction of the arrow. ***Variation 2:*** Pick up the pace.	**Strike** ***Variation 1:*** Striking action with a partner (touch your own back & then your partner). ***Variation 2:*** Strike a target.	Coordination, strength & balance: Core exercise
4 Session 15	Cardiovascular: Pass the bean bag down the line while standing on one leg.	**Slide** ***Variation 1:*** Double leg hops & slide lunge. ***Variation 2:*** Pair up & give two slides to the left/right & clap & two slide to the left/right & high five your partner.	**Strike** ***Variation 1:*** Transferring weight in & out the block ***Variation 2:*** Transfer weight in & out the block & add a strike.	Coordination, strength & balance: Yes & no game (yes= stand & no = sit)
4 Session 16	Cardiovascular: In a line, do under & over with a soft ball.	**Slide** ***Variation 1*:** Slide from side to side & on 'stop' command, freeze & change direction. ***Variation 2:*** Increase pace.	**Strike** ***Variation 1:*** By hugging yourself, step in & out a block & practice hip rotation. ***Variation 2:*** Step into block, with ice cream stick and perform three small swings.	Coordination, strength & balance: Robot clap game.
5 Session 17	Cardiovascular: Partner up, stand back to back & follow instructions with a bean bag.	**Jump** ***Variation 1:*** Jump on the spot, bend knees & on command, touch toes. ***Variation 2:*** Partner up & hook-in & jump in directions of the arrow.	**Dribble** ***Variation 1:*** Partner up & face each other one meter apart & take tennis ball, roll it around your feet and bounce to your partner. ***Variation 2:*** Focus on accurate bounces.	Coordination, strength & balance: Turn in a circle on the spot & on command balance on one leg.

5 Session 18	Cardiovascular: Partner up, stand back to back on one leg & follow instructions with a bean bag.	**Jump** ***Variation 1:*** Stand on a bean bag & jump in the direction of the arrow BUT land softly. ***Variation 2:*** Pick up the pace.	**Dribble** ***Variation 1:*** Bounce & catch a ball with two hands. ***Variation 2:*** Pair up, bounce two your partner with one hand & catch with two.	Coordination, strength & balance: Star jumps on robot colours.
5 Session 19	Cardiovascular: Throw & catch a bean bag & on command do the instruction with the bean bag.	**Jump** ***Variation 1:*** Bean bag is on the ground, bend down & pick it up, jump & turn 180 degrees & land on both feet. ***Variation 2:*** Stand behind the square, do fast feet & on command jump as far over the square as you can & land on both feet.	**Dribble** ***Variation 1:*** In a square, dribble your ball with one hand. ***Variation 2:*** Same as above & on command change direction.	Coordination, strength & balance: Core exercise
5 Session 20	Cardiovascular: Hop on one leg & on the command do the instructions with the bean bag.	**Jump** ***Variation 1:*** Stand behind the block & make your body as small as you can (like an egg) & on command jump over the block & make an egg. ***Variation 2:*** Focus on bending knees.	**Dribble** ***Variation 1***: Pair up & one child dribbles the ball & on command the other one needs to catch the ball with both hands & switch positions. ***Variation 2:*** Make a line, front child dribbles the ball x 4, gives the ball to the next child & stands in the back of the line.	Coordination, strength & balance: Pair up for sit-ups.
6	Cardiovascular: Jumping jacks & on command, make an egg.	**Hop**	**Kick** ***Variation 1:*** Stand behind a cone & run on the spot & on	Coordination, strength & balance:

Session 21		***Variation 1:*** Green & red dot – green = stand on one leg & red = heel-to-toe position. ***Variation 2:*** Balance on a rope in the heel-to-toe position & on command balance on non-dominant leg.	the command knock over the cone with dominant foot. ***Variation 2:*** Same as above but pick up the pace.	Stand on all fours like a bear & follow instruction (lift left leg).
6 Session 22	Cardiovascular: Scissor jumps & on command balance on toes.	**Hop** ***Variation 1:*** Green & red dot – green = frog jumps & red = balance on non-dominant leg. ***Variation 2***: Walk on a rope & on command balance in a heel-to-toe position.	**Kick** ***Variation 1:*** Stand behind cone, balance on non-dominant leg & on command kick cone with dominant leg. ***Variation 2:*** Same as above, increase balancing time.	Coordination, strength & balance: In the crab position & follow commands (lift left hand in the air).
6 Session 23	Cardiovascular: Make a small circle & run clockwise & on command do frog jumps.	**Hop** ***Variation 1:*** Hop on dominant leg & on command balance in heel-to-toe position. ***Variation 2***: Stand behind a cone & hop over the cone with dominant leg.	**Kick** ***Variation 1:*** Stand behind cone, run on the spot & on command balance & kick cone. ***Variation 2:*** Same as above, increase pace.	Coordination, strength & balance: Caterpillar walk
6 Session 24	Cardiovascular: Hopscotch on the spot.	**Hop** ***Variation 1:*** Place 5 blocks in a row & hop with dominant leg in each block. ***Variation 2:*** Stand & hop like a bunny & on first command hop on one leg & second command balance on toes.	**Kick** ***Variation 1:*** Partner up, kick a ball to a friend. ***Variation 2:*** Same as above, run on the spot & balance before the kick.	Coordination, strength & balance: Lie on stomach and open arms & lift up feet.

The activities were based on integrated neuromuscular training (INT) programmes. INT programmes are based on various essential gross motor skills such as locomotor and object manipulation, which increase and strengthen children's FMS and fitness levels (Duncan *et al.,* 2017). INT programmes have six different goals. Two specific goals the programme focused on, was to ensure that optimal growth and development takes place, especially when working with Grade One children, as well as to ensure that children learn a variety of gross motor skills as well as to enhance and improve their strength and stability. All of the interventions contributed to physical fitness and the development of the participants' FMS (Myer *et al.,* 2011). When children partook in the active brain-breaks they were not expected to execute activities that they cannot do, by using the basis of INT programmes the children were challenged to use their neuromuscular strength and FMS, the researcher were not externally leading the children. By using the INT programmes, children had the opportunity to move their bodies through space with movements that they can do. The INT link well with children between 6-7 years old.

The intervention was implemented during regular class time in between different lessons. The brain-breaks took place continuously as there were no interruptions in the middle of the six-week cycle. The researcher was consistent throughout the study and the intervention at each school was exactly the same. This was controlled by the researcher on a weekly basis to ensure validity and reliability. The active brain-breaks were prepared and planned before the intervention started. The researcher ensured this by making sure the schools did the same active brain-breaks every week. The assistants who were responsible for the testing were blind-testers to the participants. The researcher did this to ensure reliability and to eliminate bias. The researcher used the same equipment for the intervention at both schools.

Theoretical basis for the intervention

It is vital to base PA interventions on a theory and an approach to ensure effectiveness and long-term results (Nutbeam, 1999). There are various theories and approaches that researchers use and it is crucial to choose the most appropriate one. Different theories and models that are being used in health-promotion research are the Health Belief Model, Cognitive/Information Processing, Theory of Reaction Action, Social Cognitive Theory, Social Support Theories, Intervention Mapping, Dynamic System Theory, Behavior Modification and Transtheoretical Model (Elder *et al.,* 1999). Moreover, the dynamic systems theory is designed to assist in developing an appropriate intervention programme in PA promotion. Bakhtiar (2013) concluded that applying the dynamic systems theory in an intervention study could potentially ensure improvement in children's gross motor skills. The current study was based on the Dynamic Systems Theory because the researcher developed an intervention programme to possibly enhance the FMS and PA levels of the children.

Dynamic Systems Theory

The active brain-breaks intervention was based on the dynamic systems theory (Thelen, 2005). According to Gallahue (1987), it is essential for children to learn how to execute motor skills correctly from a young age. If children are able to master FMS from a young age, they are likely to be more active and participate in sports. Therefore, it is beneficial that children must acquire the necessary experiences and guidance during school time to learn and develop their motor skills (Bakhtiar, 2013). The dynamic system theory is non-linear, and therefore the development of each child is unique and children do not develop their milestones at exactly the same age. Children go through all the stages of motor skills development at their own pace. Individual factors known as constraints might have a possible influence on the development of children. These constraints include motivation, encouragement, positive feedback, body shape and mass as well as environmental factors. Each individual's biological system adapts differently to a task and to the environment and this contributes to the theory being non-linear (Bakhtiar, 2013). Therefore, this theory was applicable to this specific study as the participants were in the same age group, although they were developing their FMS at their own pace. The brain-breaks encouraged them to continue the development of their FMS and PA levels.

Intervention approach

This intervention was based on the top down approach, which looked at specific foundational factors such as: performance skills and patterns, context, activity demands and the specific needs of a child (Weinstock-Zlotnick & Hinojosa, 2004). Macdonald stated in 1995 that the top down approach helps to plan, implement and develop programmes.

The specific top down approach that was used is the Cognitive-motor intervention approach (CM). There is a positive interaction between the cognitive, affective and motor abilities of children in this approach. By applying this approach, gross motor skills were conceptualized as a problem-solving skill. The problem-solving skill can be broken up into three different components namely: planning the motor action, executing the movement and then evaluating the movement to determine if it was successful. External factors like motivation, self-confidence and an interest in the activities play a big role in this approach. The main goal of this approach is to be able to improve children's motor skills in order for them to function better on a daily basis and to improve and enhance their PA patterns. Automatically, by improving their PA patterns this would contribute to a reduction in sedentary behaviour (Pienaar, 2012). The reason why the top down approach was used was because the researcher planned the specific actions that would be implemented in the brain-breaks. The intervention was executed, and afterwards an evaluation took place to determine if the intervention was successful.

The INT aligns well with the dynamic systems theory as children partook in an intervention that allowed and gave them the opportunity to move in a certain way. Looking at the integration between the top-down approach and the dynamic systems theory a hybrid approach was used. The top-down approach was used to design and plan the intervention; however, children were only guided during the activities (dynamic systems theory).

Ethics

Ethics clearance was obtained from the Research Ethics Committee of Stellenbosch (REC-2019-8456) and Coventry University (P94100), and thereafter, permission was granted by the Western Cape Education Department (WCED) to be able to approach the specific schools in South Africa. The principals at the schools as well as the children's parents and guardians gave permission for the study to be conducted before the researcher approached the children. Each participant's parents or guardian were asked for their informed consent, and thereafter, each participant signed an assent form. The assent form and procedures were explained to each individual verbally in a language that they understood. There were pictures on the assent form for participants who were not able to read. If the individual did not want to participate in the programme, they were not forced to do so. If a parent or guardian did not give consent for their child to participate, the child could still do so, but the researcher excluded their data from the study. Due to the fact that the study took place over three terms during 2019, the researcher maintained continuous communication with the parents and teachers to ensure that they were aware of what was happening and what phase their child/children were participating in.

The testing, monitoring and intervention took place in a safe environment where the participants felt comfortable. The researcher is a qualified Kinderkineticist registered with SAPIK (01/014/06/1415/005) and has a Level 2 First Aid Certificate. A Kinderkineticist focuses on the optimal growth and development of children between the ages of 0 and 13 years by designing and implementing science-based programmes to develop and enhance their gross motor skills. All the data that was collected from the study was saved on a password-protected computer in an office that was locked at all times. Only the researcher, supervisors and statistician had access to the computer and the office. The researcher worked with a numbering system where each participant received a number and therefore no names were used. The results of the participants were kept confidential at all times.

Statistical analysis

Summary statistics were expressed as means, medians, standard deviations, frequency counts and percentages. Comparisons between boys and girls for continuous variables were performed by using one-way ANOVA. Normal probability plots were inspected for normality and were mostly found to be acceptable. Levene's test was used to check for homogeneity of variance. The participants were included in the model as a random effect and skill and sex as fixed effects. School, sex, group and time were included as fixed effects, together with all the sex, group*time interaction effects. Sex did not influence the results; therefore, the focus was on the group*time interaction effect, which tested the hypothesis that the change from pre- to post-test was the same for both control and experimental groups. Post hoc testing was done using Fisher least significant difference (LSD) testing. Categorical mastery outcomes were compared between boys and girls using cross tabulation and the Chi-Square test. In cases where small (≤5) cell frequencies were found, the generalized Fisher Exact test was done. Data were analysed by Excel (Microsoft®), Statistica version 13.5 (TIBCO Software Inc., Palo Alto, California, USA).

Summary

In this chapter, the researcher explained the aims and objective of the articles, what type of research design was implemented and gave more information about the study design. An in-depth explanation was given about the participants and schools that took part in this study as well as the two phases that the study consisted of. Outlines and explanations were given about the procedures of the project, as well as information about all the assessments, test battery, Actigraphs and the intervention. The ethical aspects and statistical analysis were also explained.

REFERENCES

ADAMS, J. & WHITE, M. 2003. Are activity promotion interventions based on the transtheoretical model effective? A critical review. *British Journal of Sports Medicine*. 37:106–114.

AIBAR, A., BOIS, J.E., ZARAGOZA, J., GENERELO, E., JULIAN, J.A. & PAILLARD, T. 2014. Do epoch lengths affect adolescents' compliance with physical activity guidelines? *Journal of Sport Medicine and Physical Fitness.* 54(3): 255-263.

AMUSA, L.O., GOON, D.T., AMEY, A.K. & TORIOLA, A.L. 2011. Health-related physical fitness among rural primary school children in Tshannda, South Africa. *Scientific Research and Essays.* 6(22): 4665-4680.

ARMSTRONG, M.E.G., LAMBERT, E.V. & LAMBERT, M.I. 2011. Physical fitness of South African primary school children, 6 to 13 years of age: Discovery vitality health of the Nation study. *Perceptual and Motor Skills.* 113(3): 999-1016.

BAKHTIAR, S. 2013. The Implementation of Dynamic System Theory and the Principles of Growth in Physical Education of Elementary School. *Asian Social Science*. 9(12):105–109.

BARNETT, L.M., RIDGERS, N.D., ZASK, A. & SALMON, J. 2015. Journal of Science and Medicine in Sport Face validity and reliability of a pictorial instrument for assessing fundamental movement skill perceived competence in young children. *Journal of Science and Medicine in Sport*. 18(1):98–102.

BARNETT, L.M., VAZOU, S., ABBOTT, G., BOWE, S.J., ROBINSON, L.E., RIDGERS, N.D. & SALMON, J. 2016. Construct validity of the pictorial scale of Perceived Movement Skill Competence. *Psychology of Sport & Exercise*. 22:294–302.

BIDZAN-BLUMA, I. & LIPOWSKA, M. 2018. Physical Activity and Cognitive Functioning of Children: A Systematic Review. *International Journal of Environmental Health Research and Public Health.* 15(800): 1-13.

BRUG, J., OENEMA, A. & FERREIRA, I. 2005. Theory, evidence and Intervention Mapping to improve behavior nutrition and physical activity interventions. *International Journal of Behavioral Nutrition and Physical Activity.* 2:1-7.

CANTELL, M., WILSON, A. & DEWEY, D. 2014. The motivational state and perceived benefits and barriers to physical activity participation in parents and preschool age children. *Science & Sports.* 29.

CARDON, G., BAILON, R., BERGMEIR, C., RUIZ, J.R., LUCIA, A. & GARATACHEA, N. 2013. Personal pdf file for Actigraph GT3X: Validation and Determination of Physical Activity

Intensity Cut Points Actigraph GT3X : Validation and Determination of Physical Activity Intensity Cut Points. *International Journal of Sports Medicine*. 1–9.

CATTUZZO, M.T., HENRIQUE, R., RE, A.H.N., DE OLIVEIRA, I.S., MELO, B.M., DE SOUSA MOURA, M., DE ARAUJO, R.C. & STODDEN, D. 2016. Motor competence and health related physical fitness in youth: A systematic review. *Journal of Science and Medicine in Sport.* 19:123-129.

CROUTER, S.E., FLYNN, J.I. & BASSETT, D.R. 2015. Estimating physical activity in youth using a wrist accelerometer. *Medicine & Science in Sports & Exercise.* 47(5): 944-951.

DE VRIES, S.I., GARRE, F.G., ENGBERS, L.H., HILDEBRANDT, V.H. 2010. Evaluation of Neural Networks to Identify Types of Activity Using Accelerometers. *Medicine and Science in Sports and Exercise*. 43(1):101–107.

DUNCAN, M.J., EYRE, E.L.J. & OXFORD, S.W. 2017. The effects of 10 weeks Integrated Neuromuscular Training on fundamental movement skills and physical self-efficacy. *Journal of Strength and Conditioning*. 1–32.

ELDER, J.P., AYALA, G.X. & HARRIS, S. 1999. Theories and Intervention Approaches to Health-Behavior Change in Primary Care. *American Journal of Preventive Medicine*. 17(4):16–20.

FAIRCLOUGH, S.J., NOONAN, R., ROWLANDS, A.V., VAN HEES, V., KNOWLES, Z. & BODDY, L.M. 2016. Wear compliance and activity in children wearing wrist and hip-mounted accelerometers. *Medicine & Science in Sports Exercise.* 48(2): 245-253.

FLANNELLY, K.J., FLANNELLY, L.T. & JANKOWSKI, K.R.B. 2018. Threats to the Internal Validity of Experimental and Quasi-Experimental Research in Healthcare. *Journal of Health care Chaplaincy.* 0: 1-24.

GRIMSHAW, J., CAMPBELL, M., ECCLES, M. & STEEN, N. 2000. Experimental and quasi-experimental designs for evaluating guideline implementation strategies. *Family Practice*. 17:11–16.

JOUBERT, I.; HARTELL, C. & LOMBARD, K. 2016. *Navorsing: 'n Gids vir die beginnernavorser*. Kaapstad: Van Schaik.

KATZMARZYK, P.T., DENSTEL, K.D., BEALS, K., BOLLING, C., WRIGHT, C., CROUTER, S.E., MCKENZIE, T.L., PATE, R.R., SAELENS, B.E., STAIANO, A.E., STANISH, H.I. & SISSON, S.B. 2016. Results from the United States of America's 2016 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health.* 13(2): 307-313.

KELLY, L.A., MCMILLAN, D.G.E., ANDERSON, A., FIPPENGER, M., FILLERUP, G. &

RIDER, J. 2013. Validity of actigraphs uniaxial and triaxial accelerometers for assessment of physical activity in adults in laboratory conditions. *BMC Medical Physics*. 13(5):1–7.

KIM, Y., BEETS, M.W. & WELK, G.J. 2012. Everything you wanted to know about selecting the "right" Actigraph accelerometer cut-points for youth, but… : A systematic review. *Journal of Science and Medicine in Sport*. 15(4):311–321.

KOLIMECKHOV, S. 2017. European Journal of Physical Education and Sport Science PHYSICAL FITNESS ASSESSMENT IN CHILDREN AND ADOLESCENTS: A SYSTEMATIC REVIEW. *European Journal of Physical Education and Sport Science*. 3(4):65–79.

KVALO, S.E., BRU, E., BRONNICK, K. & DYRSTAD, S.M. 2017. Does increased physical activity in school affect children's executive function and aerobic fitness? *Scandinavian Journal of Medicine Science and Sports.* 27:1833-1841.

MCCLELLAND, M.M., CAMERON, C.E., DUNCAN, R., BOWLES, R.P., ACOCK, A.C., MIAO, A. & PRATT, M.E. 2014. Predictors of early growth in academic achievement: the head-toes-knees-shoulders task. *Frontiers in Psychology.* 5(599): 1-14.

MCLELLAN, G., ARTHUR, R., DONNELLY, S. & BUCHAN, D.S. 2020. Segmented sedentary time and physical activity patterns throughout the week from wrist-worn ActiGraph GT3X+ accelerometers among children 7-12 years old. *Journal of Sport and Health Science.* 9: 179-188.

MICKLESFIELD, L.K., PEDRO, T.M., KAHN, K., KINSMAN, J., PETTIFOR, J.M., TOLLMAN, S. & NORRIS, S.A. 2014. Physical activity and sedentary behavior among adolescents in rural South Africa: levels, patterns and correlates. *Public Health*. 40(14):1–10.

MIGUELES, J.H., CADENAS-SANCHEZ, C., EKELAND, U., NYSTROM, C.D., MORA-GONZALEZ, J., LOF, M., LABAYEN, I., RUIZ, J.R. & ORTEGA, F.B. 2017. Accelerometer Data Collection and Processing Criteria to Assess Physical Activity and Other Outcomes: A Systematic Review and Practical Considerations. *Sports Medicine.* 47:1821-1845.

MONYEKI, M.A., KOPPES, L.L.J., KEMPER, H.C.G., MONYEKI, K.D., TORIOLA, A.L., PIENAAR, A.E. & TWISK, J.W.R. 2005. Body composition and physical fitness of undernourished South African rural primary school children. *European Journal of Clinical Nutrition.* 59: 877-883.

MONASTA, L., LOBSTEIN, T., COLE, T.J., VIGNEROVÁ, J. & CATTANEO, A. 2010. Defining overweight and obesity in pre-school children: IOTF reference or WHO standard? *Obesity Reviews.* 12(4): 295-300.

MOMBARG, R., JELSMA, D. & HARTMAN, E. 2013. Effect of Wii-Intervention on balance of children with poor motor performance. *Research in Developmental Disabilities.* 34: 2996-3003.

MURRAY, D.M., CATELLIER, D.J., HANNAN, P.J., MARGARITA, S., STEVENS, J., SCHMITZ, K.H., RICE, J.C. & TERRY, L. 2007. NIH Public Access. *Medicine and Science in Sports and Exercise*. 36(5):876–882.

SLADE, S.C., DIONNE, C.E., UNDERWOOD, M. & BUCHBINDER, R. 2016. Consensus on Exercise Reporting Template (CERT): Explanation and Elaboration Statement. *British Journal of Sport Medicine.* 50: 1428-1437.

MUSALEK, M., KOKSTEJN, J., PAPEZ, P., SCHEFFLER, C., CZERNITZK, A. & KOZIEL, S. 2017. Impact of normal weight obesity on fundamental motor skills in pre-school children aged 3 to 6 years. *Journal of Biology and Clinical Anthropology*. 74(3):203–212.

MYER, G., FAIGENBAUM, A., FORD, K., BEST, T., BERGERON, M. & HEWETT, T. 2011. When to Initiate Integrative Neuromuscular Training to Reduce Sport-Related Injuries and Enhance Health in Youth? *Current Sport Medicine Reports.* 10(3):157-166.

PATE, R.R., PFEIFFER, K.A., TROST, S.G., ZIEGLER, P. & DOWDA, M. 2004. Physical Activity among Children Attending Preschools. *Pediatrics*. 114(5):1258–1263.

PATE, R.R., ALMEIDA, M.J., MCIVER, K.L., PFEIFFER, K.A., DOWDA, M., RUSSELL, R., ALMEIDA, M.J., KERRY, L. 2006. Validation and Calibration of an Accelerometer in Preschool Children. *Obesity*. 14(11):2000–2006.

PATE, R., MCIVER, K., DOWDA, M., BROWN, W.H. 2008. Directly Observed Physical Activity Levels in Preschool Children. *Journal of School Health*. 78(8):438–444.

PIENAAR, A.E., VAN REENEN, I. & WEBER, A.M. 2016. Sex differences in fundamental movement skills of a selected group of 6-year-old South African children. *Early Child Development and Care*. 186(12): 1994-2008.

PUYUA, M.R., ADOLPH, A.L., VOHRA, F.A., BUTTE, N.F., MAURICE, R. 2002. Validation and Calibration of Physical Activity Monitors in Children. *Obesity research*. 10(3):150–157.

PONITZ, C., McCLELLAND, M. 2009 & MORRISON, J. A Structured Observation of Behavioral Self-Regulation and Its Contribution to Kindergarten Outcomes. *Developmental Psychology.* 45(3): 605-619.

SADEQ, K.D., YAZDANPANAH, A. & KHARAZMI, E. 2016. Effectiveness of Interventional Program based on Trans-Theoretical Model to Promote Regular Physical Activity in children with hypertension and diabetes patients. *European Academic Research.* 3(11): 12058-12073.

SCHMITZ, K.H., TREUTH, M., HANNA, P., RING, K.B., CATELLIER, D. & PATE, R. 2008. NIH Public Access. *Medicine and Science in Sports and Exercise*. 37(1):155–161.

THELEN, H. 2005. Dynamic Systems Theory and the Complexity of Change. *Psychoanalytic Dialogues.* 15(2): 255-283.

WEINSTOCK-ZLOTNICK, G., HINOJOSA, J. & PRACTICE, T. 2017. Bottom-Up or Top-Down Evaluation: Is One Better Than the Other? *The American Journal of Occupational Therapy*. 58(5):594–599.

WELK, G.J., SCHABEN, J.A. & MORROW, J.R. 2004. Reliability of Accelerometer-based Activity Monitors: A Generalizability Study. *Medicine and Science in Sports and Exercise*. (4):1637–1645.

WILLUMSEN, J. & BULL, F. 2020. Development of WHO guidelines on physical activity, sedentary behaviour and sleep for children less than 5 years of age. *Journal of Physical Activity and Health.* 17(1): 96-100.

WOODS, C., MUTRIE, N. & SCOTT, M. 2002. Physical activity intervention: a Transtheoretical Model-based intervention designed to help sedentary young adults become active. *Health Education Research*. 17(4):451–460.

ULRICH, D.A. 1985. Test of Gross Motor Development (2nd ed.). Austin, Texas: Pro-ed.

UYS, M., BASSETT, S., DRAPER, C.E., MICKLESFIELD, L., MONYEKI, A., DE VILLIERS, A., LAMBERT, E.V. 2016. Results from South Africa’s 2016 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health*. 13(2):265–273.

Chapter 4

Research article 1

Fundamental movement skills proficiency amongst neurotypical Grade One children in Cape Town, South Africa: A Descriptive study

This referencing and formatting of this chapter has been done according to the guidelines of the Sport Sciences for Health Journal (see website- https://www.springer.com/journal/11332). The referencing style of The American Psychological Association (APA) was used and may differ from that used in other chapters in this thesis. This article has been submitted for consideration in the Journal for Sport Sciences for Health.

Fundamental Movement Skill Proficiency Amongst Neurotypical Grade One Children in Cape Town, South Africa: A Descriptive Study

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Abstract

Globally, there is a growing need to recognise and realise the importance of childhood physical activity (PA). For children to be active, they need to be proficient in fundamental movement skills (FMS) because these skills serve as the building blocks for more specific and complex movements later in life. To date, no previous study has investigated the FMS proficiency of children in Cape Town, South Africa (SA). This study investigated the FMS proficiency of Grade 1 children (N=178) from two schools in Cape Town (SA) using the Test of Gross Motor Development-2 (TGMD-2). The results indicated that 35% of the participants mastered all their FMS. Generally, children performed better in locomotor than object control skills, however, no statistically significant differences were found in locomotor skills between boys and girls. There was a statistically significant difference ($p = 0.01$) in object control skills, where boys performed better than girls. The results indicated that run was the highest mastered skill and hop the most difficult to master. The greatest difference between boys and girls were in kick and roll, where boys performed better. Although the results look seemingly good in comparison to international studies, it is recommended that children should continue to practice their FMS, especially strike, hop, leap and gallop, as they were the most difficult skills to master. These results highlight the importance of FMS proficiency and describe the proficiency of Grade 1 children in a selected area in the Western Cape.

Keywords: Motor competence, Physical activity, Mastery, Locomotor, Object control, Grade 1 learners.

Introduction

The holistic benefits of participation in physical activity (PA) for health, physical, social and cognitive development during childhood are well established (Balaban*,* 2018). PA allows children to move their bodies through space at different levels, develop gross motor skills, have fun, learn in structured settings and enjoy free play. However, to be physically active, children need to be competent in performing fundamental movement skills (FMS) (Mukherjee, Jamie & Fong, 2017). FMS refer to the ability to execute locomotor (running, hopping and jumping), object control (striking, catching and kicking) and stability skills (balancing and twisting). These skills are considered the building blocks for more complex movements and skills later in life (Gallahue, Ozmun & Goodway, 2012).

However, FMS do not develop naturally as is generally believed (O'Brien, Belton & Issartel, 2016). In order for children to move towards a positive trajectory of FMS development, these skills need to be taught, continuously practised and refined, alongside appropriate feedback from teachers, parents and coaches (O'Brien et al. 2016; Mukherjee et al. 2017; Duncan, Roscoe, Noon, Clark, O'Brien & Eyre, 2019). In this context, the age range two to seven years is identified as the key developmental phase for the development of FMS within the Hourglass Model of Motor Development (Gallahue et al. 2012). According to this model, children in this phase need to specifically focus on, and develop their FMS, build on their rudimentary movement phase (which is the phase before FMS begin to develop), and prepare for movements that are more specialized. Children should also have the potential to master FMS by the age of seven (Gallahue et al. 2012).

The importance of competence in FMS among young children has been widely acknowledged (Cliff, Okely, Morgan, Jones, Steele & Baur 2012; De Meester, Stodden, Goodway, True, Brian, Ferkel & Haerens, 2018; O'Brien et al. 2016; Bolger, Bolger, O'Neill, Coughlan, O'Brien, Lacey & Burns, 2018). However, most studies report low levels of FMS proficiency among young children and that mastery of FMS at these ages suggested by theoretical models, such as the Hourglass Model of Motor Development, are not reached (Bryant, Duncan & Birch, 2013; Foulkes, Knowles, Fairclough, Stratton, O'Dwyer, Ridgers & Foweather, 2015; O'Brien et al. 2016; Mukherjee et al. 2017; Bolger et al. 2018; De Meester et al. 2018; Duncan et al. 2019). Low FMS competence levels are of concern as FMS also have a strong influence on children's social, cognitive and emotional skills (O'Brien et al. 2016). Furthermore, a lack of proficiency in FMS can potentially lead to physical inactivity (Cliff et al. 2012). Therefore, to ensure that strategies can be put in place to enhance FMS where needed and to avoid children developing a proficiency barrier towards subsequent health-enhancing PA (Bolger et al. 2018), it is important to monitor FMS levels across contexts and cultures. Although the aforementioned research indicated that many children were not as proficient in their FMS as expected, it is important to note that the majority of these studies have been conducted in the UK, Ireland, Singapore and the US (Bryant et al. 2013; Foulkes et al. 2015; O'Brien et al. 2016; Mukherjee et al. 2017; Bolger et al. 2018; De Meester et al. 2018; Duncan et al. 2019), and that the findings are not transferable to other countries because of geographical and cultural differences. Differences in FMS between countries can be explained by the role of PA in their daily routine, the type of exposure they get to sports and activities on a regular basis. As well as type of sports that are encouraged by schools and parents due to their culture (Bardid et al. 2015).

To date, no study has examined the FMS proficiency of Grade 1 children in Cape Town, South Africa. Understanding this issue is important for public health specialists and educationalists. Although Physical Education (PE) is still part of the South African school curriculum, schools are progressively disinvesting in PE, resulting in children getting fewer opportunities to practise and develop their FMS (Draper, Tomaz, Bassett, Burnett, Burnett, Christie, Cozett, de Milander, Krog, Monyeki, Naidoo, Naidoo, Prioreschi, Walter, Watson &

Lambert, 2018). Without understanding how proficient South African children are in their FMS, evidence-based intervention strategies to improve children's holistic development through FMS will not be possible. Consequently, the current study addresses this gap and: a) Determines the FMS proficiency of a sample of South African children in Grade 1 (between six to eight years old); and b) examines differences in FMS proficiency between boys and girls.

Method

Participants

This was a descriptive study design. Following institutional approval (#8456) from the Research Ethics Committee of the Institution involved and the Western Cape Education Department (WCED), the researcher approached the schools to take part in the study. This was a sample of convenience, the Grade 1 classes of two schools in the Bellville and Stellenbosch regions, South Africa, (N=178; n=98 boys and n=80 girls) volunteered to participate in the current study. Written consent from the parents or legal guardians and assent from the children were obtained prior to participation. All participants were free of any neuromuscular disorder or special education needs, which could impede movement (information was retrieved from the teachers at the specific schools).

Procedures and Assessments

All tests took place in the schools' halls at stations (eight children per station) allocated for the various assessments. Children undertook measurements in a standardised order, comprising of FMS. Children received a number for all the assessments to ensure that every child completed the assessment and to ensure anonymity.

Fundamental movement skills

The Test of Gross Motor Development-2 (TGMD-2) was used to assess the FMS (Ulrich, 2000). The TGMD-2 assesses proficiency in two motor area composites, namely locomotor and object control. Locomotor skills consist of run, hop, horizontal jump, leap, gallop and slide. Object control skills include striking a stationary ball, stationary dribble, catch, overhand throw, kick and underhand roll. A clear demonstration was given for each skill and participants performed one practise trial per skill and two formal test trials as indicated in the TGMD-2 protocol manual (Ulrich, 2000). The scores of the two formal test trials created a raw score for each skill. For run, jump, slide and gallop, participants were able to score between 0-8, for leap between 0-6 and for hop between 0-10. In striking, dribble, kick, throw and roll between 0-8 and for catch between 0-6. Scores for run, hop, horizontal jump, leap, gallop and slide were summed to create a locomotor subtest score of 0 to 48. Scores from striking a stationary ball, stationary dribble, catch, overhand throw, kick and underhand roll were summed to create an object control subtest score of 0 to 48. The two subtest scores were calculated according to the TGMD-2 guidelines to create a total FMS score. Performances of each skill were video recorded using Samsung tablets (CE0890). On completion, the videos were transferred to a memory stick and slowed down to assess the FMS on a computer. In line with prior research (Barnett, Stodden, Cohen, Smith, Lubans, Lenoir, Ivonen, Miller, Laukkanen, Dudley, Lander, Brown & Morgan 2016; Duncan et al. 2019), FMS were scored by five researchers who received prior training on TGMD-2 scoring. Experienced Kinderkineticists[1] performed the inter-rater reliability analysis for the TGMD-2. The intra-class correlations (ICC) agreement for the final locomotor and object control scores (combined) were 0.88 and the Kendall's W, 0.90.

Data analysis

The descriptive statistics of each FMS and the related performance criteria were scored according to the specific TGMD-2 protocol (Ulrich, 2000). In order to determine FMS

[1] Kinderkinetics is a profession that aims to develop and enhance the total well-being of children between 0-12 years of age, by stimulation, rectifying and the promotion of age specific motor and physical development. The word KINDER refers to the specialization area and KINESES refers to rectifying the child's movements (Pienaar, 2009).

proficiency, previous protocols from O'Brien et al (2016:557) and Duncan et al (2019:1) were followed: a) "mastery" was described as the correct performance of all the skill criteria of both formal trials; b) "near mastery (NM)" was described as the correct performance of all criteria except one on both formal trials; c) "poor" was described where the performance was incorrect in two or more of the criteria of both formal trials (Duncan et al. 2019:1). The number of participants that achieved "mastery", "NM" and "poor" were calculated for each skill. For example; if a child received 8 out of 8 for run, mastery was achieved, 6 or 7 out of 8 was near mastery and 0 to 5 out of 8 was poor. A binary variable was determined for "mastery" and "near mastery" for each skill of the TGMD-2 and described as "advanced skill mastery" (O'Brien et al. 2016:557). The raw scores for the TGMD-2 skills were categorised according to levels of mastery, namely "mastery", "NM" and "poor", which were coded as "1" (mastery and near mastery) and poor as "0" (Duncan et al. 2019:1). The percentage of participants who achieved mastery, NM and poor for each skill was determined. Comparisons between boys and girls for continuous variables were performed by using one-way ANOVA. Normal probability plots were inspected for normality and were mostly found to be acceptable. Levene's test was used to check for homogeneity of variance. Categorical mastery outcomes were compared between boys and girls using cross tabulation and the Chi-Square test. In cases where "small (≤5)" cell frequencies were found; the generalized Fisher Exact test was done. The Cohen's D effect sizes were determined to see if there were any practical differences. Data were analysed by Excel (Microsoft®), Statistica version 13.5 (TIBCO Software Inc., Palo Alto, California, USA).

Results

Fundamental movement skills

The final sample for the study consisted of N=178 participants (55% boys and 45% girls) and ages ranged from six to eight years (M=6.7, SD=0.43). The TGMD-2 skills were divided into three categories, namely: “mastery”, “NM” and “poor”. In the current study 35% of the participants mastered all the FMS, 37% were at the NM level and 28% did not master any of the skills (poor). In addition, 37% mastered locomotor skills, 34% achieved NM and 30% were poor. Regarding the object control skills, 33% achieved mastery, 41% NM and 26% poor. Table 4.1 displays the mean and SD for the total FMS score, total locomotor and object control scores for all the participants and for boys and girls separately.

TABLE 4.1 Mean and SD for Total FMS scores

Skill	Mean	SD
Total FMS Score (0-96)	73	4.4
Total Locomotor Score (0-48)	36	2.5
Total Object Control Score (0-48)	37	1.9
Total Locomotor (Boys) (0-48)	36	2.6
Total Locomotor (Girls) (0-48)	36	2.4
Total Object Control (Boys) (0-48)*	39	1.9
Total Object Control (Girls) (0-48)*	36	1.9

Figure 4.1 displays the proficiency levels of all the TGMD-2 skills (locomotor and object control) for the boys and girls together. The highest mastered locomotor skill was running (67%) and the least mastered skill was hopping (16%). In object control the highest mastered skill was catch (52%) and the least mastered skill strike (18%).

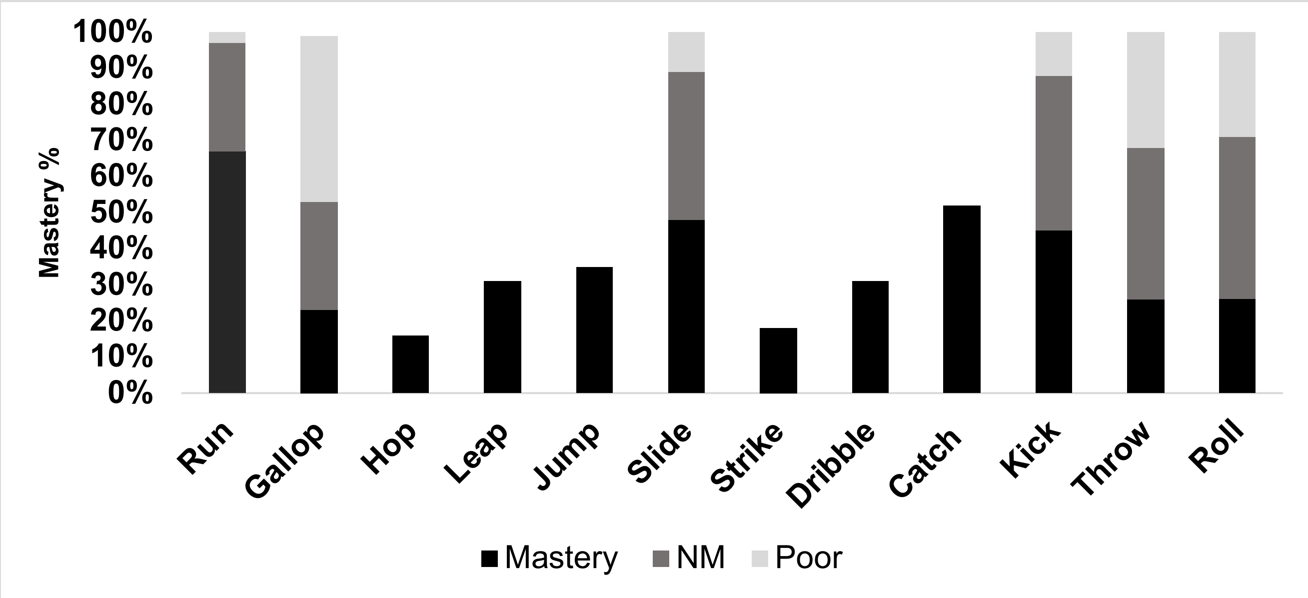

FIGURE 4.1 FMS proficiency of the whole sample

Regarding the differences between the raw scores of locomotor and object control skills between boys and girls, the data showed no statistically significant difference in the locomotor scores ($p>0.05$). Conversely, a statistically significant difference ($p=0.01$) was found in the object control skills subtest, where boys had a higher mean score (39 ± 1.9) than girls (36 ± 1.9) (Table 4.1), the Cohen's D effect sizes indicate a small practical difference (0.19). The results depict a difference for kicking ($p=0.01$), with a medium practical difference (0.45) and striking ($p=0.01$) with a small practical difference (0.37) between boys and girls, where boys performed better. As depicted in Figure 4.2 and 4.3, sex played no role in most of the FMS. According to the results, boys and girls had very close mastery scores in locomotor skills. In object control skills, there were more differences between boys and girls. In striking a stationary ball, 22% of the boys and 13% of the girls demonstrated mastery. Dribble, catch and roll showed no sex difference; however, catch was the best mastered skill and the only skill where girls performed better than boys. A statistically significant difference between boys and girls ($p=0.03$) was shown in throw, with a small practical difference (0.31) between boys and girls; 33% of the boys and 18% of the girls mastered throw.

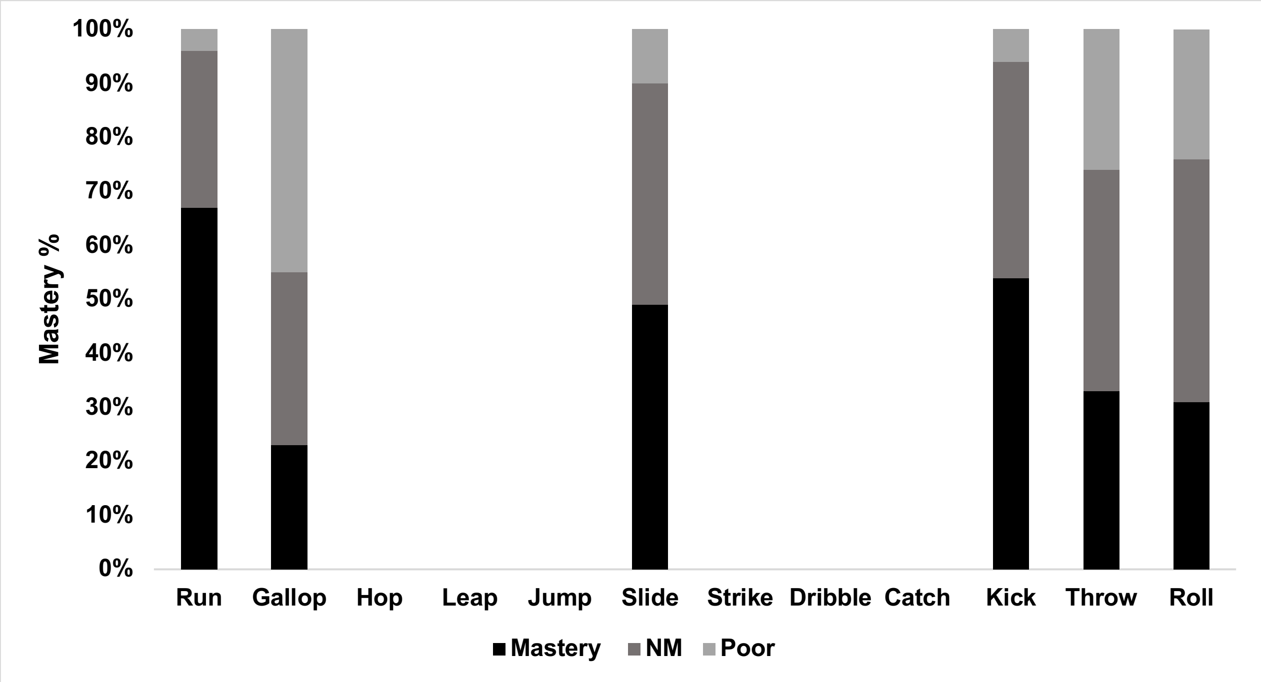

FIGURE 4.2 FMS proficiency for boys

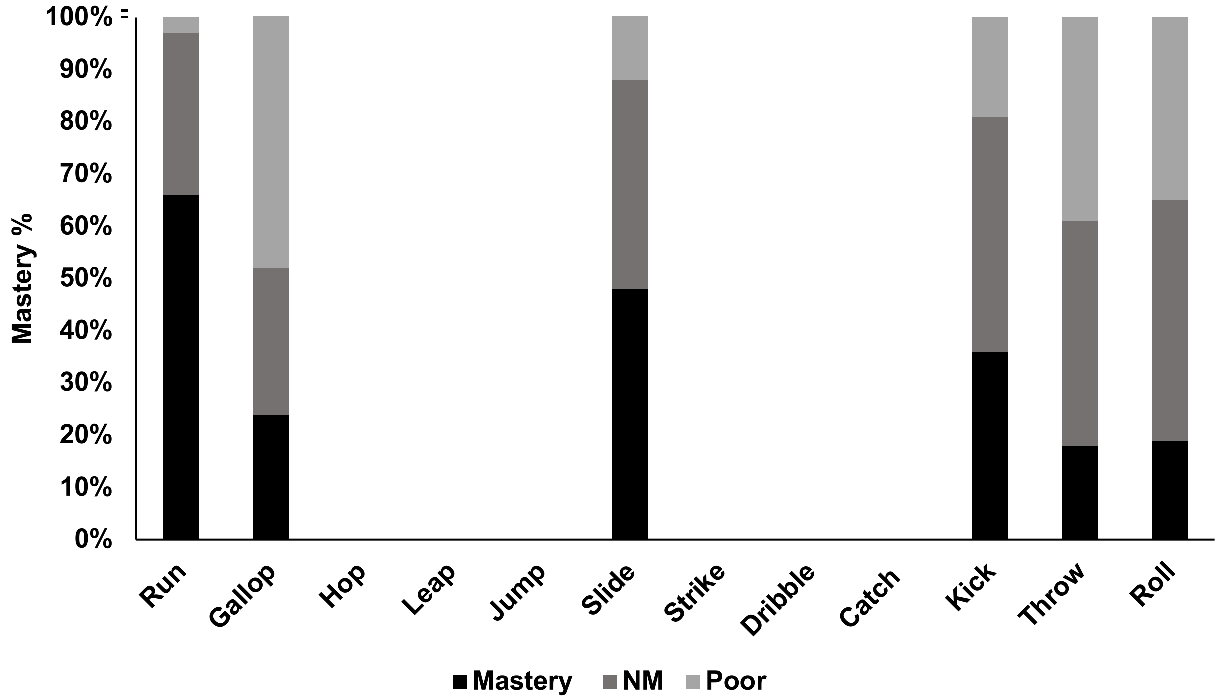

FIGURE 4.3 FMS proficiency for girls

Discussion

The current study is the first to present data on FMS proficiency in the Western Cape for children aged between 6-8 years old. The key findings of the present study were that FMS proficiency of this sample of children were relatively good for their age, as 35% of the total sample mastered their FMS, 27% achieved NM and 28% did not master their FMS at all, studies of O'Brien et al (2016) & Mukherjee et al (2017) found lower results in the total mastered skills, NM and poorly mastered. It is positive that over a third of the children mastered their FMS between 6-8 years old, children that have mastered their FMS can now start to prepare for more complex movements especially skills that are more sport specific (Gallahue et al. 2012); however nearly a third have not mastered their FMS. Globally, it is expected that children should be able to master their FMS between the ages of four to six years old. By the time children go to primary school, they should exhibit age-appropriate mastery of locomotor and object control skills (Gallahue & Ozmun, 2006). Nevertheless, researchers have found that these assumptions are not in line with children's skills at that age (Mukherjee et al. 2017). There were no statistically significant differences between the overall locomotor and object control skills proficiency levels in the current study, but participants performed better in locomotor skills overall. Differences can be seen between skills in children as well as differences between boys and girls. Locomotor skills like leap, gallop and hop are more difficult to master, as it requires much more coordination, rhythm and timing to execute. On the other hand, object control skills such as striking a ball, roll and throw also demands more technique as one's body need to rotate and the legs need to be in coordination with the arms. However, according to Gallahue & Ozmun children need to be able to master these skills and therefore more attention needs to be given to specific skills.

Although the children performed better in their locomotor skills, according to Westerndorp, Houwen, Hartman and Visscher (2011), young children's locomotor skills are underdeveloped because they require simultaneous coordination from the left and right sides of the body, which makes the skill more difficult to execute. The study done by Bryant et al (2014) also supports the findings of Westerndorp et al (2011). The current study is in support of the findings of Mukherjee et al (2017) who investigated the FMS proficiency of 6-to-9-year-old Singaporean children (N=244). The highest mastered skill was run and the least was hop, which is in line with the current study. Halverson & Williams, 1985 concluded that the ability for children to hop requires a good amount of force to lift their bodies from the ground, propel upwards into flight and immediately to balance their body on one leg when they land. In the TGMD-2 specifically they need to complete three consecutive hops and change over to the other leg in the same motion, and therefore they need timing and coordination which makes this skill more complex. Pienaar, Van Reenen & Weber (2016) explored the differences in FMS between 6-year-old boys and girls (N=72) and concluded that run was the highest mastered skill. Therefore, the researcher can conclude that the highest mastered skill and most difficult skill to master were locomotor skills. The study done by Pienaar et al (2016) in the North-West Province only evaluated catching, kicking and throwing, and found that throwing was the least mastered object control skill and catching the highest mastered skill. Compared to the current study, catching was also the highest mastered skill. The study done by Mukherjee et al (2017) also found catch was the highest mastered skill and roll the least mastered skill.

No sex differences in overall locomotor and object control was seen in the current study, which is in line with the study done by Mukherjee et al. (2017) and Roscoe, James & Duncan (2019). Statistically significant sex differences in the current study were only found in two object control skills, namely kick and throw, in which boys had higher proficiency scores than girls. These findings correspond with those of Bryant et al (2014) who investigated the FMS and weight status of 6-to-11-year old British primary school children (N=281). The study of Pienaar et al (2016) concluded that boys showed a higher percentage of mastery in object control skills and that there was a statistically significant difference between boys and girls in kick. In the present study, catch was the only skill that girls mastered better than boys, which is contradictory to Hardy, King, Farrell, Macniven & Howlett, (2013), who concluded that boys outperformed girls. The studies of Pang and Fong (2009), Hardy et al (2010), Bryant et al (2014) and Foulkes et al (2015) reported that boys performed better than girls in object control skills. It could be speculated that boys prefer to play ball games for structured activities, as well as during free play, and therefore, increase the mastery of object control skills (Mukherjee et al. 2017). Some FMS are easier to master than others, the reason for this can be that some children are still in their initial or elementary phase of executing the skills and other children are already in the mature phase. Certain skills like running and jumping come more naturally, as they are easier movements to execute where leaping and throwing can be more complex due to the type of movement, body control, coordination and timing. Therefore, it is important to understand how children acquire and develop their FMS, if a child's form (mechanics) are closer to a mature phase, he/she are more likely to be able to master the skill. Children's physical development also plays an important role, such as changes in their height, weight and physique (bone growth and muscular development) (Haibach et al. 1977).

Socio-cultural, environmental and geographical factors and differences could result in differences in FMS proficiency and sex differences in skills as well as differences between South African and International studies (Duncan et al. 2019). However, Malina, Bouchard & Bar-Or (2004) concluded that children in the primary school age are mainly in the pre-pubertal maturational phase, and therefore, boys and girls should be more or less on the same level of proficiency. Boys performed slightly better in certain skills than the girls, which should be taken into consideration when working with children to increase their FMS proficiency. The majority of the present study's findings are comparable with the findings of Pienaar et al (2016), which is the only other study that has been done in South Africa on the

FMS proficiency of 6-year-old children. The result of the current study was drawn from 6-8 year old children in only two schools in the Belville and Stellenbosch regions of Cape Town, and therefore it cannot be generalised.

Limitation

Potential sources of bias that could have influenced the results of this study could have been that all the data were collected by female assistants and that the boys performed differently. Cultural bias also might have had an influence in some of the skills assessed by the TGMD-2.

Conclusion

The study found that over a third of the Grade 1 children aged between 6-8 years old mastered their FMS and almost a third remained in the 'poor' category. Run and catch were the two easiest skills to master, while leap and gallop were the most difficult, providing a clear indication of focus for future FMS interventions. Significant differences were seen between boys and girls in kick, strike and throw with the boys performing better. Children should participate more in specific locomotor skills, such as gallop, hop and leap and practise, coordination and rhythm. More emphasis needs to be placed on strike, throw and dribble, as it would help children to improve their overall FMS proficiency levels. Girls should focus more on kick, roll, throw and strike as they performed poorly in these skills. The above-mentioned skills are not necessary skills that children would execute while they participate in free play, and therefore, children should be motivated and encouraged to participate in more specific skills to reach mastery in FMS. Part of children's developmental process they need to develop and learn FMS, the school setting would be the ideal environment to get exposure to these skills, which will later assist them with sport specific skills. By getting exposure to PA and FMS forms part of children's school curriculum. Teachers, coaches, parents and therapists can use these results to develop specific intervention programmes that improve FMS proficiency whilst keeping gender differences in mind.

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REFERENCES

BALABAN, V. 2018. The Relationship between Objectively Measured Physical Activity and Fundamental Motor Skills in 8 to 11 Years Old Children from the Czech Republic. *Montenegrin Journal of Sport Science and Medicine.* 7(2): 1-6.

BARNETT, L.M., STODDEN, D., COHEN, K.E., SMITH, J.J., LUBANS, D.R., LENOIR, M., IIVONEN, S., MILLER, A.D., LAUKKANEN, A., DUDLEY, D., LANDER, N.J., BROWN, H. & MORGAN, P.J. 2016. Fundamental Movement skills: An Important Focus. *Journal of Teaching in Physical Education.* 35(3): 219-225.

BARDID, F., RUDD, J.R., LENOIR, M., POLMAN, R. & BARNETT, L.M. 2015. Cross-cultural comparison of motor competence in children from Australia and Belgium. *Frontiers in Psychology.* 6(964): 1-8.

BOLGER, L.E., BOLGER, L.A., O'NEILL, C. & COUGHLAN, E., O'BRIEN, W., LACEY, S. & BURNS, C. 2018. Age and Sex Differences in Fundamental Movement Skills among a Cohort of Irish School Children. *Journal of Motor Learning and Development.* 6: 81-100.

BRYANT, E.S., DUNCAN, M.J. & BIRCH, S.L. 2013. Fundamental movement skills and weight status in British primary school children. *European Journal of Sport Science.* 14(7): 730-736.

CLIFF, D.P., OKELY, A.D., MORGAN, P.J., JONES, R.A., STEELE, J.R. & BAUR, L.A. 2012. Proficiency Deficiency: Mastery of Fundamental Movement Skills and Skill Components in Overweight and Obese Children. *Obesity Journal*. 20(5): 1024-1033.

DE MEESTER, A., STODDEN, D., GOODWAY, J., TRUE, L., BRIAN, A., FERKEL, R. & HAERENS, L. 2018. Identifying a motor proficiency barrier for meeting physical activity guidelines in children. *Journal of Science and Medicine in Sport.* 21(1): 58-62.

DRAPER, C.E., TOMAZ, S.A., BASSET, S.H., BURNETT, C., CHRISTIE, C.J., COZETT, C., DE MILANDER, M., KROG, S., MONYEKI, A., NAIDOO, N., NAIDOO, R., PRIORESCHI, A., WALTER, C., WATSON, E. & LAMBERT, E.V. 2018. Results from South Africa's 2018 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health.* 15(2): 406-408.

DUNCAN, M.J., ROSCOE, C.M.P., NOON, M., CLARK, C.C.T., O'BRIEN, W. & EYRE, E.L.J. 2019. Run, jump, throw and catch: How proficient are children attending English schools at the fundamental motor skills identified as key within the school curriculum? *European Physical Education Review.* 1-13.

FOULKES, J.D., KNOWLES, Z., FAIRCLOUGH, S.J., STRATTON, G., O'DWYER, M., RIDGERS, N.D. & FOWEATHER, L. 2015. Fundamental movement skills in relation to weekday and weekend physical activity in children. *Perceptual and Motor Skills.* 121(1): 260-283.

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

GALLAHUE, D.L., OZMUN, J.C. & GOODWAY, J. 2012. Understanding motor development: infants, children, adolescents, adults. Seventh edition. *Boston (MA): McGraw-Hill.*

HALVERSON, L.E. & WILLIAMS, K. 1985. Developmental sequences for hopping over distance: a prelongitudinal screening. *Researh Quarterly for Exercise and Sport.* 6: 37-44.

HARDY, L.L., KING, L., FARRELL, L., MACNIVEN, R. & HOWLETT, S. 2010. Fundamental movement skills among Australian preschool children. *Journal of Science and Medicine in Sport*. 13: 503-508.

HAIBACH, P.S., REID, G. & COLLIER, D.H. 1977. Motor Learning and Development. *United States:* Human Kinetics.

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

MUKHERJEE, S., JAMIE, L.C.T. & FONG, L.H. 2017. Fundamental Motor Skill Proficiency of 6- to 9-year old Singaporean Children. *Perceptual and Motor Skills.* 124(3): 584-600.

O'BRIEN, W., BELTON, S. & ISSARTEL, J. 2016. Fundamental movement skill proficiency amongst adolescent youth. *Physical Education and Sport Pedagogy.* 21(6): 557-571.

PANG, A.W. & FONG, D.T. 2009. Fundamental Motor Skill Proficiency of Hong Kong Children Aged 6-9 Years. *Research in Sports Medicine.* 17:125-144.

PIENAAR, A.E. 2009. Kinderkinetics: An investment in the total well-being of children. *South African Journal for Research in Sport, Physical Education and Recreation.* 31(1): 49-67.

PIENAAR, A.E. & KEMP, C. 2014. Motor proficiency profile of Grade 1 learners in the North West Province of South Africa: NW-child study. *South African Journal of Research in Sport, Physical Education and Recreation.* 36(1): 167-182.

PIENAAR, A.E., VAN REENEN, I. & WEBER, A.M. 2016. Sex differences in fundamental movement skills of a selected group of 6-year-old South African children. *Early Child Development and Care*. 186(12): 1994-2008.

ROSCOE, C.M.P., JAMES, R.S. & DUNCAN, M.J. 2019. Accelerometer-based physical activity levels, fundamental movement skills and weight status of British preschool children from a deprived area. *European Journal of Pediatrics.* 178: 1043-1052.
WESTENDORP, M., HOUWEN, S., HARTMAN, E. & VISSCHER, C. 2011. Are gross motor skills and sports participation related in children with intellectual disabilities? *Research in Developmental Disabilities.* 32: 1147-1153.
ULRICH, D.A. (2000). Test of Gross Motor Development (2nd ed.). Austin: Pro-ed.

Chapter 5

Research article 2

Physical fitness and weight status of Grade one children in Cape Town, South Africa

This referencing and formatting of this chapter has been done according to the guidelines of the Journal of Sports Medicine and Physical Fitness (see website- https://www.minervamedica.it/en/journals/sports-med-physical-fitness/index.php). The referencing style of The American Medical Association was used and may differ from that used in other chapters in this thesis. This article has been submitted for consideration in the Journal of Sports Medicine and Physical Fitness.

Physical fitness and weight status of Grade One children in Cape Town, South Africa

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Abstract

Physical fitness and weight in young children are important indicators of health status because they can prevent childhood obesity and potentially benefit children because children who take part in physical fitness exercises are automatically more physically active. Literature has shown that fatness and physical fitness are very intertwined and therefore, it is important to consider the two together as they have an influence on each other. The aim of this study was, therefore, to investigate the physical fitness levels and weight status of Grade 1 children (N=184), as well as the differences between boys and girls from two schools in Cape Town, South Africa. Physical fitness skills was evaluated by means of five widely-used components, namely: cardiorespiratory fitness; muscular strength; agility; flexibility; and coordination. Children's height and mass were measured to determine their Body Mass Index (BMI) and the International Obesity Task Force (IOTF) cut-offs were used to establish under and overweight classifications of the children. In comparison, boys performed better than girls in the standing broad jump, shuttle run and throwing, whereas girls performed better in the flexibility test. 84.23% children were classified in the normal weight category, 10.86% were overweight and 4.89% were obese. The children in the current study were relatively fit in comparison to other provinces in South Africa; however, they can still improve significantly in their fitness levels.

Keywords: Physical fitness, physically active, weight, body mass index

Introduction

Children with high physical fitness levels are often in good health, whereas children with low physical fitness levels are at an increased risk of cardiovascular diseases and other co-morbidities.[1] Physical fitness can be defined as health-related fitness that consists of cardiorespiratory and muscular endurance, muscular strength, body composition and flexibility, as well as skill-related fitness, which involves agility, balance, coordination, power, reaction time and speed. Health- and skill-related fitness plays a big role in children's physical activity (PA) patterns,[2] and therefore, children's physical fitness levels could be a facilitator of PA engagement from childhood through adolescence into adulthood.[3] According to Lopes,[4] a high BMI (overweight/obese) could potentially be associated with low levels of motor competence and physical fitness. However, it is vital to keep in mind that physical fitness is also dependent on genetic, anatomical, physiological and environmental factors.[5]

Globally, children are viewed as the most active population; however, more children are presenting with low levels of PA and physical fitness, which can potentially lead to childhood obesity.[6] According to the International PA Guidelines, children's physical fitness levels are deteriorating rapidly and children do not meet the PA guidelines needed for good health. It is extremely important for children to participate in an adequate amount of moderate to vigorous physical activity (MVPA) per day.[7] Regular participation in MVPA contributes to physical fitness, body composition and bone health, whilst also preventing excess adiposity.[6] Malina,[8] contends that childhood is a critical period to develop and promote healthy behaviours associated with physical fitness and PA.

Around the world, the weight status of children is escalating, which could lead to numerous associated diseases, such as: hypertension; Type 2 Diabetes; high blood pressures and cardiovascular diseases.[9-11] A recent survey across 195 countries concluded that roughly, 107.7 million children were obese and according to the Non-communicable Disease (NCD) Risk Factor Collaboration, the prevalence of obesity from 1975 to 2016 increased from 0.7% to 5.6% among girls and from 0.9% to 7.8% among boys.[11] In 2016, the South African Department of Health indicated that one in every four girls and one in every five boys between the ages of 2 and 14 years were either overweight or obese. According to Kirsten,[12] South African studies tend to emphasise childhood under-nutrition because it is a concern in the country rather than other important factors, such as physical fitness. Although slightly dated, the research by Kirsten,[12] found that 9% of children aged between 6 and 13 years old in the Western Cape were overweight and 4% obese.

Likewise, although some studies performed in SA (North-West, Limpopo and Gauteng Provinces) investigated the physical fitness levels and weight status, or BMI of children; the majority of these studies are relatively dated. Furthermore, to the knowledge of the researcher, similar studies have not been conducted in the Western Cape Province.[13-16] More studies in this field, as well as studies that specifically focus on the Western Cape Province, are needed. This is necessary to gain a better understanding of South African children's physical fitness levels and weight status in order to develop age and sex specific intervention programmes.[10] The main aim of this study was to determine the physical fitness levels and weight status of Grade 1 children in Cape Town. A secondary aim was to determine whether there were any differences in physical fitness and weight status between boys and girls.

Methods

Participants

Following approval from the Research Ethics Committee of the Institution involved (#8456) and the Western Cape Education Department (WCED), the researcher approached the specific schools in order to partake in the study. The Grade 1 (mean age = 6.1 years old) classes from two schools in Cape Town (N=191[n = 106 boys and n = 85 girls]) were a convenience sample and volunteered to participate in this study. Written consent from the parents and/or legal guardians and assent from the participants were obtained prior to participation. All the participants were free from any neuromuscular disorders or special education needs which could impede movement. Participants were included in the study if: they were in Grade one, attended the selected schools, parents completed the informed consent form and the children signed the assent form. Participants were excluded if they: had a hearing or sight impairment, were unwilling to participate in the measurements, had severe medical conditions, for example, heart or ear defect or unable to run or jump.

Procedures and Measures

All tests took place in each school's hall, where stations were allocated to the various physical fitness tests. The children's measurements were taken in a standardised order, which included height, weight and the various physical fitness tests.

Physical Fitness

Physical fitness levels were assessed using five valid and reliable tests also seen as a modified EUROFIT (adapted from the original EUROFIT), which have been widely employed in previous studies.[3] They included the Leger test for cardiorespiratory fitness (endurance);[2] standing broad jump for muscular strength (explosiveness);[17] the 4- x 5-meter shuttle run for agility (speed);[18] the sit-and-reach test for flexibility;[18] and throwing a ball for coordination.[3] A clear demonstration of each test was given before a participant performed the assessment trials. The Leger test (20-meter shuttle run endurance test) was assessed at different stages and the total running time was added. For this test, learners received only one formal trial, which was conducted at the beginning of the day. The distance of the standing broad jump was measured in centimetres; participants received three trials and the best score was used. For the 4-x 5-meter shuttle run, the participants received one familiarization trial and two formal trials. Their time was recorded in seconds and the best time was used. For the sit-and-reach test, participants sat with their backs against a wall, the bench (25cm high and 60cm long) was placed at their feet and they had to stretch forward, while their legs remained in a straight position. The metric scale was moved to the tip of their fingers. The maximum distance was measured and participants performed two trials. The overhand throwing technique was used in the throwing test and each participant received three trials with both arms. These measurements were used in previous South African studies.[14-15, 19]

Anthropometry

Participants' anthropometric measurements, were taken while children were barefooted and dressed in their Physical Education kit (t-shirt and shorts). Body mass (kg) and height (cm) were assessed before data collection started using a calibrated Trystom (P375) scale (TPLZ1T46CLNDBI300) (Co. TRYSTOM, spol. s r.o./1993-2015 www.trystom.cz) and portable anthropometer (P375). The measurements were taken to the nearest 0.1 kg and cm.

Statistical Analysis

The statistical analysis was conducted with STATISTICA 13.5. The level of statistical significance was set at $p<0.05$. Differences in the various physical fitness tests between boys and girls were investigated using one-way ANOVA. Normal probability plots were inspected to check for normality and in cases where it was suspected to be a problem non-parametric Mann-Whitney U tests were calculated. The latter results were mostly similar to the ANOVA F-test outcomes, and therefore, only the ANOVA results were reported. Levene's test was used to test for homogeneity-of-variance, which was, in all cases, not significant. The Cohen's D effect sizes were determined to see if there were any practical differences. Data were analysed by Excel (Microsoft®), Statistica version 13.5 (TIBCO Software Inc., Palo Alto, California, USA).

Results

Physical fitness test

Table 5.1 presents the mean and standard deviation of the physical fitness test components.

TABLE 5.1. MEAN AND SD OF THE PHYSICAL FITNESS TESTS (BOYS & GIRLS)

Physical fitness tests	Mean	Standard Deviation (SD)
Standing jump (cm)	112.46	18.81
Shuttle run (4 x 5) (secs)	14.04	1.17
Flexibility (sit-and-reach) (cm)	18.35	5.41
Throwing Right arm (m)	11.23	5.04
Throwing Left arm (m)	6.62	2.52
20m shuttle run endurance test (laps)	3.8	2.04

Table 5.2 depicts the differences between boys and girls for each physical fitness skill. An ANOVA test (F-test) was used to analyse the sex differences to determine any statistically significant differences and Cohen's D effect sizes were calculated.

TABLE 5.2. SEX DIFFERENCES IN THE PHYSICAL FITNESS TEST RESULTS

Physical fitness skills	Sex	Mean	SD	F-test (p value)	Cohen's D effect sizes
Standing Broad jump (cm)	Boys Girls	115.71 108.25	17.55 19.64	p=0.04	0.40 (medium)
Shuttle run (4 x 5) (seconds)	Boys Girls	13.86 14.28	1.23 1.07	p=0.03	0.36 (small)
Flexibility (sit-and-reach) (cm)	Boys Girls	17.67 19.35	5.74 4.89	p=0.03	0.31 (small)
Throwing Right arm (m)	Boys Girls	12.15 10.03	5.26 4.54	p=0.01	0.43 (medium)
Throwing Left arm (m)	Boys Girls	6.88 6.25	2.73 2.19	p=0.07	0.25 (small)
20m Shuttle run endurance (Cardiorespiratory endurance [VO2 max])	Boys Girls	23.1 22.4	3.37 2.74	p=0.17	0.1 (neglectable)

There was a statistically significant difference (p = 0.04) for the standing broad jump, where the boys had a higher mean score (115.71 ± 17.55) compared to girls (108.25 ± 19.64). Boys achieved a higher mean score in throwing with the right arm (12.15 ± 5.26) compared to the girls who had a score of 10.03 ± 4.54 (p = 0.01). Boys also performed statistically significant better in the shuttle run (4 x 5) (13.86 ± 1.23) compared to the girls (14.28 ± 1.07) (p = 0.03). Flexibility was the only skill where girls performed better than boys, also demonstrating a statistically significant difference (p = 0.03). The Cohen's D effect size showed a medium practical difference of 0.43 between boys and girls for throwing with the right arm. There were no differences between boys and girls for the 20m shuttle run endurance test (Cardiorespiratory endurance [VO2 max]).

Weight status

Height and weight were measured to calculate the BMI. Table 5.3 displays the mean height, weight and BMI for boys and girls.

TABLE 5.3. SEX DIFFERENCES FOR ANTHROPOMETRIC MEASUREMENTS

Anthropometry measurements	Sex	M	SD	F-test (p value)	Cohen's D effect sizes
Height (cm)	Boys	119.99	6.13		
	Girls	118.52	6.35	p=0.11	0.24 (small)
Weight (kg)	Boys	23.30	5.30		
	Girls	22.14	5.58	p=0.06	0.21 (small)
BMI	Boys	16.00	2.48		
	Girls	15.50	2.52	p=0.06	0.2 (small)

There were no statistically significant differences in weight, height or BMI between the boys and girls. The International Obesity Task Force (IOTF) norms developed by Cole,[20] were used to determine the proportion of normal weight, overweight and obese participants. According to these norms, 84.23% of participants in the current study had normal weight (boys 45.65%; girls 38.58%), 10.86% (boys 7.06%; girls 3.80%) were overweight and 4.89% (boys 3.26%; girls 1.63%) were obese.

Discussion

Overall, the performance of the participants in the current study was 'average' in the physical fitness tests compared to norms of other countries. However, in the South African context, the participants performed 'well', and therefore, the researcher could speculate that the participants were relatively fit and had a normal weight status.

Physical fitness tests

Compared to girls, the boys performed better overall in the physical fitness tests. According to the European norms of Tomkinson,[21] the performance of South African children of this age cohort was poor to moderate, except in the sit-and-reach test. The differences between boys and girls can also be due to restrictions that are described in the Newell's constraints model, where one can be restricted due to a task or the environment. Therefore, when children partake in physical fitness skills their ability to perform the task can be influenced by the environment as well as the type of skill and complexity of the movements and the structural and functional nature of the child. [24] The results are comparable to the findings of Monyeki,[19] who assessed South African primary school children's body composition and physical fitness. The mean scores for the standing broad jump, shuttle run, and flexibility were slightly higher in the current study compared to the 7-year-olds in the study conducted by Monyeki,[19] which indicated that the participants in the current study had better physical fitness levels. Although the current study found differences between boys and girls for the standing broad jump and throw, the boys performed better in the shuttle run and girls performed better in flexibility. Monyeki,[19] found no statistically significant differences between boys and girls for these tests. Armstrong,[15] investigated the physical fitness levels of 6- to 13-year-old South African children and focused on differences in various ethnic groups. The mean scores for Grade 1 children in the standing broad jump and flexibility tests were slightly higher than the results of the current study. A possible reason for this could be that children came from different socio-economic environments and the type of activities, they were exposed to daily could be a contributing factor, however this is pure speculation and could be investigated in the future.[15] Another South African study conducted by Amusa,[14] investigated the physical fitness levels of rural Grade 1 children. However, the current study found higher mean values for the standing broad jump, but lower mean values for the flexibility test. Amusa,[14] found that boys had a higher mean score for flexibility than girls. The above-mentioned studies,[14-15 & 19] are all South African studies, but were not conducted in Cape Town, and thus it is not directly comparable to the results of the current study. This finding could possibly indicate that the participants in the current study were fitter and stronger in muscular strength than children in other areas of South Africa.

Tomkinson,[21] conducted the EUROFIT (European Physical Fitness Test Battery) in over 30 countries and classified the mean fitness score for boys and girls (9 to 17 years) by a normative quantile-based framework (5th to 80th and above percentiles). The percentiles give an indication of the fitness levels of children. There are only comparable normative values in Table 5.4 for the standing broad jump, sit-and-reach and the 20-meter shuttle run, but not for the 4- x 5-meter shuttle run because Tomkinson[21] did a 10- x 4-meter shuttle run and there were no norms for throwing.

TABLE 5.4. NORMATIVE PERCENTILES FOR PHYSICAL FITNESS SKILLS OF BOYS AND GIRLS

Physical Fitness	Boys percentile	Girls percentile
Standing broad jump	10th to 20th	10th to 20th
Sit-and-reach	60th	50th to 60th
20m Shuttle run (VO2 max -ml/kg/min)	5th	5th
20m Shuttle run (laps)	5th	5th

When comparing the standing broad jump results of the 9-year-old learners of the current study, the boys and girls were placed between the 10th and 20th percentile, which is low. For the sit-and-reach assessment, the boys were on the 60th percentile and the girls between the 50th and 60th percentile, which is considered good. For the 20-meter shuttle run endurance test, the boys and girls were placed below the 5th percentile, which indicates that the levels of cardiorespiratory fitness were poor. Therefore, it is suggested that children need to improve their aerobic endurance levels. This shows that according to international norms set by the World Health Organisation (WHO), the population of the current study performed 'average' overall in the standing broad jump, although they performed 'well' in terms of South African studies.[14, 19] According to the percentiles,[21] boys performed better in flexibility than girls and for the

20-meter shuttle run endurance test, boys and girls had very low scores. Overall, the performance of the participants in the current study was average, but in comparison to other South African studies, the participants performed quite well. The results indicate that Grade 1 children have potential to improve their physical fitness skills, especially cardiorespiratory endurance, and should be encouraged to be more physically active by adopting good PA behaviours. A potential way for children to intensify their PA levels at school would be to increase opportunities for PA during the school day. This could certainly be an avenue for future research. It is crucial that more studies are done in South Africa, to determine children's physical fitness levels, especially in different socio-economic environments and regions, and to have a better understanding of how physically fit South African children of all ages are.

Weight status

The findings of the current study are in line with the outcomes of Kemp & Pienaar,[22] who conducted a study on Grade 1 learners in the North-West Province of South Africa. In the current study, participants had similar means in height and weight, as well as BMI. Although Armstrong[15] compared different ethnic groups, there are comparable results that are in line with the current study's height and weight scores. Amusa[14] also found no difference between boys and girls in height and weight. By comparing the results of height, weight and BMI of the current study with the growth standards set by the WHO (2007), the height of the boys and girls is on the 50th percentile and the weight of boys between the 85th and 97th percentile and the girls between the 50th and 85th percentile. Therefore, the participants' BMI and height were in line with their age according to the growth standards. Armstrong,[15] investigated the physical fitness and anthropometry measurements of 6- to 13-year-old children in South Africa and found that 15.4% were overweight or obese, which corresponds to the findings of the current study. Another South African study conducted by Symington,[23] explored the relationship between stunted and overweight children aged between 3 and 9 years in two provinces (Gauteng and Mpumalanga). Symington,[23] concluded that 12% of the children were overweight or obese. The growth standards percentiles of the children's weight could possibly indicate overweight or obesity and the reason for such a high prevalence could be because of multiple factors, such as poor dietary habits and lifestyles, as well as physical inactivity. More studies are needed to establish the BMI of children, as well as the contributing factors that lead to overweight or obesity in order to prevent childhood obesity. This would greatly assist in the development of appropriate intervention programmes and promotion of healthy lifestyles and being physically active.

Limitations

The sample size of the current study can be seen as a limitation because the results cannot be generalized and it is not representative of the population, it is therefore recommended that future studies include more participants. There was no control over the cause and effect of the results and no clarity whether the weight of the children had an effect on their physical fitness. Furthermore, there is no concrete evidence that their lower physical fitness levels could lead to overweight and obesity. More research in this field is imperative. The study only explored the results of Grade 1 children, and therefore, it is recommended that children in other Grades are included as well.

Conclusions

To conclude, boys exhibited better physical fitness than girls, especially in the standing broad jump, shuttle run and throwing tests. However, girls performed better than boys in the flexibility. With reference to the South African context, the current population group demonstrated higher physical fitness levels compared to previous South African studies, compared to international norms, their physical fitness levels are low. Therefore, it is recommended that children of this age cohort should specifically focus on aerobic endurance as well as lower body muscular power. Boys need to focus on flexibility and girls on muscular strength, agility and coordination skills. To improve these children’s physical fitness levels, it is recommended that they should be more physically active during the day in order to enhance their physical fitness levels. These results can be encouraging to schools to create more awareness in their curriculum that children should be physically active during the day, as well as to motivate them. By being more active could potentially assist children in their physical fitness results. In terms of weight status, according to the growth percentile charts, the participants had a normal weight status but there was a slight tendency towards being overweight. This study offers new data for Cape Town and has practical applications for teachers, parents and therapists. The data presented in the current study presents physical fitness profiles of children from a specific age cohort in Cape Town for the first time, which can be used as a reference point to target future interventions to enhance the fitness and health of children in Cape Town, South Africa.

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REFERENCES

1. Jaakkola, T., Yli-Piipari, S., Huotari, P., Watt, A. & Liukkonen, J. Fundamental movement skills and physical fitness as predictors of physical activity: A 6-year follow-up study. *Scan J Med Sci Sports* 2015;1-8.
2. Ruiz, J.R., Silva, G., Oliveira, N., Ribeiro, J.C., Oliveira, J.F. & Mota, J. Criterion-related validity of the 20-m shuttle run test in youths aged 13-19 years. *J Sports Sci* 2009;27(9).
3. Fernandez-Santos, J.R., Ruiz, J.R., Gonzalez-Montesinos, J.L. & Castro-Piñero, J. Reliability and Validity of Field-Based Tests to Assess Upper-Body Muscular Strength in Children aged 6-12 Years. *Pediatr Exerc Sci* 2016;28(2):331-340.
4. Lopes, V.P., Maia, J.A.R., Rodrigues, L.P. & Malina, R. Motor coordination, physical activity and fitness as predictors of longitudinal change in adiposity during childhood. *Eur J Sport Sci* 2012;12(4):384-391.
5. Malina, R., Bouchard, C. & Bar-Or, O. Growth, Maturation and Physical Activity. Human Kinetics: Champaign, IL, USA 2004.
6. Fang, H., Quan, M., Zhou, T., Sun, S., Zhang, J., Zhang, H., Cao, Z., Zhao, G., Wang, R. & Chen, P. Relationship between Physical Activity and Physical Fitness in Preschool Children: A Cross-Sectional Study. *BioMed Res Int* 2017;1-8.
7. McLellan, G., Arthur, R., Donnelly, S. & Buchan, D.S. Segmented sedentary time and physical activity patterns throughout the week from wrist-worn ActiGraph GT3X accelerometers among children 7-12 years old. *J Sport Health Sci* 2020;9:179-188.
8. Malina, R.M. Physical activity and fitness: Pathways from childhood to adulthood. *Am J Hum Biol* 2001;13(2):162-172.
9. Negash, S., Agyemang, C., Matsha, T.E., Peer, N., Erasmus, R.T. & Kengne, A.P. Differential prevalence and associations of overweight and obesity by gender and population group among school learners in South Africa: A cross-sectional study. *BMC Obes* 2017;4:29-37.
10. Klingberg, S., Draper, C.E., Micklesfield, L.K., Benjamin-Neelon, S.E. & Van Sluijs, E.M.F. Childhood Obesity Prevention in Africa: A Systematic Review of Intervention Effectiveness and Implementation. *Int J Environ Res Public Health* 2019;16:1212-1230.
11. Rad, S.A., Mokhtar, N., Kiwanuka, F. Effect of a Four Weeks Aerobic Training Intervention on Body Fat Percentage and Physical Fitness Indices among 5- to 6-year-

old Obese, Overweight and Normal Weight Children: A Quasi-experimental Study. *Int J Kinesiol Sports Science* 2019;7(1):12-17.

12. Kirsten, A.P., Marais, D. & Schübl, C. The influence of socio-demographic factors on the nutritional status of children in the Stellenbosch area, Western Cape. *South Afri J Clin Nutr* 2013;26(3):124-131.
13. Truter, L., Pienaar, A.E. & Du Toit, D. Relationships between overweight, obesity and physical fitness of nine- to twelve-year-old South African children. *S Afr Fam Pract* 2010;52(3):227-233.
14. Amusa, L.O., Goon, D.T., Amey, A.K. & Toriola, A.L. Health-related physical fitness among young rural primary school children in Tshannda, South Africa. *Sci Res essays* 2011;6(22):4665-4680.
15. Armstrong, M.E.G., Lambert, E.V. & Lambert, M.I. Physical fitness of South African primary school children, 6 to 13 years of age: Discovery Vitality health of Nation study. *Percept Mot Skills* 2011;113(3):999-1016.
16. Du Toit, D., Pienaar, A.E. & Truter, L. Relationship between physical fitness and academic performance in South African children. *S Afr J Res Sport PH Journal* 2011;33(3):23-35.
17. Ruiz, J.R., Casto-Piñero, J., España-Romero, V., Artero, E.G., Ortega, F.B., Cuenca, M.M., Jimenez-Pavón, D., Chillón, P., Girela-Rejón, M.J., Mora, J., Gutiérrez, A., Suni, J., Sjöström, M. & Castillo, M.J. Field-based fitness assessment in young people: The ALPHA health-related fitness test battery for children and adolescents. *Br J Sports Med* 2011;45:518-524.
18. Milosevic, V. & Petrovic, A. Reliability of field-based tests for monitoring and assessing physical fitness in preschool children. *Serb J Sports Sci* 2015;9(1):20-26.
19. Monyeki, M.A., Koppes, L.L.J., Kemper, H.C.G., Monyeki, K.D., Toriola, A.L., Pienaar, A.E. & Twisk, J.W.R. Body composition and physical fitness of undernourished South African rural primary school children. *Eur J Clin Nutr* 2005;59:877-883.
20. Cole, T.J., Bellizzi, M.C., Flegal, K.M. & Dietz, W.H. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240-1246.
21. Tomkinson, G.R., Lang, J.J., Tremblay, M.S., Dale, M., Leblanc, A.G., Belanger, K., Ortega, F.B. & Léger, L. International normative 20 m shuttle run values from 1 142 026 children and youth representing 50 countries. *Br J Sports Med* 2017;51:1545-1554.

22. Kemp, C. & Pienaar, A.E. Relationship between the body composition and motor and physical competence of Grade 1 learners in South Africa. *J Sports Med Phys Fitness* 2013; 53(6): 635-643.
23. Symington, E.A., Gericke, G.J., Nel, J.H. & Labadarios, D. The relationship between stunting and overweight among children from South Africa: Secondary analysis of the National Food Consumption Survey-Fortification Baseline I. *S Afr Med J* 2016;106(1):65-69.
24. Nazario, P.F. & Vieira, J.L.P. Sport context and the motor development of children. *Rev Bras Cineantropom Hum.* 2013: 1-10.

Chapter 6

Research article 3

The effect of active brain-breaks on fundamental movement skills and executive functioning of Grade one children in Cape Town, South Africa

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The effect of active brain-breaks on fundamental movement skills and executive functioning of Grade one children in Cape Town, South Africa

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Abstract

Fundamental movement skills (FMS) are basic movement patterns that serve as the building blocks for movements that are more complex and later needed for participation in sport. Children require their FMS in order to be physically active and potentially reach the 60-minute of moderate-to-vigorous physical activity (MVPA) per day, as proposed by the World Health Organisation (WHO). Unfortunately, children are becoming less active because of increasing sedentary lifestyles. Implementing classroom-based interventions such as active brain-breaks [10-minute bouts of physical activity (PA)] on a daily basis, could potentially assist children to be more active, practise their FMS and most importantly, take a break from academic work. Globally, research emphasises the impact of PA on children's cognitive performance, specifically executive function (EF). Therefore, the aim of the current study was to assess the FMS and EF of Grade 1 (6- to 8-years-old) learners (N=157) in Cape Town, South Africa, before and after 6-week active brain-break intervention. A control (n=53) and experimental (n=104) group took part in the study. FMS were evaluated using the Test for Gross Motor Development (TGMD-2) and EF by means of the Head Toes Knees and Shoulder task (HTKS). The results indicate that the experimental group's overall FMS ($p<0.05$) and EF ($p<0.01$) improved, but not to a statistically significant extent, from pre- to post-test. Object control skills improved significantly better than locomotor skills. The results highlight the importance of exposing Grade 1 learners to FMS and PA bouts during academic lessons, creating opportunities for movement, activeness, development of FMS and enhancement of EF.

Keywords
Movement patterns, classroom-based interventions, cognitive performance, physical activity.

Introduction

The school environment is a well-established setting, as it is safe and ideal to enhance children's physical activity (PA), create healthy habits and develop their fundamental movement skills (FMS) (Wilson et al., 2015). FMS are locomotor, object control and stability skills, which are the basic movement patterns that children between the ages of four and seven years old require (Barnett et al., 2016). However, FMS need to be practised continuously (Barnett et al., 2016); making it crucial for children to master these skills to enable the development of positive PA trajectories throughout life.

Globally, physical education (PE) has lost its status as a stand-alone subject in schools (Draper et al., 2018) and has consequently become marginalised. This has intensified the need to explore the inclusion of classroom-based activities, such as active brain-breaks, to develop FMS and increase PA in children's daily school routines (Egger et al., 2019).

Active brain-breaks consist of short periods of PA that provide a break from academic work during a traditional school lesson. Literature indicates that PA not only promotes positive classroom behaviour, but also enhances children's cognitive function and performance, which can lead to better concentration (Norris et al., 2019). Classroom-based studies have shown active brain-breaks to be beneficial for children's cognition, PA and mental health (Käll et al., 2015). According to Käll et al. (2015), Wilson et al. (2015) and Egger et al. (2019), there is a notable association and growing evidence of a correlation between PA and different aspects of cognition. There is a vital relationship between the motor and cognitive development of an individual, which contributes to executive function (EF). Therefore, a cognitive and motor intervention could enhance these factors (Stein et al., 2017).

EF is an important factor in decision-making and academic achievement (Diamond, 2013). EF signifies the top-down approach of an individual's mental processes that allows goal-directed and precise behaviour, which comprises of three components, namely: (1) *updating* (the ability to keep applicable information in working memory); (2) *inhibition* (the capability to avoid dominant responses); and (3) *shifting* (the ability to change between different tasks) (Diamond, 2013:44; Egger et al., 2019:1). According to Diamond (2013), inhibition is the first attribute that fully develops in children and shifting is the last. Geertsen et al. (2016) and Schmidt et al. (2017) reported a fundamental relationship between EF and PA, and therefore, the implementation of active brain-breaks during academic lessons could have a positive effect on children (Egger et al., 2019).

The implementation of classroom-based interventions could contribute to the 60-minutes of moderate-to-vigorous physical activity (MVPA) per day, as proposed by the WHO, to ensure that children develop healthy habits (Wilson et al., 2015). The two types of classroom activity breaks frequently referred to in literature are: (1) PA, which is integrated during academic lessons; and (2) active breaks that consist of short bouts of PA in between academic lessons (Webster et al., 2015). The majority of the short activity bouts employed in previous research consist of FMS, aerobic exercises, coordination, jogging on the spot, hopping and skipping (Szabo-Reed et al., 2017). When implementing active brain-break interventions, it is important to incorporate more than one focus to ensure that participants are active, execute skills correctly, as well as receive cognitive stimulation (Mulvey et al., 2018). During active brain-breaks, participants often practise the activity or skill and therefore, their concentration and focus could enhance EF (Mulvey et al., 2018). Mulvey et al. (2018) implemented an intervention with preschool learners that focused on the execution of cognitively demanding activities and various gross motor skills (GMS). Exposing children to activity breaks that include a sufficient amount of FMS on a daily basis may be a pragmatic way to help develop FMS proficiency during school hours (Mulvey et al., 2018). However, this remains an unexplored area.

TAKE 10! (Goh et al., 2016) and *Energizers* (Mitchell et al., 2013) are two 10-minute classroom-based PA intervention programmes that were implemented in schools. The results of these studies showed significant improvements in concentration, PA and FMS of young children. In a review undertaken by Carlson et al. (2015), teachers reported that the PA breaks in the classroom, improved the learners' behaviour and academic performance. Another study by Bremer and Cairney (2018) explored three intervention programmes that focused on gross motor skills (GMS), FMS and EF. Bremer and Cairney (2018) reported that participants with good GMS and FMS had better EF, performed better academically and demonstrated better response accuracy and working memory. However, they concluded that additional research was necessary in terms of intervention duration and content (Bremer & Cairney, 2018). To date, only one study has implemented a classroom-based brain-break intervention in the South African context. Mok et al. (2020) conducted a study in primary schools over eight different countries, including SA. This study implemented three- to five-minute active brain-breaks via videos, and determined children's attitudes towards PA by using a questionnaire. Mok and co-authors reported that children in their study had positive attitudes and perceptions toward PA (Mok et al., 2020). Although the study by Mok et al. (2020) demonstrates the practicability of brain-breaks in the South African context, questions remain as to whether such an intervention can help enhance children's FMS and whether active brain-breaks influence EF.

The current study addressed the need for classroom-based active brain-breaks focusing on FMS. Although active brain-break studies to enhance children's PA and cognition have been conducted, no study in SA has examined an FMS active brain-break intervention and the influence thereof on children's FMS and EF. The activities included in the intervention were based on integrated neuromuscular training (INT) programmes, which are based on various essential gross motor skills, such as locomotor and object control skills that increase and strengthen children's FMS (Faigenbaum et al., 2011; Myer & Faigenbaum, 2011; Duncan et al., 2017). Because the developmental trajectories of FMS and EF in primary school children are reasonably similar (Diamond, 2003), there is a correlation between motor and cognitive development according to Roebers and Kauer (2009). It is, however, still important to explore whether an active brain-break intervention, focused on FMS, would have a positive effect on children's FMS and EF. Therefore, the current study sought to investigate the latter in a sample of South African Grade 1 learners aged from six to eight years old. The aim of the study was to assess the children's FMS and EF before and after a 10-minute active brain-break intervention. This six-week intervention were conducted twice a day, two times per week.

Method

Participants

This was a convenience sample. Two schools in the Western Cape Province, South Africa participated in this study. Two classes at each school formed the experimental group and one class, the control group. It was not possible to split one class in the middle for the experimental and control group to have equal participants, and therefore two classes formed the experimental group. Six to eight-year-old children (N=157 [n=90 boys and n=67 girls]) participated in the study. Prior to data collection, ethical clearance was obtained from the Research Ethics Committee Humanoria (#8456) of the institution. Only when parents or legal guardians gave written consent and the children's assent was received, were the selected participants allowed to participate. Participants were included in the study if: they were in Grade one, attended the selected schools, parents completed the informed consent form and the children signed the assent form. Participants were excluded if they: had a hearing or sight impairment, were unwilling to participate in the measurements, had severe medical conditions, for example, heart or ear defect, unable to run or jump or miss more than 30% of the intervention. In the current study, all the participants were eligible to participate.

Design

This article was based on a quasi-experimental study design. Following the pre-test, the experimental group participated in 10-minute active brain-breaks, twice a day, twice weekly and over a period of 6 weeks, resulting in a total of 24 active brain breaks. The first active brain-break took place early in the morning (between 08:15-08:45) and the second one later (10:30-11:00) the same morning. The researcher and two trained assistants presented the intervention, which was designed by the researcher. Because children need to be competent in FMS in order to engage in PA, the active brain-breaks of the current study focussed on locomotor (run, hop, gallop, jump, leap and slide) and object control (strike, dribble, catch, kick, throw and roll) skills. See Table 6.1 for the intervention outline and focuses. The control group continued with their normal day-to-day activities and took part in a PE session presented by their teacher once a week.

Table 6.1. Intervention outline

WEEK	SESSION	WARM-UP (2 MIN)		CORE ACTIVITIES (3 MIN)		COOL DOWN (1-2 MIN)	
1	1-4	**Activities** -Skip in a small circle & on instruction play "Simon Says". -Hands on ground & run with feet. -Crab position & use your hands & touch your feet	**Focus** Cardiovascular	**Activity 1** -Run & jog on the spot (green & red card). -Run & sit on chair. -Run in & around a block (speed varies) -High knees -Run on the command of the whistle & use arms.	**Focus** Run	**Activities** -March on the spot with beanbag & perform instructions. -Caterpillar walk	**Focus** Balance, Coordination & Strength
				Activity 2 -Throw a beanbag in the air & catch. -Throw beanbag in a circle with friends. -Catch small ball. -Throw beanbag & catch with a cone. -Throw & catch beanbag with a cone in pairs.	**Focus** Catch		
2	5-8	**Activities** -Hopscotch varieties. -Jump from side to side. -Run in different directions. -Jumping jacks	**Focus** Cardiovascular & Balance	**Activity 1** -Gallop arms in a train formation. -Gallop varieties in & out of a block. -Gallop in a circle. -Ski hops.	**Focus** Gallop	**Activities** -Core activities -Windmills -Caterpillar walk	**Focus** Balance, Coordination & Strength
				Activity 2 -Step out of a block (pretend to throw) & jump back in. -Step on my friend's feet. -Throw cotton wool. -Throw bean bags with stepping out of a block.	**Focus** Throw		
3	9-12	**Activities** -Fast & slow runs -Rotate beanbag around feet.	**Focus** Cardiovascular	**Activity 1** -Hop over block & land on one foot. -Stand on one foot behind beanbag & swing non-supported foot over & land on that foot. -Jump on a dot & balance on one leg. -Jump over a small cone & land on one foot & balance for 1 second.	**Focus** Leap	**Activities** -Ring-a-rosie -"Simon Says"	**Focus** Balance, Coordination & Strength

WEEK	SESSION	WARM-UP (2 MIN)		CORE ACTIVITIES (3 MIN)		COOL DOWN (1-2 MIN)	
		Activities -Find a beanbag. -Skip in a big circle.	**Focus** Cardiovascular	**Activity 2** -roll ball to a friend. -lunge down to a friend a place a beanbag at their feet. -lunge down & roll a ball in between a friend's foot. -in a circle roll a ball.	**Focus** Roll	**Activities** -Trace the outlines of your body with a beanbag.	**Focus** Balance, Coordination & Strength
4	13-16	**Activities** -Jump on & off a dot. -Run around & on a command stop & freeze. -Pass the beanbag to a friend while balancing on one leg. -Pass the ball under your legs.	**Focus** Cardiovascular & Balance	**Activity 1** -In a block perform a sequence given by a command, slide twice to the right & once to the left. -Slide in a circle following the direction of the arrows. -double leg hops & side lunge. -Fast slides in directions.	**Focus** Slide	**Activities** -Sit with beanbag on the head & lift your feet for 10 seconds. -Plank for 10 seconds. -Stand & sit by asking fun questions. -Robot clap game	**Focus** Balance, Coordination & Strength
				Activity 2 -Strike swinging motion with a small stick. -Pair up & with small stick, do the strike motion & touch your friends back. -Strike a dot. -Strike & step forward & hug yourselves.	**Focus** Strike		
5	17-20	**Activities** -Pair up, back to back & give beanbag under, over & sideways to a friend. -Same as above but on one leg.	**Focus** Cardiovascular & Balance	**Activity 1** -Jump on & off a beanbag. -Stand on the beanbag & jump in directions as indicated. -Bend down & pick-up a beanbag, jump up & turn 180 degrees. -Stand behind the beanbag & go down & make your body as small as an egg & jump up & over the beanbag.	**Focus** Jump	**Activities** -Balance on one leg for as long as possible. -Star jumps.	**Focus** Balance, Coordination & Strength

Table 6.1 (Cont.)

Table 6.1 (Cont.)

WEEK	SESSION	WARM-UP (2 MIN)		CORE ACTIVITIES (3 MIN)		COOL DOWN (1-2 MIN)	
		Activities -Run on the spot & catch & throw a beanbag. -Hop on one leg & on the command freeze & follow the instructions.	**Focus** Cardiovascular & Balance	**Activity 2** -Bounce a ball to a friend. -Bounce & catch a ball without dropping the ball. -Dribble a ball around a square. -Pair up & dribble the ball & bounce to your friend.	**Focus** Dribble	**Activities** -Lie on your back & pretend to ride a bicycle. -Hook feet in with a friend & do sit-up.	**Focus** Balance, Coordination & Strength
6	21-24	**Activities** -Jumping jacks -Scissor jump -Run in a circle & on command jump like a frog. -Hopscotch on the spot.	**Focus** Cardiovascular, Coordination & Balance	**Activity 1** -Green card= balance on one leg & red card = heel-to-toe position. -Green card= frog jumps & red card= balance on non-dominant leg. -Green card= hop on dominant leg in block & red card= heel-to-toe position. -Hop with dominant foot in different blocks placed out.	**Focus** Hop	**Activities** -In a bear position lift up limbs on instruction. -Crab position for 10 seconds. -Caterpillar walk -Superman (aeroplane)	**Focus** Balance, Coordination & Strength
				Activity 2 -Stand behind a cone & kick it. -Stand behind cone & balance on non-dominant leg & kick cone. -Run on the spot behind a cone & on command kick the cone. -In pairs, kick a tennis ball to your friend.	**Focus** Kick		

Procedures

Both FMS and EF were assessed using validated tools, pre- and post-intervention. FMS were assessed with the Test of Gross Motor Development (TGMD-2) (Ulrich, 1985) and EF by using the Head Toes Knees and Shoulders (HTKS) task (Ponitz et al., 2008). All measurements took place in the school halls, and the 6-week active brain-break intervention, which commenced after the pre-test, took place in the classroom at each child's desk or chair or on the carpet in front of the classroom. The researcher made sure that each participant had his or her own equipment needed for each active brain-break. The active brain-break activities were age-appropriate, simple to understand and execute, but complex enough to engage the children's EF.

Measures

Fundamental Movement Skills: TGMD-2

The TGMD-2 is specifically designed for children between 3- and 10-years-old (Ulrich, 1985). It assesses proficiency in two motor-area composites, namely: (1) locomotor; and (2) object control. Each of the composites comprises of specific subtests. The locomotor subtests are: run; hop; horizontal jump; leap; gallop; and slide, whereas object control consists of: striking a stationary ball; stationary dribble; catch; overhand throw; kick; and underhand roll. A clear demonstration was given for each skill and the participants performed one practise trial per skill, followed by two formal test trials as indicated in the TGMD-2 protocol manual (Ulrich, 1985). The scores of each skill obtained in the two formal test trials formed the raw score. Scores for run, hop, horizontal jump, leap, gallop and slide were added to create a locomotor subtest score (0 to 48) and scores for striking a stationary ball, stationary dribble, catch, overhand throw, kick and underhand roll were added to create an object control subtest score (0 to 48). The two subtest scores calculate the final FMS score also known, according to the TGMD-2 guidelines, as the Gross Motor Quotient. The performances of each skill were video-recorded using Samsung tablets (CE0890). On completion, the videos were stored on a memory stick and subsequently slowed down to assess the FMS. The researcher and four assistants, who received training on scoring the TGMD-2, scored the FMS. The latter is in agreement with previous research studies (Barnett et al., 2016; Duncan et al., 2019). Experienced Kinderkineticists performed inter-rater reliability analysis for the TGMD-2[2]. The intra-class correlations (ICC) for the final locomotor and object control score (combined) were 0.88 and the Kendal W, 0.9.

Executive Function

The Head Toes Knees and Shoulders test (HTKS) is a valid and reliable instrument to assess a combination of brain functions, such as inhibitory control, working memory and attention focus of children between 4- and 8-years-old (Ponitz et al., 2008). The inter-rater reliability of this test is 0.90 (Ponitz et al., 2009:610). The HTKS incorporates different aspects of executive functioning (EF) into a game, which can be played with children. The raw score ranges from 0 to 52. This task (HTKS) is a response conflict EF task, which requires the participant to perform the opposite of what is asked. Measurements took place in a one-on-one setting (researcher and participant), in a small hall with no distractions. The HTKS is dependent on the instructions and interaction between the researcher and the participant. This test has three sections and four paired behavioural rules. The researcher demonstrated each

[2] Kinderkinetics is a profession that aims to develop and enhance the total well-being of children between 0-12 years of age, by stimulation, rectifying and the promotion of age specific motor and physical development. The word KINDER refers to the specialization area and KINESES refers to rectifying the child's movements (Pienaar, 2009).

item, for example, “Touch your head”, but instead the participant had to do the opposite and touch his/her toes. To start off, participants had to respond correctly to the following command: “Touch your head”. Thereafter they were instructed to switch rules by doing the opposite of what the researcher instructed. The administration and scoring were performed according to the guidelines of HTKS (Ponitz et al., 2009).

Statistical analysis

All the data was analysed with STATISTICA 13.5. Data was analysed using mixed model ANOVA using “Imer Package in R”. The level of statistical significance was set at less than $p<0.05$. Participants were included in the model as a random effect to take into account the repeated measures component of the experimental design. School, sex, group and time were included as fixed effects, together with all the sex, group*time interaction effects. Sex did not influence the results; therefore, the focus was on the group*time interaction effect, which tested the hypothesis that the change from pre- to post-test was the same for both control and experimental groups. Normal probability plots were inspected for deviations from normality and in cases where deemed necessary, Box-Cox transformations were applied. The Box-Cox results were, however, not much different from the untransformed results, and therefore, only the latter was reported. Fisher least significant difference (LSD) post hoc testing was used to perform pairwise comparisons for the interaction results. The Cohen’s D effect sizes were determined to see if there were any practical differences. Data were analysed by Excel (Microsoft®), Statistica version 13.5 (TIBCO Software Inc., Palo Alto, California, USA).

Results

Fundamental movement skills

The final sample (N=15) comprised 6- to 8-year-olds (M=6.7, SD=0.43). Table 6.2 displays the mean and SD for the pre- and post- test for the control and experimental groups. It is interesting to note that the experimental and control group did not start with the same raw scores for the locomotor skills, which had an influence on the results because the experimental group had a higher starting raw score than the control group and thus had less to improve on.

Table 6.2. Mean and SD for Total FMS scores

Total FMS (0.96) 72 ± 10.9							
Total Locomotor Score (0-48) 35 ± 8.4				**Total Object Control Score (0-48)** 37 ± 5.5			
Locomotor (Control group)		**Locomotor** (Experimental group)		**Object Control** (Control group)		**Object Control*** (Experimental group)	
Pre-test 33 ± 6.9	Post-test 36 ± 4.7	Pre-test 37 ± 5.4	Post-test 37 ± 5.7	Pre-test 38 ± 6.9	Post-test 37 ± 5.4	Pre-test 37 ± 4.8	Post-test 39 ± 4.6
Change (pre to post)* 2.89 ± 6.08 (p=0.01)		Change (pre to post) -0.12 ± 6.77		Change (pre to post) -0.39 ± 6.44		Change (pre to post) 1.73 ± 5.22	
*p=0.01				*p=0.04			

**statistically significant differences*

Between the pre- and post-test, a statistically significant difference ($p<0.05$) was found for the FMS of all the children. However, when separated, the two groups (experimental and control), displayed no statistically significant difference from the pre- to post-test. There was a change from the pre- to post-test ($p=0.01$) for the control group in their locomotor skills, for the experimental group there was no change. The Cohen's D effect sizes indicate a medium practical difference (0.46) from pre-to post-testing between the two groups. For the object control skills there was a change from the pre- to post-test ($p=0.04$) in the experimental group, however there was no change for the control group. For the object control skills, from pre- to post-testing between the two groups there was a small practical difference (0.37). The raw FMS score calculated using the locomotor and object control scores for the pre-and post-test of the experimental and control groups, as well as the SD, are presented in Figure 6.1. The total pre-test score for the control group was 72 and for the post-test 75; the experimental group's pre-test score was 74 compared to 76 in the post-test.

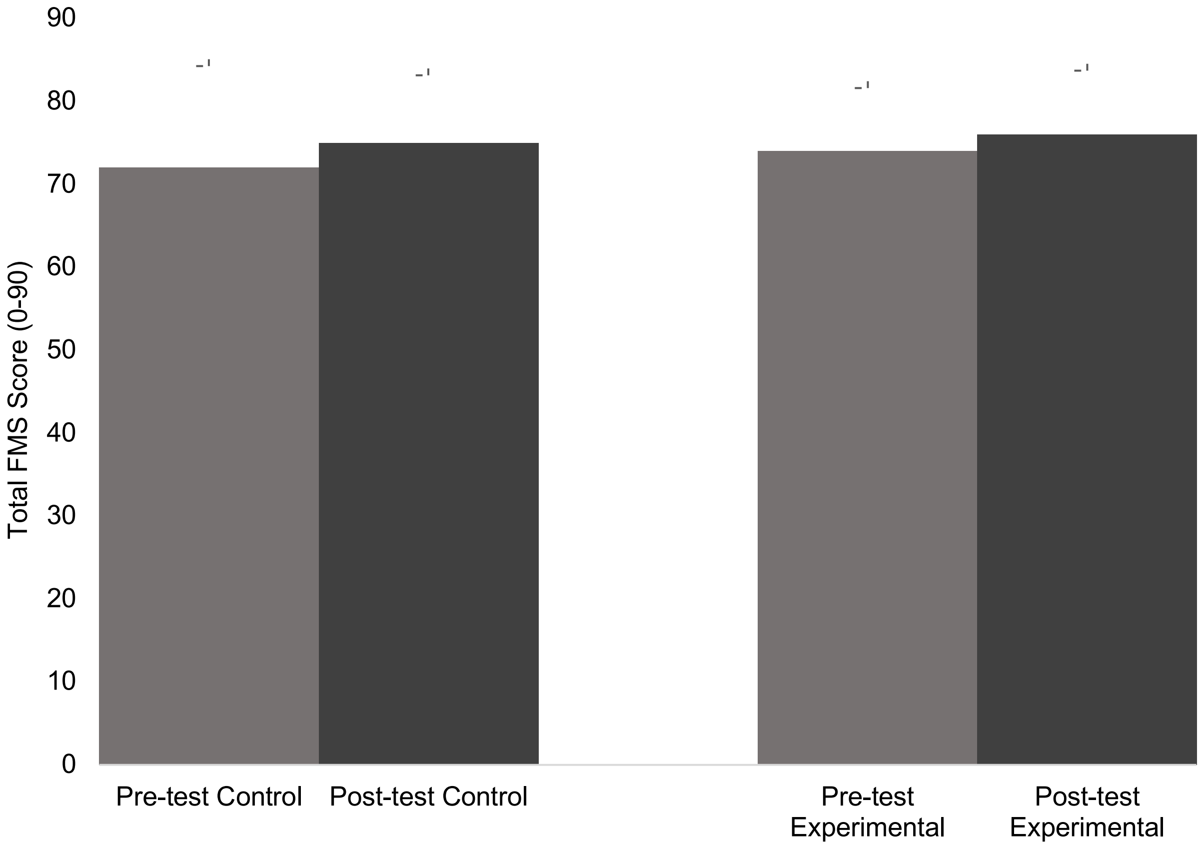

Figure 6.1. Raw Total FMS score and SD of the pre- and post-test

Figure 6.2 shows the raw locomotor and object control scores, as well as the SD for the experimental and control groups' FMS. The control group's locomotor score for the pre-test was 33 ± 6.9 and the post-test was 36 ± 4.7, whereas the experimental group had a pre-test score of 37 ± 5.4 and a post-test score of 37 ± 5.7. For object control, the control group's pre-test score was 38 ± 6.9 and the post-test score 37 ± 5.4 and for the experimental group the pre-test score was 37 ± 4.8 and the post-test score 39 ± 4.6.

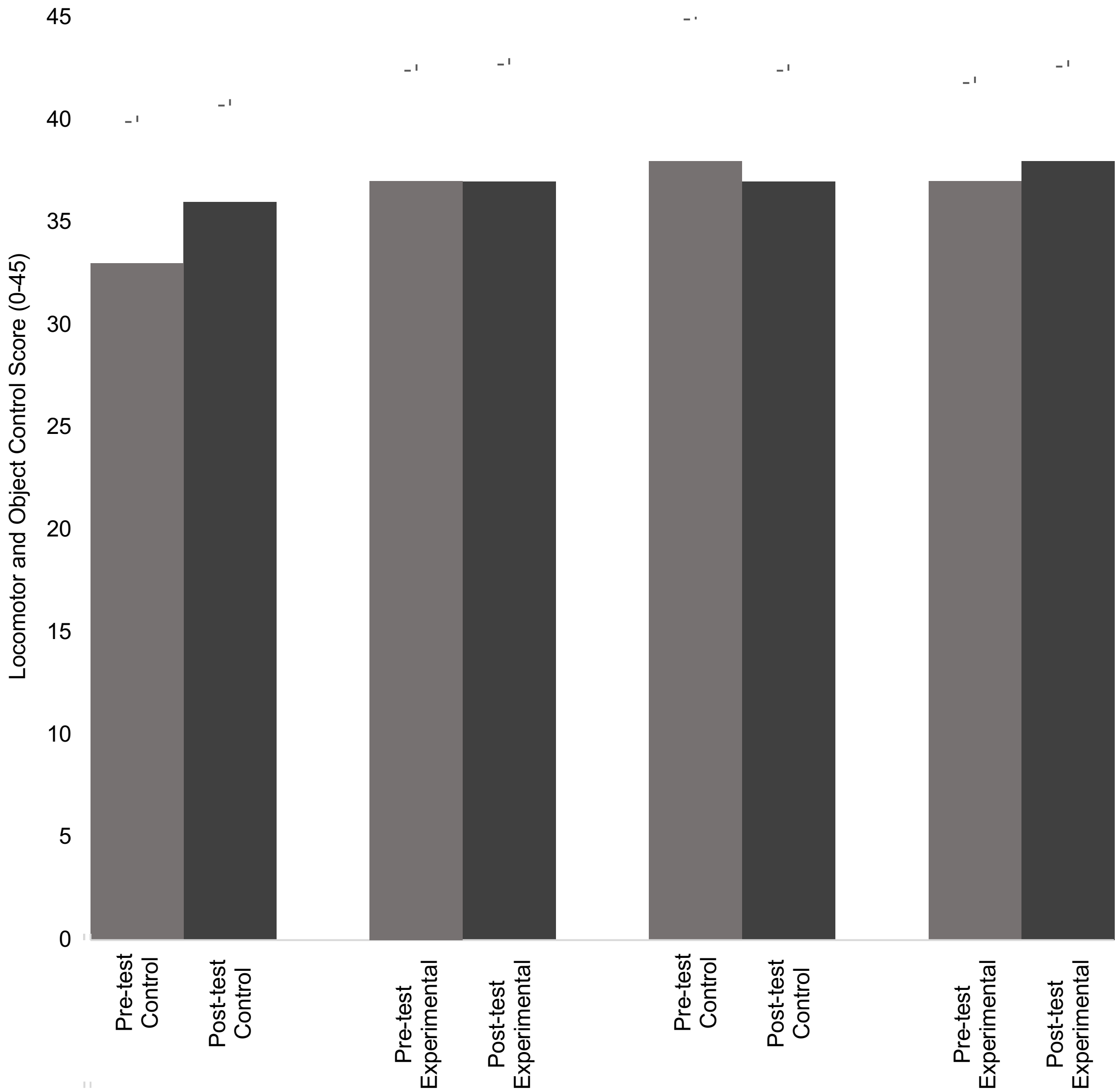

Figure 6.2. Raw locomotor and object control scores from pre- to post-test

The total locomotor score indicated a statistically significant difference (p=0.05) between the experimental and control groups. Thus, there was an interaction effect from pre- to post-test because the scores were not the same for the experimental and control groups. For the locomotor skills, a statistically significant difference was observed in leap (p<0.05), with a small practical difference (0.36), jump (p<0.05), with a small practical difference (0.33) and slide (p<0.05), with a small practical difference

(0.37) between the experimental and control groups. The experimental group showed a greater increase from pre- to post-test than the control group. In the object control skills, a statistically significant difference was exhibited in strike ($p<0.05$), with a small practical difference (0.3), for the experimental group from pre- to post-test, as well as in dribble ($p<0.05$), with a small practical difference (0.21), kick ($p<0.05$), with small practical difference (0.3) and roll ($p<0.05$), with a negligible practical difference (0.09) for both the experimental and control groups from pre- to post-test.

Executive function

The results showed a statistically significant difference ($p<0.01$) between the experimental and control groups from pre- to post-test, the Cohen's D effect sizes indicate a medium practical difference (0.4). The results signified a main effect, as both groups increased significantly, to the same extent. Table 6.3 displays the mean and SD of both groups.

Table 6.3. Mean and SD for Final Scores of HTKS

FINAL SCORE (0-52)	MEAN	SD
Pre-test Score (Experimental Group)	39	11.9
Pre-test Score (Control Group)	40	9.7
Post-test Score (Experimental Group)	46	8.7
Post-test Score (Control Group)	45	8.2

Discussion

The current study presents results detailing the FMS and EF of a group of Grade 1 learners in the Cape Town, South Africa before and after an active brain-break intervention. This is the first study in South Africa to implement an active brain-break intervention focusing on FMS and EF. Therefore, it is difficult to compare the results to prior work because no previous studies have examined this phenomenon in the same way. Importantly, the current study demonstrates a definite place for active brain-breaks in the South African school curriculum, a context that is underrepresented in the literature. Although not all the results demonstrated a significance, the active brain-breaks could potentially on a long-term basis be very beneficial for children. On daily basis children would get exposure to FMS and PA, get the opportunity to practice their skills and take a break from academic work. The active brain-breaks could also be a good substitute for PE and contribute to the 60-minutes of MVPA per day recommended by the WHO.

The key findings of the present study indicate that although the experimental group's overall FMS score from pre- to post-test increased slightly, it was not significant. The control group's overall score decreased and it could be speculated that because these participants received no exposure to the intervention, they could have lost motivation because they were not included in the experimental group. For the locomotor composite, the experimental group's pre- and post-test score remained the same, indicating that the intervention did not have an effect on locomotor skills. Van Capelle et al. (2017) contend that FMS interventions have a greater effect on object control than locomotor skills because children between 3 and 6 years of age tend to have generally lower scores in object control. According to Van Capelle et al. (2017), this could be because of greater standards in locomotor skills at baseline in comparison to object control skills. For the object control subtest in the current study, the experimental group's score increased from pre- to post-test, however, the difference was not statistically significant.

To the researcher's knowledge, only one other international study in the USA has implemented an FMS and cognitive intervention to date and used the TGMD-2 and HTKS to evaluate the participants' performance (Mulvey et al., 2018). Because

Mulvey and colleagues did not make use of an active brain-breaks intervention and the duration of the sessions differed, it is difficult to compare their results to the results of the current study. The experimental group of the current study showed an increase in object control from pre- to post-test, which is similar to the findings of Mulvey et al. (2018). Studies conducted by Whitt-Glover et al. (2011), Wilson et al. (2015) and Stein et al. (2017), had comparable approaches to the current study, but different methodologies, testing instruments and intervention focuses. Stein et al. (2017) investigated the correlation between motor competence and EF of kindergarten children using similar intervention activities compared to the current study. According to Stein et al. (2017) there were positive correlations between motor competence and EF from the pre- to post-test.

Comparable to the current study, Whitt-Glover et al. (2011) and Wilson et al. (2015) implemented a similar approach of 10-minute active brain-break interventions. Wilson et al. (2015) concluded that there was no effect on the participants' on-task behaviour and attention; however, the active brain-breaks contributed towards the recommended daily PA and showed no disruption towards classroom work. Whitt-Glover et al. (2011) found that the participants' PA increased, as well as their on-task behaviour. Both of the above studies did not make use of an FMS intervention, but monitored the participants' PA patterns in order to see whether their moderate-to-vigorous physical activity (MVPA) improved or not.

In the current study, there were statistically significant increases in EF from the pre- to post-test in both groups, although the experimental group showed a greater magnitude of change compared to the control group. Stein et al. (2017) performed two different EF tests, namely the "Simon-says" and "Hearts-and-Flowers" task in their study. They reported that the experimental group showed an increase in inhibitory control. Stein et al. (2017) concluded that children who participate in group interventions, place more demand on their cognitive functions because they have to adapt their own behaviour to that of their classmates and they need to concentrate more on the activities. Therefore, group interventions can possibly provide better EF results than one-on-one situations because more demands are placed on the children's cognitive functions (Stein et al., 2017). Mulvey et al. (2018) concluded that the HTKS is a good assessment tool to use for a gross motor skill intervention. Mulvey and colleagues found that FMS interventions had a positive effect on EF, which corresponds with the current study's results, because the experimental group of the current study demonstrated an overall increase in FMS and EF.

Although the HTKS test is documented as a valid and reliable measuring instrument of overall EF in 6- to 8-year-old children, it is recognised that, in the current study, it only provided an overall measure of EF, which might be considered blunt. Consequently, individual measurements of working memory, inhibitory control and attention focus were not determined in the current study. This should be considered as a future priority to enable researchers to understand that active brain-breaks have different effects on different aspects of EF. It is also worth noting that performing multiple assessments on EF in a school setting may be challenging, and therefore the HTKS task is a popular measuring instrument to use in a school setting. According to the results of the EF, the researcher can only speculate about a possible ceiling or learning effect when observing the differences between the two groups during the pre- and post-testing. In the current study, there might have been individual differences with the timing of engagement in the intervention sessions and some participants might have been active for the whole 10-minutes and others not, although the researcher and assistants gave continuous verbal feedback and encouragement to keep them active and focussed throughout. It is recommended that future research should track participants during the intervention to determine the actual activity level of each participant.

Conclusions

This study demonstrated that a 6-week active brain-break intervention increased the raw FMS and EF scores in 6- to 8-year-old children. Object control skills improved to a greater extent than locomotor skills, and thus it could be suggested that the active brain-breaks had a greater effect on the children's object control skills. Therefore, it is recommended that in the future, the duration of the intervention should be longer, at least 8 to 12 weeks. The studies of Stewart et al. (2014), Liu et al. (2007) and Whitt-Glover et al. (2011) implemented interventions between 8-12 weeks and received significant results. The reason for this is that the children can get more exposure to the activities and an opportunity to practice the FMS more regularly. It is also advised that children should participate in regular (every school day if possible) active brain-breaks. An increase in the frequency of the sessions could also contribute to children's FMS and EF. The study showed that it was practically possible to implement and conduct a classroom-based active brain-breaks intervention focusing on FMS in South African schools. It could, therefore, create an opportunity for children to be active in the classroom and to practise their FMS at the same time. Introducing children to active brain-breaks on a daily basis could possibly contribute to their FMS proficiency, give them exposure where they perhaps would not have received any other form of PA and provide a short break from academic work in order to enhance their concentration. More emphasis should be placed on locomotor skills, because the least improvement was reported in this area. It would be recommended to revise the locomotor activities in the intervention to ensure that the available space is optimally utilized. In order to improve locomotor skills, it is necessary to practice and teach techniques of the skills, learn timing and coordination, partake in cardiovascular, strength and balance exercises and to encourage and motivate children. Teachers, parents, coaches and therapists should use active brain-breaks to assist, encourage and motivate children to be more active inside and outside the classroom to enhance FMS and EF and counteract sedentary behaviour among children.

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REFERENCES

Barnett LM, Stodden D, Cohen KE, Smith JJ, Lubans DR, Lenoir M, Iivonen S, Miller AD, Laukkanen A, Dudley D, Lander NJ, Brown H and Morgan PJ (2016) Fundamental Movement Skills: An Important Focus. *Journal of Teaching in Physical Education* 35(3): 219-225.

Bremer E and Cairney J (2018) Fundamental Movement Skills and Health-Related Outcomes: A Narrative Review of Longitudinal and Intervention Studies Targeting Typically Developing Children. *American Journal of Lifestyle Medicine* 12(2): 148-159.

Carlson JA, Engelberg JK, Cain KL, Conway TL, Mignano AM, Bonilla EA, Geremia C and Sallis JF (2015) Implementing classroom physical activity breaks: Association with student physical activity and classroom behaviour. *Preventive Medicine* 81: 67-72.

Diamond A (2003) Close interrelation of Motor Development and Cognitive Development and of the Cerebellum and Prefrontal Cortex. *Child Development* 71: 44-56.

Diamond A (2013) Executive functions. *Annual Review of Psychology* 64: 135-168.

Draper CE, Tomaz SA, Bassett SH, Burnett C, Christie CJ, Cozett C, De Milander M, Krog S, Monyeki A, Naidoo N, Naidoo R, Prioreschi A, Walter C, Watson E and Lambert EV (2018) Results from South Africa's 2018 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health* 15(2): 406-408.

Duncan MJ, Eyre ELJ and Oxford SW (2017) The effects of 10 weeks Integrated Neuromuscular Training on fundamental movement skills and physical self-efficacy. *Journal of Strength and Conditioning* 32(12): 1–32.

Duncan MJ, Roscoe CMP, Noon M, Clark CCT, O'Brien W and Eyre ELJ (2019) Run, jump, throw and catch: How proficient are children attending English schools at the fundamental motor skills identified as key within the school curriculum? *European Physical Education Review* 1-29.

Egger F, Benzing V, Conzelmann A and Schmidt M (2019) Boost your brain, while having a break! The effects of long-term cognitively engaging physical activity breaks on children's executive functions and academic achievement. *Public Library of Science Journal* 14(3): 1-20.

Faigenbaum AV, Farrell A and Fabiano M (2011) Effects of Integrative Neuromuscular Training on Fitness Performance in Children. *Pediatric Exercise Science* 23: 573-584.

Geertsen S, Thomas R, Larsen MN, Dahn IM, Andersen JN, Krause-Jensen M, Korup V, Nielsen CM, Wienecke J, Ritz C, Krustrup P and Landbye-Jensen J (2016) Motor skills and exercise capacity are associated with objective measures of cognitive functions and Academic Performance in Preadolescent Children. *Public Library of Science Journal* 11(8): 1-16.

Goh TL, Hannon J, Webster C, Podlog L and Newton M (2016) Effects of a TAKE 10! Classroom-Based Physical Activity Intervention on Third-to Fifth-Grade Children's On-task Behaviour. *Journal of Physical Activity and Health* 13: 712-718.

Käll LB, Malmgren H, Olsson E, Lindén T and Nilsson M (2015) Effects of a Curricular Physical Activity Intervention on Children's School Performance, Wellness, and Brain Development. *Journal of School Health* 85(10): 704-713.

Myer GD and Faigenbaum AV (2011) Exercise is sports medicine in youth: Integrative neuromuscular training to optimize motor development and reduce risk of sports related injury. *Pediatric Physical Activity* 1: 39-48.

Mitchell B, Maclennan S, Latimer K, Graham D, Gilmore J and Rush E (2013) Improvement of fundamental movement skills through support and mentorship of classroom teachers. *Obesity Research and Clinical Practice* 7: 230-234.

Mok MMC, Chin M, Korcz A, Popeska B, Edginton CR, Uzunoz FS, Podnar H, Coetzee D, Georgescu L, Emeljanovas A, Pasic M, Balasekaran G, Anderson E and Durstine JL (2020) Brain Breaks Physical Activity Solutions in the Classroom and on Attitudes toward Physical Activity: A Randomized Controlled Trial among Primary Students from Eight Countries. *International Journal of Environmental Research and Public Health* 17: 1666-1677.

Mulvey KL, Taunton S, Pennell A and Brian A (2018) Head, Toes, Knees, SKIP! Improving Preschool Children's Executive Function through a Motor Competence Intervention. *Journal of Sport and Exercise Psychology* 40: 233-239.

Norris E, Van Steen T, Direito A and Stamatakis E (2019) Physically active lessons in school and their impact on physical activity, educational, health and cognition outcomes: A systematic review and meta-analysis. *British Journal of Sports Medicine* 0: 1-14.

Ponitz CC, Macclelland MM, Jewkes AM, Connor CM, Farris CL and Morrison FJ (2008) Touch your toes! Developing a direct measure of behavioural regulation in early childhood. *Early Childhood Research Quarterly* 23: 141-158.

Ponitz C, Macclelland M and MORRISON JA (2009) Structured Observation of Behavioural Self-Regulation and Its Contribution to Kindergarten Outcomes. *Developmental Psychology* 45(3): 605-619.

Roebers CM and Kauer M (2009) Motor and Cognitive Control in a Normative Sample of 7-year-olds. *Developmental Science* 12: 175-181.

Schmidt M, Egger F, Benzing V, Jäger K, Conzelmann A, Roebers CM and Pesce C (2017) Disentangling the relationship between children's motor ability, executive function and academic achievement. *Public Library of Science Journal* 12(8): 1-20.

Stein M, Auerswald M and Ebersbach M (2017) Relationship between Motor and Executive Functions and the Effect of an Acute Coordinative Intervention on Executive Functions in Kindergartens. *Frontiers in Psychology* 8: 1-14.

Szabo-Reed AN, Willis EA, Lee J, Hillman CH, Washburn RA and Donnelly JE (2017) Impact of 3 years of classroom physical activity bouts on time-on-task behaviour. *Journal of Medicine and Science in Sport and Exercise* 49(11): 2343-2350.

Ulrich DA (1985) *Test of Gross Motor Development*, 2nd ed. Austin, TE: Pro-ed.

Van Capelle A, Broderick CR, Van Doorn N, Ward RE and Parmenter BJ (2017) Interventions to improve fundamental movement skills in pre-school aged children: A systematic review and meta-analysis. *Journal of Science and Medicine in Sport* 1-9.

Webster CA, Russ L, Vazou S, Goh TL and Erwin H (2015) Integrating movement in academic classrooms: Understanding, applying and advancing the knowledge base. *Obesity Reviews* 16(8): 691-701.

Whitt-Glover MC, Ham SA and Yancey AK (2011) Instant Recess: A Practical Tool for Increasing Physical Activity during the School Day. *Progress in Community Health Partnerships: Research, Education, and Action* 5: 289-297.

Wilson AN, Olds T, Lushington K, Petkov J and Dollman J (2015). The impact of 10-minute activity breaks outside the classroom on male students' on-task behaviour and sustained attention: A randomised crossover design. *The Journal of Paediatrics* 1-8.

Chapter 7

Research article 4

The effect of active brain-breaks during a typical school day on the in-school physical activity patterns of Grade 1 children in Belville region, South Africa

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The effect of active brain-breaks during a typical school day on the in-school physical activity patterns of Grade 1 children in the Belville region, Western Cape

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Abstract

Background: Establishing the physical activity (PA) patterns of children during a school day can potentially give researchers, teachers and therapists a better understanding of children's PA patterns. Implementing PA interventions during a school day can help children to reach the 60 minutes of moderate-to-vigorous PA (MVPA), as recommended by the World Health Organization (WHO). The aim of the current study was to investigate the impact of classroom PA active brain-breaks on the in-school activity levels of Grade 1 (6- to 8-years-old) learners (N=48) by comparing baseline results to the intervention PA patterns of the participants.

Methods: Children wore Actigraphs (counts per minute) for five consecutive school days so that their PA patterns could be monitored, and thereafter they participated in a six-week active brain-breaks [10-minute bouts of PA] intervention.

Results: The results indicated that on a typical school day, children spend an average of 106.2 ± 30.9 minutes in sedentary behaviour, 43.7 ± 13.7 minutes in moderate PA and 26.5 ± 13.6 minutes in vigorous PA. No differences were found between boys and girls. During the intervention the children's sedentary behaviour decreased and their vigorous PA increased.

Conclusion: The participation of the children in the active brain-breaks intervention decreased their sedentary behaviour and increased their vigorous PA. The results emphasise the importance of participation in daily FMS and PA in order to increase Grade 1s' in-school PA patterns and decrease sedentary behaviour.

Keywords

Physical activity, sedentary, interventions, moderate-to-vigorous PA, monitor, physical activity patterns.

Introduction

The physical activity (PA) guidelines proposed by the World Health Organization (WHO) recommend that children should participate in 60 minutes of moderate-to-vigorous physical activity (MVPA) per day.[1] South Africa's 2018 Report Card on Physical Activity for Children and Youth reported that between 48 and 51.7% of children meet the 60-minute requirement of MVPA per day.[2] Furthermore, Cooper,[3] concluded that less than 40% of children between the ages of 9- to 10-years-old in 10 different countries meet the daily recommended guidelines. According to the WHO, these recommended guidelines play an important role in children's movement behaviours, development and the prevention and management of childhood obesity and non-communicable diseases.[4] According to Müller,[5] a great portion of South African school children are overweight and obese. There is a positive relationship between PA, health and the overall well-being of a child,[1] and therefore, it is crucial to ensure that children participate in PA to decrease inactivity. This means that there remains concern to examine effective ways to enhance children's PA.[2]

Walter,[6] measured the in-school PA patterns of South African children during school time (five consecutive school days) using Actigraph accelerometers. The results indicate that children spend 35 minutes of their school day participating in MVPA, which contributes to 58% of the daily-recommended guidelines. Another South African study explored the PA patterns of children and concluded that boys were more active than girls.[7] Tomaz,[8] also measured the PA patterns of South African children using Actigraph accelerometers and concluded that children participated in 37 minutes of MVPA per day. The majority of the children in Tomaz's,[8] study met the daily recommended guidelines of MVPA. Tremblay,[9] purport that although global efforts have been implemented to increase PA and decrease sedentary time, the issue remains a challenge for governments, schools, therapists, teachers and parents.

Schools present an ideal environment for the implementation of PA and classroom-based interventions that can potentially enhance children's in-school PA levels and contribute to the recommended guidelines as stipulated by the WHO.[10] Primary school children spend an average of six hours per day at school, and 65% of this time is spent being sedentary,[11] Clemes,[12] also contend that many children are sedentary during a typical school day as they sit most of the time. The school environment can, therefore, be the hub where interventions can be implemented in order to make a difference in children's PA levels.[13] Children who adopt sedentary behaviour are more likely to experience cardio metabolic risk factors and lower self-esteem, as well as possible lower cognitive development.[14] School-based interventions can also possibly decrease risk factors for the development of chronic diseases.[5] As researchers, teachers, parents and therapists try to increase the PA levels of children during and after school hours, there is a necessity to monitor the PA patterns of children during the day.[15] Monitoring children's PA patterns can provide an indication of whether children participate in an adequate amount of PA during the day. Additionally, monitoring their PA patterns can determine the effect of PA interventions on children's PA levels.[15] In South Africa, school children are exposed to daily lunch breaks where they can play, as well as participate in physical education (PE) class once per week (between 40-45 minutes). However, the stand-alone status of PE as a school subject is unfortunately losing its importance in South African schools.[2] Therefore, the need to investigate the implementation of classroom-based activities, such as active brain-breaks, could possibly enhance children's fundamental movement skills (FMS) and increase PA.[16]

Active brain-breaks are short bouts of PA without educational content, which take place inside a classroom.[17] During active brain-breaks, children participate in a variety of PA in the classroom that provide an opportunity to take a short break from academic work and potentially increase their in-school PA levels.[18, 19] By monitoring active brain-break interventions, the current study could provide an indication whether any changes took place in the PA levels of children during a typical school day. Objective measurements such as accelerometers were used to monitor children's PA patterns, as well as to establish time spent being sedentary and/or in MVPA. This has become a more feasible and objective method than questionnaires and self-reported measurements.[20]

Accelerometers, which measure the acceleration of body segments, can be worn on the hip, waist or wrist. In the literature, there is disagreement about whether hip- or wrist- worn placements are more accurate. Studies undertaken by Fairclough,[21] and Berglind and Tynelius,[22] purports that the hip placement is more reliable. However, Noonan,[23] found that wrist-worn devices presented more reliable results and children found them to be more comfortable than hip-worn devices. What is crucial is not only the placement of the device but also the classification of sedentary behaviour, moderate and vigorous PA. In some cases, sedentary time can be overestimated and MVPA underestimated or vice versa, or irregular PA data can be collected. Therefore, researchers face challenges when it comes to the appropriate classification of sedentary time and how to quantify it.[9] Migueles,[20] provide guidance to researchers regarding the placement of accelerometers, as well as different cut-points (time spent in sedentary behaviour, moderate and vigorous PA), that can be used. Research has shown that PA enhances children's cognitive function and academic performance.[24] Implementing classroom-based PA interventions, such as active brain-breaks could potentially help children to be more active during the day, decrease sedentary time in the classroom, improve PA, enhance attention and on-task behaviour, as well as improve academic achievement.[14,25] To date, only one study has implemented a classroom-based brain-break intervention in South Africa.[26] The aforementioned study examined a three- to five-minute active brain-break intervention (twice a day, five days a week over a four month period) via videos and determined the children's attitudes toward PA by using a questionnaire.[26] The most important finding from the study of Mok[26] was that the PA breaks improved the children's attitude toward PA.

The current study focused on a classroom-based active brain-break intervention with the focus on FMS. The reason for choosing FMS and not merely PA was because the development of FMS is vital for children between the ages of 4- to 6-years-old.[27] A good FMS foundation can over time lead to the development of PA that is in line with the Stodden model. [28] No study in SA has investigated an FMS active brain-break intervention and the effect it has on children's PA levels during a school day. The activities of the intervention were based on integrated neuromuscular training (INT) programmes, which are based on various essential gross motor skills, such as locomotor and object control skills (FMS).[29, 30]

The purpose of this study was to investigate the impact of classroom PA brain-breaks on the in-school activity levels of Grade 1 children by comparing baseline results to the intervention PA patterns of the participants.

Methods

Participants

Following institutional approval (#8456) from the Research Ethics Committee (REC) of the institution involved and the Education Department of the region, six to eight year old children from a school in the Western Cape Province, South Africa, (N=48 [n=28 boys and n=20 girls]), volunteered to participate in the current study. Written consent from the parents/ legal guardians and assent from the children were obtained prior to participation. The school had three Grade 1 classes; two classes formed the experimental group. Participants were included in the study if: they were in Grade one, attended the selected schools, parents completed the informed consent form and the children signed the assent form. Participants were excluded if they: had a hearing or sight impairment, were unwilling to participate in the measurements, had severe medical conditions, for example, heart or ear defect, unable to run or jump or miss more than 30% of the intervention.

Procedures

The data collection and intervention took place at the specific school. Accelerometers monitored the children's in-school PA patterns during five consecutive school days before the intervention started (baseline testing), as well as on four days during the intervention. The devices were placed on the children's dominant wrist at 08:00 in the morning and were taken off at 13:00 in the afternoon. Each monitor had a unique code to ensure each child wore the same monitor every day. The researcher kept a daily log book of the exact times the accelerometers where placed on and taken off in order to make the non-wear time easy recognizable during the data analysis.

Intervention

This was a Comparative Effectiveness Research design (CER) (pre- post-test design with no control group) as well as a descriptive study design. The two experimental classes participated in a 10-minute classroom-based active brain-break intervention twice a week over 6 weeks, which added up to 24 active brain-breaks. The first active brain-break took place early in the morning (between 08:15 – 08:45) and the second one later in the morning (between 10:30 – 11:00). The active brain-breaks took place in the classroom behind each child's desk/chair or on the carpet. The researcher and two assistants were present at each session to explain the activities, assist the children where necessary and to ensure that the children participated in all the activities.

The self-designed active brain-breaks were based on integrated neuromuscular training (INT) programmes and incorporated locomotor and object control skills with the aim of enhancing and strengthening children's FMS and physical fitness levels.[30] See Table 7.1 for the intervention outline and focuses. Two FMS (Table 7.1) were chosen each week. Recognising that FMS such as leap, gallop and slide are more difficult to master inside a classroom, specific attention was given to activities that attempted to develop these skills.

Accelerometery

Children's PA was measured using a wrist-worn Actigraph GT3X+ accelerometer (Actigraph LLC, Pensacola, FL; USA). Each device was programmed to capture data from 08h00 on Monday to 13h00 on Friday. The ActiLife version 16.13.4 (ActiLife LLC, Pensacola, FL; USA) was used to initialize and download in 5-second epochs, as well as to clean and score all data. The researcher made sure each participant wore the device during the day. The time that the children did not wear the device (between 13:30 to 08:00) was erased after data collection to avoid non-wear or sedentary time. Only data recorded from 08:00 to 13:00 was considered as a valid day and was considered for analysis. The devices were initialized to capture data in 100Hz and the low-frequency extension was not enabled. Cut-points of Crouter,[31] were used to determine the different intensities of PA. Sedentary <275, light physical activity (LPA) were between 276-415 counts per 5-seconds, moderate physical activity (MPA) between 461 and 777 counts per 5-seconds and vigorous physical activity (VPA), <778 counts per 5-seconds.[31]

TABLE 7.1. INTERVENTION OUTLINE

WEEK	SESSION	WARM-UP (2 MIN)		CORE ACTIVITIES (3 MIN)		COOL DOWN (1-2 MIN)	
1	1-4	**Activities** -Skip in a small circle & on instruction play "Simon Says". -Hands on ground & run with feet. -Crab position & use your hands & touch your feet	**Focus** Cardiovascular	**Activity 1** -Run & jog on the spot (green & red card). -Run & sit on chair. -Run in & around a block (speed varies) -High knees -Run on the command of the whistle & use arms.	**Focus** Run	**Activities** -March on the spot with beanbag & perform instructions. -Caterpillar walk	**Focus** Balance, Coordination & Strength
				Activity 2 -Throw a beanbag in the air & catch. -Throw beanbag in a circle with friends. -Catch small ball. -Throw beanbag & catch with a cone. -Throw & catch beanbag with a cone in pairs.	**Focus** Catch		
2	5-8	**Activities** -Hopscotch varieties. -Jump from side to side. -Run in different directions. -Jumping jacks	**Focus** Cardiovascular & Balance	**Activity 1** -Gallop arms in a train formation. -Gallop varieties in & out of a block. -Gallop in a circle. -Ski hops.	**Focus** Gallop	**Activities** -Core activities -Windmills -Caterpillar walk	**Focus** Balance, Coordination & Strength
				Activity 2 -Step out of a block (pretend to throw) & jump back in. -Step on my friend's feet. -Throw cotton wool. -Throw bean bags with stepping out of a block.	**Focus** Throw		
3	9-12	**Activities** -Fast & slow runs -Rotate beanbag around feet.	**Focus** Cardiovascular	**Activity 1** -Hop over block & land on one foot. -Stand on one foot behind beanbag & swing non-supported foot over & land on that foot. -Jump on a dot & balance on one leg. -Jump over a small cone & land on one foot & balance for 1 second.	**Focus** Leap	**Activities** -Ring-a-rosie -"Simon Says"	**Focus** Balance, Coordination & Strength

WEEK	SESSION	WARM-UP (2 MIN)		CORE ACTIVITIES (3 MIN)		COOL DOWN (1-2 MIN)	
		Activities -Find a beanbag. -Skip in a big circle.	**Focus** Cardiovascular	**Activity 2** -roll ball to a friend. -lunge down to a friend a place a beanbag at their feet. -lunge down & roll a ball in between a friend's foot. -in a circle roll a ball.	**Focus** Roll	**Activities** -Trace the outlines of your body with a beanbag.	**Focus** Balance, Coordination & Strength
4	13-16	**Activities** -Jump on & off a dot. -Run around & on a command stop & freeze. -Pass the beanbag to a friend while balancing on one leg. -Pass the ball under your legs.	**Focus** Cardiovascular & Balance	**Activity 1** -In a block perform a sequence given by a command, slide twice to the right & once to the left. -Slide in a circle following the direction of the arrows. -double leg hops & side lunge. -Fast slides in directions.	**Focus** Slide	**Activities** -Sit with beanbag on the head & lift your feet for 10 seconds. -Plank for 10 seconds. -Stand & sit by asking fun questions. -Robot clap game	**Focus** Balance, Coordination & Strength
				Activity 2 -Strike swinging motion with a small stick. -Pair up & with small stick, do the strike motion & touch your friends back. -Strike a dot. -Strike & step forward & hug yourselves.	**Focus** Strike		
5	17-20	**Activities** -Pair up, back to back & give beanbag under, over & sideways to a friend. -Same as above but on one leg.	**Focus** Cardiovascular & Balance	**Activity 1** -Jump on & off a beanbag. -Stand on the beanbag & jump in directions as indicated. -Bend down & pick-up a beanbag, jump up & turn 180 degrees. -Stand behind the beanbag & go down & make your body as small as an egg & jump up & over the beanbag.	**Focus** Jump	**Activities** -Balance on one leg for as long as possible. -Star jumps.	**Focus** Balance, Coordination & Strength

Table 7.1 (Cont.)

Table 7.1 (Cont.)

WEEK	SESSION	WARM-UP (2 MIN)		CORE ACTIVITIES (3 MIN)		COOL DOWN (1-2 MIN)	
		Activities -Run on the spot & catch & throw a beanbag. -Hop on one leg & on the command freeze & follow the instructions.	**Focus** Cardiovascular & Balance	**Activity 2** -Bounce a ball to a friend. -Bounce & catch a ball without dropping the ball. -Dribble a ball around a square. -Pair up & dribble the ball & bounce to your friend.	**Focus** Dribble	**Activities** -Lie on your back & pretend to ride a bicycle. -Hook feet in with a friend & do sit-up.	**Focus** Balance, Coordination & Strength
6	21-24	**Activities** -Jumping jacks -Scissor jump -Run in a circle & on command jump like a frog. -Hopscotch on the spot.	**Focus** Cardiovascular, Coordination & Balance	**Activity 1** -Green card= balance on one leg & red card = heel-to-toe position. -Green card= frog jumps & red card= balance on non-dominant leg. -Green card= hop on dominant leg in block & red card= heel-to-toe position. -Hop with dominant foot in different blocks placed out.	**Focus** Hop	**Activities** -In a bear position lift up limbs on instruction. -Crab position for 10 seconds. -Caterpillar walk -Superman (aeroplane)	**Focus** Balance, Coordination & Strength
				Activity 2 -Stand behind a cone & kick it. -Stand behind cone & balance on non-dominant leg & kick cone. -Run on the spot behind a cone & on command kick the cone. -In pairs, kick a tennis ball to your friend.	**Focus** Kick		

Statistical analysis

Mixed model ANOVA was performed to compare activity times between the pre- and intervention zones. The participants were included as a random effect and gender zone and period as fixed effects. Fisher's least significant difference (LSD) was used for post hoc testing. Recognizing within the pre-test measurements (baseline testing), that on day four, children participated in a PE lesson. This was atypical of their habitual PA patterns and would skew the pre data in terms of representing habitual PA, the analysis was rerun omitting this day's data. A comparison was made between the four days of pre-tests where no PE was present and the four specific days that the children participated in the active brain-break intervention. The Cohen's D effect sizes were determined to see if there were any practical differences.

Results

The final sample (N=48) consisted of 6- to 8-year-old learners (M=6.6, SD= 0.4). Table 7.2 displays a composite score (five consecutive school days combined), of the mean and SD time (minutes) that the children spend in sedentary behaviour, moderate and vigorous PA during a typical school day from 08:00 to 13:00 (actual wear time = 300 minutes) as well as the percentage that children spend in sedentary behaviour, moderate and vigorous PA during the day. The activity zones are defined as sedentary, moderate and vigorous.

TABLE 7.2. MEAN AND SD FOR SEDENTARY, MODERATE AND VIGOROUS PA

	Sedentary (minutes)	Sedentary %	Moderate (minutes)	Moderate %	Vigorous (minutes)	Vigorous %
Overall (Baseline testing)	106.2 ± 30.9	35	43.7 ± 13.7	14	26.5 ± 13.6	8
Boys (Baseline testing)	108.1 ± 30.7	36	42.9 ± 13.0	14	26.2 ± 13.9	8
Girls (Baseline testing)	103.6 ± 31.2	34	44.8 ± 14.6	14	26.8 ± 13.9	8
Overall (During intervention)	100.1 ± 20.0	33	41.9 ± 11.6	13	34.1 ± 11.9	11
Boys (During intervention)	102.7 ± 18.7	34	41.9 ± 10.4	13	32.9 ± 11.0	10
Girls (During intervention)	96.5 ± 21.2	32	42.0 ± 13.1	14	32.9 ± 11.0	10

Figure 7.1 demonstrates the children's PA in each activity zone (sedentary, moderate and vigorous) during the pre-test and on the intervention days.

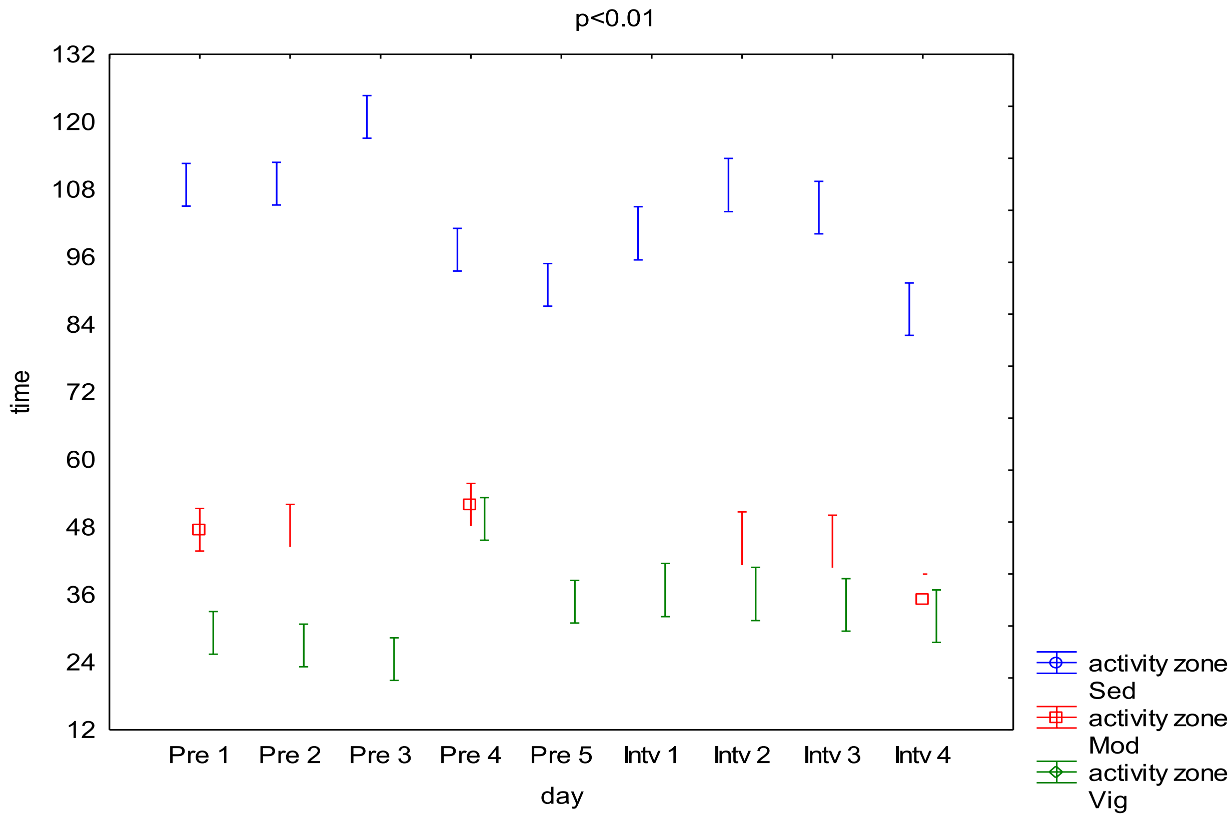

FIGURE 7.1. MEAN AND SD MINUTES FOR SEDENTARY, MODERATE AND VIGOROUS PA DURING PRE-TEST AND THE INTERVENTION

Figure 7.2 demonstrates the mean and SD for the sedentary behaviour, moderate and vigorous PA during four pre-test days (day four with PE lesson excluded) and the four days of the intervention.

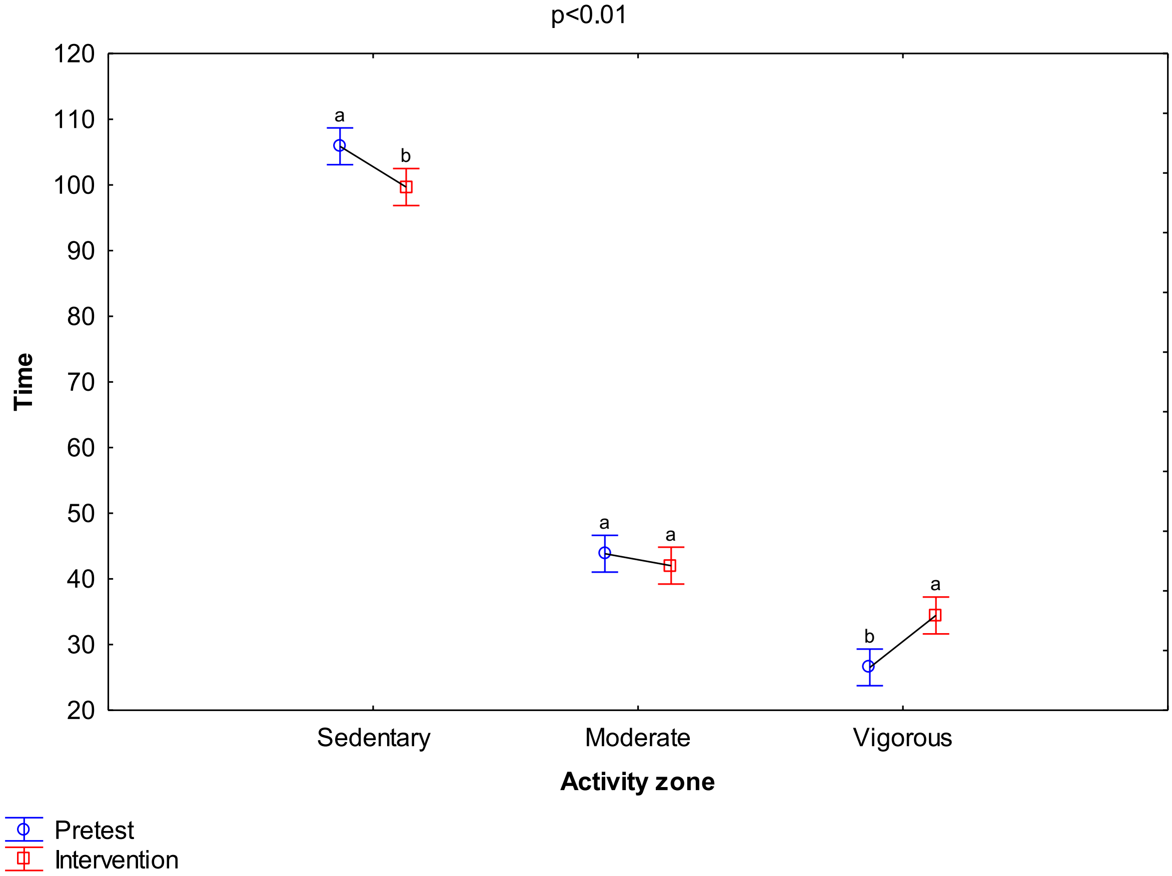

FIGURE 7.2. MEAN AND SD MINUTES FOR SEDENTARY, MODERATE AND VIGOROUS PA BETWEEN PRE-TEST AND THE INTERVENTION

**In the above figure the same letters (a and a) indicate no statistically significant difference, and if it differs (a and b) it indicates there was a statistically significant difference.*

There was a statistically significant difference ($p<0.05$) (Figure 7.2) between the sedentary behaviour, moderate and vigorous PA of the participants. Figure 7.2 indicates increased activity in the intervention period due to a significant decrease of time spent in sedentary behaviour, coupled with increased time spent in vigorous PA. On a typical school day, participants spent an average of 106.2 minutes in sedentary behaviour, whereas during the intervention it was 100.1 minutes ($p<0.01$), the Cohen's D effect sizes indicate a small practical difference (0.25). For moderate PA, participants spent average of 44 minutes in this category and during the intervention, 41 minutes ($p<0.01$), there was only a small practical difference (0.16) according to

Cohen’s D effect sizes. Lastly on a typical school day, participants spent an average of 26 minutes in vigorous PA and during the intervention 34 minutes ($p<0.01$), the Cohen’s D effect sizes indicate a medium practical difference (0.61).

Discussion

This study explored the PA levels of the children on five consecutive school days, and thereafter the children participated in a six-week active brain-break intervention. During the pre-test, the children took part in a typical PE lesson on day four, after a second statistical analysis was performed; day four was excluded in order to see what the effect of the brain-breaks was. During the intervention, the children were monitored with accelerometers on four random days in order to determine if any changes took place in their sedentary behaviour, moderate and vigorous PA levels. The duration of each school day was 5 hours (300 minutes) from 08:00 to13:00. Walter,[6,32] showed that the participants in their studies were 66% sedentary during a school day, which indicates that the participants in the current study were less sedentary.

In the current study, children only had one 20-minute break during the school day. According to the guidelines of Pate,[10] children should participate in 30 minutes of MVPA during a typical school day. In the current study, the children met the recommendations of Pate.[10] Gidlow,[33] found that children performed 29.3 minutes of MVPA during a school day (08:00-14:00). In the above-mentioned study a statistically significant difference was evident between boys and girls; boys were more sedentary than the girls. The South African studies,[6,7] concluded that boys were more active than girls. However, the children who participated in that study were older (8- to 14-years-old) than the population group of the current study.

As reported in the results, on day four the children participated in a typical PE lesson during which their vigorous PA demonstrated a tremendous spike and their sedentary behaviour decreased. Therefore, the researcher can speculate that participation in PE lessons can potentially increase children's PA levels, especially because of the time duration of the lessons. However, the children only get exposed to one PE lesson per week. During the intervention of the current study, the participants had the opportunity to practise FMS on a regular basis and the aim was to determine whether active brain-breaks had an effect on PA levels. A statistically significant difference was found between the time that children were spending in sedentary behaviour and moderate PA, compared to the time spent in in vigorous PA; the study found that they spent less time in sedentary behaviour and moderate PA and more time in vigorous PA. No statistically significant differences were found between boys and girls. The researcher can only speculate that the boys and girls partake in the same amount of PA during school time. Therefore, it could be speculated that the active brain-breaks increased the participants' PA levels on the specific days that they participated in the intervention. In an attempt to increase primary school children's PA levels, in the study done by Scruggs,[34] a morning and lunch as well as a fitness break intervention was implemented during the school day, which lasted for 15 minutes and consisted of a variety of locomotor and non-locomotor activities. Scruggs,[34] concluded that the fitness breaks increased the children's PA levels and contributed to their MVPA. Bershwinger and Brusseau,[35] implemented a study similar to the current one, where children were monitored using pedometers during a school day and thereafter activity breaks were conducted. The children's MVPA increased significantly when they participated in the activity breaks.[35] Walter,[32] explored the PA patterns of primary school children using accelerometers and implemented a 6-week intervention. The study concluded that the intervention increased the children's MVPA and decreased their sedentary behaviour time.[32] The increases in children's PA levels made a valuable contribution to the daily 60 minutes of MVPA recommendation.[32] A few studies,[36-40] monitored children using accelerometers and implemented 10- to 15-minute active brain-breaks and concluded that children were less sedentary and that the intervention contributed to their daily MVPA.

The current study examined the in-school PA patterns of children during a pre-test period and during classroom-based active brain-breaks. The results showed a significant increase in the vigorous PA patterns of the children during school time, and consequently reduced sedentary behaviour as well. Thus, indicating that the active brain-breaks had a potential positive impact. It was clear that taking part in a PE lesson provided by the school can significantly increase their PA levels. Therefore, the active brain-breaks can likely increase children's moderate and vigorous PA levels on the days where no PE is scheduled on the timetable. PE can be very beneficial for children; however, active brain-breaks can be a good daily supplement for PE. Moreover, schools need to realize the tremendous effect that PE has on children's PA levels and place more emphasis on PE on a weekly basis. However, it would provide added value if schools could implement active brain-breaks during the school day because it would potentially provide an opportunity for children to continuously practise FMS and increase their MVPA levels, especially on the days where there is no PE. Previous research found that classroom-based active brain-breaks had positive effects on children's on-task behaviour and academic performance and provided children with the opportunity to take short breaks from academic work.[14] The current study only examined children's PA levels during a typical school week (pre-test) and during randomly selected active brain-break days. Future studies could potentially implement active brain-breaks daily, as well as investigate which activities provided the most MVPA. The current study will make a valuable contribution to the South African literature on the PA levels of children and also indicate that it is practically possible and economical to implement active brain-breaks in the classroom to promote children's PA during the day.

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REFERENCES

1. McLellan, G., Arthur, R., Donnelly, S. & Buchan, D.S. Segmented sedentary time and physical activity patterns throughout the week from wrist-worn ActiGraph GT3X accelerometers among children 7-12 years old. *Journal of Sport and Health Sciences* 2020; 9: 179-188.
2. Draper, C.E., Tomaz, S.A., Bassett, S.H., Burnett, C., Christie, C.J., COZETT, C., De Milander, M., Krog, S., Monyeki, A., Naidoo, N., Naidoo, R., Prioreschi, A., Walter, C., Watson, E. & Lambert, E.V. Results from South Africa's 2018 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health* 2018; 15(2): 406-408.
3. Cooper, A.R., Goodman, A., Page, A.S., Sherar, L.B., Esliger, D.W., Van Sluijs, E.M., Andersen, L.B., Anderssen, S., Cardon, G., Davey, R., Froberg, K., Hallal, P., Janz, K.F., Kordas, K., Kreimler, S., Pate, R.R., Puder, J.J., Reilly, J.J., Salmon, J., Sardina, L.B., Timperio, A. & Ekelund, U. Objectively measured physical activity and sedentary time in youth: The International Children's Accelerometery Database (ICAD). *International Journal Behavioural Nutrition and Physical Activity* 2015; 12: 113-123.
4. Draper, C.E., Tomaz, S.A., Cook, C.J., Jugdav, S.S., Ramsammy, C., Besharati, S., Van Heerden, A., Vilakazi, K., Cockcroft, K., Howard, S.J. & Okely, A.D. Understanding the influence of 24-hour movement behaviours on the health and development of preschool children from low-income South African settings: The SUNRISE pilot study. *South African Journal of Sports Medicine* 2020; 32(1): 1-7.
5. Müller, I., Schindler, C., Adams, L., Endes, K., Gall, S., Gerber, M., Htun, N.S.N., Nqweniso, S., Joubert, N., Probst-Hensch, N., Du Randt, R., Seelig, H., Smith, D., Steinmann, P., Utzinger, J., Yap, P., Walter, C. & Pühse, U. Effect of a Multidimensional Physical Activity Intervention on Body Mass Index, Skinfolds and Fitness in South African Children: Results from a Cluster-Randomised Controlled Trial. *International Journal of Environmental Research and Public Health* 2019; 16: 232-248.
6. Walter, C.M. In-school physical activity patterns of primary school learners from disadvantaged school in South Africa: Health and lifestyle. *African Journal for Physical Health Education, Recreation and Dance* 2011; 2: 780-789.

7. Van Biljon, A., McKune, A.J., DuBose, K.D., Kolanisi, U. & Semple, S.J. Physical activity levels in urban-based South African learners: A cross-sectional study of 7348 participants. *South African Medical Journal* 2018; 108(2): 126-131.
8. Tomaz, S.A., Hinkley, T., Jones, R.A., Twine, R., Kahn, K., Norris, S.A. & Draper, C.E. Objectively measured physical activity in South African children attending preschool and Grade R: Volume, Patterns, Meeting Guidelines. *Paediatric Exercise Science* 2020; 1-7.
9. Tremblay, M.S., Aubert, S., Barnes, J.D., Saunders, T.J., Carson, V., Latimer-Cheung, A.E., Chastin, S.F.M., Altenburg, T.M., Chinapaw, M.J.M. & on behalf of SBRN terminology consensus project participants. Sedentary Behaviour Research Network (SBRN) – Terminology Consensus Project process and outcome. *International Journal of Behavioural Nutrition and Physical Activity* 2017; 14: 75-92.
10. Pate, R.R., Davis, M.G., Robinson, T.N., Stone, E.J., Mckenzie, T.L. & Young, J.C. Promoting physical activity in children and youth: A leadership role for schools. *Circulation* 2006; 114: 1214-1224.
11. Hegarty, L.M., Mair, J.L., Kirby, K., Murtage, E. & Murphy, M.H. School-based Interventions to Reduce Sedentary Behaviour in Children: A systematic review. *Public Health* 2016; 3(3): 520-541.
12. Clemes, S.A., Barber, S.E., Bingham, D.D., Ridgers, N.D., Fletcher, E., Pearson, N., Salmon, J. & Dunstan, D.W. Reducing children's classroom sitting time using sit-to-stand desks: Findings from pilot studies in UK and Australian primary schools. *Journal of Public Health* 2015; 38(3): 526-533.
13. Dobbins, M., Husson, H., Decorby, K. & Larocca, R.L. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database of Systematic Reviews* 2013; 2.
14. Mazzoli, E., Koorts, H., Salmon, J., Pesce, C., May, T., Teo, W. & Barnett, L.M. Feasibility of breaking up sitting time in mainstream and special schools with a cognitively challenging motor task. *Journal of Sport and Health Science* 2019; 8: 137-148.
15. Malan, G.F. & Nolte, K. Measuring physical activity in South African Grade 2 and 3 learners: A self-report questionnaire versus pedometer testing. *South*

African Journal for Sport, Physical Education and Recreation 2017; 39(3): 79-91.

16. Egger, F., Benzing, V., Conzelmann, A. & Schmidt, M. Boost your brain, while having a break! The effects of long-term cognitively engaging physical activity breaks on children's executive functions and academic achievement. *Public Library of Science Journal* 2019; 14(3): 1-20.
17. Norris, E., Van Steen, T., Direito, A. & Stamatakis, E. Physically active lessons in schools and their impact on physical activity, educational, health and cognition outcomes: A systematic review and meta-analysis. *British Journal of Sports Medicine* 2019; 0: 1-14.
18. Salmon, J. Novel strategies to promote children's physical activities and reduce sedentary behaviour. *Journal of Physical Activity and Health* 2010; 7(3): 299-306.
19. Watson, A., Timperio, A., Brown, H., Best, K. & Hesketh, K.D. Effect of classroom-based physical activity interventions on academic and physical activity outcomes: A systematic review and meta-analysis. *International Journal of Behavioural Nutrition and Physical Activity* 2017; 14: 114-138.
20. Migueles, J.H., Cadenas-Sanchez, C., Ekelund, U., Nyström, C.D., Mora-Gonzalez, J., Löf, M., Labayen, I., Ruiz, J.R. & Ortega, F.B. Accelerometer Data Collection and Processing Criteria to Assess Physical Activity and Other Outcomes: A Systematic Review and Practical Considerations. *Sports Medicine* 2017; 47(9): 1821-1845.
21. Fairclough, S.J., Beighle, A., Erwin, H. & Ridgers, N. School day segmented physical activity patterns of high and low active children. *BMC Public Health* 2012; 12: 406-418.
22. Berglind, D. & Tynelius, P. Objectively measured physical activity patterns, sedentary time and parent-reported screen-time across the day in four-year-old Swedish children. *BMC Public Health* 2018; 18: 69-77.
23. Noonan, R.J., Boddy, L.M., Kim, Y., Knowles, Z.R. & Fairclough, S.J. Comparison of children's free-living physical activity derived from wrist and hip raw accelerations during the segmented week. *Journal of Sports Science* 2018; 35: 2067-2072.
24. Donnelly, J.E., Hillman, C.H., Castelli, D., Etnier, J.L., Lee, S., Tomporowski, P., Lambourne, K. & Szabo-Reed, A.N. Physical activity, fitness, cognitive

function, and academic achievement in children: A systematic review. *Medicine and Science in Sports and Exercise* 2016; 48(6): 1197-1222.

25. Ma, J.K., Le Mare, L. & Gurd, B.J. Four minutes of in-class high-intensity interval activity improves selective attention in 9- to 11-year old's. *Applied Physiology, Nutrition and Metabolism* 2015; 40: 238-244.
26. Mok, M.M.C., Chin, M., Korcz, A., Popeska, B., Edginton, C.R., Uzunoz, F.S., Podnar, H., Coetzee, D., Georgescu, L., Emeljanovas, A., Pasic, M., Balasekaran, G., Anderson, E. & Durstine, J.L. Brain Breaks Physical Activity Solutions in the Classroom and on Attitudes toward Physical Activity: A Randomized Controlled Trial among Primary Students from Eight Countries. *International Journal of Environmental Research and Public Health* 2020; 17: 1666-1677.
27. Van Capelle, A., Broderick, C.R., Van Doorn, N., Ward, R.E. & Parmenter, B.J. Interventions to improve fundamental motor skills in pre-school aged children: A systematic review and meta-analysis. *Journal of Science and Medicine in Sport* 2017; 1-9.
28. Hulteen, R.M., Morgan, P.J., Barnett, L.M., Stodden, D.F. & Lubans, D.R. Development of Foundational Movement Skills: A Conceptual Model for Physical Activity Across the Lifespan. *Sports Medicine* 2018; 48: 1533-1540.
29. Faigenbaum, A.V., Farrell, A. & Fabiano, M. Effects of Integrative Neuromuscular Training on Fitness Performance in Children. *Paediatric Exercise Science* 2011; 23: 573-584.
30. Duncan, M.J., Eyre, E.L.J. & Oxford, S.W. The effects of 10 weeks Integrated Neuromuscular Training on fundamental movement skills and physical self-efficacy. *Journal of Strength and Conditioning* 2017; 32(12): 1–32.
31. Crouter, S.E., Dellavalle, D.M., Haas, J.D., Frongillo, E.A. & Bassett, D.R. Validity of ActiGraph 2-Regression Model and Matthews and NHANES and Cut-Points for Assessing Free-Living Physical Activity. *Journal of Physical Activity and Health* 2013; 10(4): 504-514.
32. Walter, C.M. Promoting physical activity: A low cost intervention programme for disadvantaged schools in Port Elizabeth, South Africa. *African Journal for Physical, Health Education, Recreation and Dance* 2014; 20(2:1): 357-371.

33. Gidlow, C.J., Cochrane, T., Davey, R. & Smith, H. In-school and out-of-school physical activity of primary and secondary school children. *Journal of Sports Sciences* 2008; 26(13): 1411-1419.
34. Scruggs, P.W., Beveridge, S.K. & Watson, D.L. Increasing children's school time physical activity using structured fitness breaks. *Paediatric Exercise Science* 2003; 15(2): 156-169.
35. Bershwinger, T. & Brusseau, T.A. The impact of classroom activity breaks on the School-Day Physical Activity of Rural Children. *International Journal of Exercise Science* 2013; 6(2): 134-143.
36. Whitt-Glover, M.C., Ham, S.A. & Yancey, A.K. Instant Recess: A Practical Tool for Increasing Physical Activity during the School Day. *Progress in Community Health Partnerships: Research, Education and Action* 2011; 5: 289-297.
37. Erwin, H., Koufroudakis, R. & Beighle, A. Children's Physical Activity Levels during Indoor Recess Dance Videos. *Journal of School Health* 2013; 83: 322-327.
38. Carlson, J.A., Engelberg, J.K., Cain, K.L., Conway, T.L., Mignano A.M., Bonilla, E.A. & Sallis, J.F. (2015). Implementing Classroom Physical Activity Breaks: Associations with Student Physical Activity and Classroom Behaviour. *Preventive Medicine*, 81: 67-72.
39. Calvert, H.G., Mahar, M.T., Flay, B. & Turner, L. Classroom-Based Physical Activity: Minimizing Disparities in School-Day Physical Activity among Elementary School Students. *Journal of Physical Activity and Health* 2017; 15: 161-168.
40. Calella, P., Mancusi, C., Pecoraro, P., Sensi, S., Sorrentino, C., Imoletti, M., Valerio, F. Classroom Active Breaks: A Feasibility Study in Southern Italy. *Health Promotion International* 2019; 35: 1-8.

Chapter 8

General Discussion & Conclusion

General Discussion

This study investigated the effects of active brain-breaks during a school day on in-school physical activity (PA) patterns, fundamental movement skills (FMS) and executive functioning (EF) of Grade One children in Cape Town, Western Cape Province. It examined, for the first time, the FMS proficiency, physical fitness and weight status of Grade One children in Cape Town, South Africa. Moreover, it is the first study in South Africa to implement a 10-minute classroom-based active brain-break intervention with a specific focus on FMS and monitoring of children's PA patterns. Previous studies have investigated the FMS and physical fitness of South African children; however, to the researcher's knowledge, no studies have yet been conducted on Grade One children in Cape Town (Monyeki *et al.,* 2005; Armstrong *et al.,* 2011; Amusa *et al.,* 2011 & Pienaar & Kemp, 2014).

The FMS proficiency results (see research article 1) concluded that 35% of the children mastered their FMS, 37% reached an NM level and 28% did not master any skills (poor). The highest mastered skill was running and the least mastered skill was hopping. In the physical fitness tests (see research article 2), a statistically significant difference was found between boys and girls. In standing broad jump, shuttle run (4 x 5m) and throwing, boys performed better, and in the sit-and-reach the girls performed better, no differences were seen in the aerobic endurance (20m shuttle run) test. The results concluded that the participants have good physical fitness levels compared to their South Africa peers, but not compared to their peers internationally. After the active brain-breaks intervention (see research article 3), the children's raw final FMS score improved; however, the difference was not statistically significant. During the active brain-breaks intervention, children's sedentary behaviour decreased and their vigorous PA increased (see research article 4).

In research article 1, over a third of the participants were able to master their FMS, whereas almost a third were not proficient in their skills. Therefore, these results address the need for children in the Cape Town area to be continuously encouraged to practice and engage in their FMS on a daily basis. The majority of the current study's findings are in line with the study done by Pienaar *et al.* (2016), who also investigated the FMS proficiency of children in the North-West Province, South Africa as well as international studies done by O'Brien *et al.* (2016); Mukherjee *et al.* (2017) & Duncan *et al.* (2019). It is recommended that more focus should be placed on locomotor skills and for girls specifically, more attention should be given to kick, roll, throw and strike, as they performed poorly in these skills. By looking at the sex differences between boys and girls it would be recommended to also implement this in interventions in the future. The results of article one is linking well with the results of article three where it is evident that more focus needs to be on the locomotor skills of the children. Even though the highest mastered skill was run, other locomotor skills like leap, gallop and hop are more mechanical and requires more coordination, rhythm and timing. It is crucial for children to partake in PA as well as to be involved in moderate-to-vigorous PA on a daily basis, as this will influence their physical fitness, body composition and bone health (Fang *et al.,* 2017). The physical fitness results address the need for children to improve their physical fitness status even though their results were good in comparison with other South African studies. The results provide valuable insight for teachers, coaches and therapists to know what important areas to focus on, as well as what the differences are between boys' and girls' physical fitness levels. The results of article two show that there are differences between boys and girls and therefore, it can be recommended to keep this in mind when looking at different interventions.

The 10-minute active brain-break intervention was easily executed in a classroom-based environment and created an opportunity for children to be physically active and practice their FMS (Wilson *et al.,* 2015). This is the first study in South Africa that implemented a 10-minute active brain-breaks intervention focusing on FMS, and EF, and therefore makes an original contribution to the literature. Previous international studies conducted by Goh *et al.* (2016) and Mitchell *et al.* (2013) implemented classroom-based 10-minute active brain-breaks focusing on PA. To date, there is only one study in South Africa that implemented an active brain-breaks intervention and the focus was primarily on PA (Mok *et al.,* 2020). The children's object control skills improved to a greater extent than their locomotors skills. However, looking at the results between the experimental and control group only the object control skills of the experimental group improved. Therefore, it is recommended to revise the locomotor skill activities of the intervention. After the intervention has been revised, it can be introduced and implemented at schools on a daily basis in order to address the need for children to be more physically active, while also practicing their FMS. According to the recommendation made by Pate *et al.* (2006), children should participate in 30-minutes of MVPA on each school day and the current study's children met these guidelines. During the active brain-breaks children's vigorous PA levels increased and their sedentary behaviour time decreased; therefore, the researcher can conclude that the active brain-breaks intervention increased children's PA levels outside of PE lesson time. The researcher can also speculate that any differences in sedentary behaviour could lead to a positive change in in-school PA. Taking into consideration the amount of time children spend at school seated doing academic work, a change of 6 minutes of vigorous PA and a decrease of 2 minutes of moderate PA will most certainly lead to a positive outcome. The active brain-breaks give children the opportunity to practice their FMS, take a break from academic work and possibly enhance their cognitive function. According to the National Curriculum Statement of South Africa, schools should use a learner-centred approach to determine the cognitive development of a child. Every child should be able to identify and solve problems using critical and creative thinking and they should be able to collect, analyse and organise information. In order to holistically develop a child to his/her full potential, teachers and therapists need to understand and have the knowledge of how a child develops. To establish a strong focus and function in young children, they need to be encouraged to actively participate in a variety of activities (active learning). In the South African schools PE form part of the curriculum, PE consist of PA exercises that take place once a week for 40-60 minutes. Unfortunately, PE is starting to fall away in many schools, it may seem like children take part in some form of PE, however, teachers are not well educated on PE. There is a lack of expertise, facilities, equipment and motivation at schools. Therefore, by participating in the active brain-breaks on a daily basis will give children the opportunity to actively engage in FMS and PA and use their cognitive function.

Limitations

There is no recent and relevant data in South Africa on the FMS proficiency, physical fitness and weight status of children, and that made it difficult to compare the current results in a South African context. To the researcher's knowledge, this is the first study in South Africa that implemented an active brain-breaks intervention with the focus on FMS. The researcher is aware that the intervention needs to be refined in order to achieve a more positive change in FMS, EF and PA patterns of children. Looking at the refinement of the intervention, it would be recommended to revise the locomotor skill activities in order to utilize the space more effectively and to ensure that the actual skills are focused on. It would be recommended to think more out of the box in terms of the space and how children can do more repetitions during the 10-minutes. During the active brain-breaks communication was essential, and therefore the researcher would recommend that the activities should be explained and demonstrated before the 10-minute active brain-break starts (it can be explained again during the 10-minutes), children would have a better understanding of what to expect and it could potentially eliminate confusion and talking to much between activities. It would also be recommended to give specific cues with a whistle during the activities. It would be recommended to have the same warm-up and cool down for each week, this way children would already know what to do when the session starts, and they get numerous repetitions in. It would have been valuable to appoint an assistant to evaluate the sessions and make sure that the children participated in all of the activities. Even though the researcher and two assistants were present at each session, their aim was to assist the children with the activities. The children that took part in the study were not blinded. Children's PA was only measured during school time and not the whole day, and therefore the total PA of children during a day is unknown. The reason that children only wore the accelerometers during school day was that the researcher only investigated the children's in-school PA patterns, and due to logistical aspects and the environments the study took place in the researcher would have lost numerous Actigraphs due to neglections and theft. Children's PA levels were not measured after the intervention to see if they retained what they had been doing for six-weeks. Only two schools took part in the study and the intervention only lasted for six weeks. It would have been beneficial to have a longer intervention. The reason that the intervention was only six weeks and not longer, was that the researcher wanted the pre- and post-testing as well as the intervention to take place in one school term, and a South African school term are between 9-10 weeks. It would be recommended to observe the interventions carefully in the future, to determine if there were any external factors that had an impact on the data collection. There was a control group in the study, however in article four, the experimental group was their own control group and this can potentially be a limitation. The experimental groups baseline testing was compared with their own intervention results. The HTKS only purports to measure EF and therefore it would be useful to use individual measurements of different parts of EF to get more constructive data. The modified EUROFIT and HTKS were product measurements and therefore no inter-rater reliability was done, however this can be done in the future. The TGMD-2 does not evaluate stability and this can be recommended to investigate in future studies. The inter-rater reliability of the TGMD-2 object control subtest had a very low score and this needs to be revised in the future. In the study of article 3 the researcher attempted to do a follow-up testing after the natural retention period, however, most of the children were absent due to the testing that took place close to the school holidays. In the future the follow-up testing needs to take place at least two weeks before the schools close. Examining children's dose of EF could be useful in order to determine if it would be more beneficial to take part in more active brain-breaks.

Take Home Message

In conclusion, this original contribution to the literature provides valuable FMS proficiency data that can assist teachers, therapists, coaches and parents in Cape Town to support children in mastering their FMS. It is recommended that interventions should specifically focus on gallop, hop and leap as well as strike, dribble and throw. It is further recommended that awareness should be increased on the need for children to continuously practice their FMS on a daily basis in order to have a positive impact on their health. The researcher recommends that more attention needs to be given to children's physical fitness levels, specifically aerobic endurance. The active brain-break intervention is the first of its kind to be implemented in South Africa and it brought a unique perspective to the study. These fun, cost effective and easy-to-administer active brain-breaks can be done anytime during the school day, with the help of therapists and teachers, and can therefore address children's need to practice and engage in FMS on a more regular basis in order to improve their proficiency, decrease sedentary behaviour and increase moderate and vigorous PA. This is important, as it contributes to children's physical fitness levels, strengthens and builds their muscles, maintains a healthy weight status and enhances their cognitive development, which will in turn help children with their daily activities, concentration and academic work.

REFERENCES

AMUSA, L.O., GOON, D.T., AMEY, A.K. & TORIOLA, A.L. 2011. Health-related physical fitness among young rural primary school children in Tshannda, South Africa. *Scientific Research and Essays.* 6(22): 4665-4680.

ARMSTRONG, M.E.G., LAMBERT, E.V. & LAMBERT, M.I. 2011. Physical fitness of South African primary school children, 6 to 13 years of age: Discovery Vitality health of Nation study. *Perceptual and Motor Skills.* 113(3): 999-1016.

DUNCAN, M.J., ROSCOE, C.M.P., NOON, M., CLARK, C.C.T., O'BRIEN, W. & EYRE, E.L.J. 2019. Run, jump, throw and catch: How proficient are children attending English schools at the fundamental motor skills identified as key within the school curriculum? *European Physical Education Review.* 1-13.

FANG, H., QUAN, M., ZHOU, T., SUN, S., ZHANG, J., ZHANG, H., CAO, Z., ZHAO, G., WANG, R. & CHEN, P. 2017. Relationship between Physical Activity and Physical Fitness in Preschool Children: A Cross-Sectional Study. *BioMed Research International.* 1-8.

MONYEKI, M.A., KOPPES, L.L.J., KEMPER, H.C.G., MONYEKI, K.D., TORIOLA, A.L., PIENAAR, A.E. & TWISK, J.W.R. 2005. Body composition and physical fitness of undernourished South African rural primary school children. *European Journal of Clinical Nutrition.* 59: 877-883.

MOK, M. M. C., CHIN, M., KORCZ, A., POPESKA, B., EDGINTON, C. R., UZUNOZ, F. S., PODNAR, H., COETZEE, D., GEORGESCU, L., EMELJANOVAS, A., PASIC, M., BALASEKARAN, G., ANDERSON, E. & DURSTINE, J. L. 2020. Brain Breaks Physical Activity Solutions in the Classroom and on Attitudes toward Physical Activity: A Randomized Controlled Trial among Primary Students from Eight Countries. *International Journal of Environmental Research and Public Health*, *17*, 1666-1677.

MUKHERJEE, S., JAMIE, L.C.T. & FONG, L.H. 2017. Fundamental Motor Skill Proficiency of 6- to 9-year old Singaporean Children. *Perceptual and Motor Skills.* 124(3): 584-600.

O'BRIEN, W., BELTON, S. & ISSARTEL, J. 2016. Fundamental movement skill proficiency amongst adolescent youth. *Physical Education and Sport Pedagogy.* 21(6): 557-571.

PIENAAR, A.E. & KEMP, C. 2014. Motor proficiency profile of Grade 1 learners in the North West Province of South Africa: NW-child study. *South African Journal of Research in Sport, Physical Education and Recreation.* 36(1): 167-182.

PIENAAR, A.E., VAN REENEN, I. & WEBER, A. 2016. Sex differences in fundamental movement skills of a selected group of 6-year-old South African children. *Early Childhood Development and Care.* 186(12):

ROSCOE, C.M.P., JAMES, R.S. & DUNCAN, M.J. 2019. Accelerometer-based physical activity levels, fundamental movement skills and weight status of British preschool children from a deprived area. *European Journal of Pediatrics.* 178: 1043-1052.

WILSON, A. N., OLDS, T., LUSHINGTON, K., PETKOV, J. & DOLLMAN, J. 2015. The impact of 10-minute activity breaks outside the classroom on male students' on-task behaviour and sustained attention: a randomised crossover design. *The Journal of Paediatrics*, 1-8.

APPENDICES

APPENDIX A

Consent form (School W)

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STELLENBOSCH UNIVERSITY

CONSENT TO PARTICIPATE IN RESEARCH

The effects of active brain-breaks during a school day on physical activity patterns, fundamental movement skills and executive functioning in Grade 1 children

You are hereby requested to give consent for your child to participate in an experimental research study conducted by Dr Africa and Odelia van Stryp from the Department of Sport Science at Stellenbosch University. The results will contribute to a Doctoral degree. Your child was selected as a possible participant in this study because he/she is a Grade 1 learner.

1. **PURPOSE OF THE STUDY**

The main aim of the study is to determine the effects of active brain-breaks during normal teaching time on physical activity patterns, fundamental movement skills and executive functioning in children. Executive functioning refers to the ability to execute and finish a task, in other words to get “things” or activities done, for example to complete your homework or to clean your room. Getting children active from an early age helps to develop healthy physical activity patterns and also encourages them to be more active and this would possibly improve their fundamental movement skills. If children are more active during the day, this would possibly enhance and improve their cognitive function in the classroom and this will lead to better concentration on their academic work. Therefore, the researcher would like to implement the active brain-breaks on Grade 1 learners.

2. **PROCEDURES**

This study will take place during 2019 and will be taking place in two different phases. If your child volunteers to participate in this study, we would ask him/her to partake in the following things:

Phase one

1. To indicate by using pictures what their perceived motor competences are;
2. To take part in an evaluation that will determine their fundamental movement skills and fitness levels;
3. To take part in a game called Head Toes Knees Shoulders that looks at children's cognitive function;
4. To let the researcher, determine their BMI (Body Mass Index).

The total duration of phase one will be between one month and it will take place during the first term of 2019. The researcher will be doing the evaluations at the school.

Phase two

The intervention will take place in the second term from April to June. After the evaluations in phase one, the children will take part in an intervention. In this phase there will be pre- and post-testing. For the pre-testing, the children's physical activity patterns will be monitored via an accelerometer (small monitor that looks like a watch) that they will wear on their wrists for five consecutive school days during school time. The researcher will place the accelerometers on the children's wrists as soon as they arrive at school and will take it off as soon as school is finished. The accelerometer will indicate how active children are. After pre-testing the classes will be divided into an experimental group and a control group.

Children in the experimental group will be participating in 10-minute active brain-breaks over a six-week period during school time to enhance their physical activity levels. The control group will not be doing the active brain-breaks. If there is an improvement in the physical activity levels of the children in the experimental group, then the active brain-breaks will be implemented with the control group as well. The active brain-breaks will take place in the classroom in between academic work. The activities will consist of a variety of big movements that will enhance and increase their physical activity levels. Children will be participating in two active brain-breaks per day, twice per week. After the intervention, both groups will take part in the post-test. They will wear the accelerometers again for five consecutive school days and they will also be evaluated using a Test for Gross Motor Development as well as the Head Toes Knees Shoulders game. This will give an indication whether the intervention has enhanced their fundamental movement skills and physical activity levels. Three weeks after the post-testing, the children will participate in a follow-up evaluation, where they will be evaluated with the Test for Gross Motor Development as well as the Head Toes Knees Shoulders game. The reason for this is to assess their fundamental movement skills as well as their cognitive function during the three weeks.

Phase two will take place throughout term two. The researcher will come to the school to do the sessions with the children.

3. POTENTIAL RISKS AND DISCOMFORTS

There are no serious risks involved in the study. All of the evaluations and the intervention will take place in a safe environment at the school. There will be honours students assisting the researcher during the evaluations and the intervention sessions with the children to make sure they are safe and doing the activities correctly. The researcher and honours students are trained in First Aid. Your child may be uncomfortable during the higher intensity activities (eg. running as fast as possible). He/she may also experience muscle soreness and sweatiness after the sessions. The children might experience discomfort or it might feel strange and uncomfortable while they are wearing the accelerometers, but it would not affect them negatively. After the first day they will get used to wearing a monitor on their wrist. The researcher will be very sensitive towards the children and if they feel uncomfortable in any way, she will let them stop.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

The benefit that the children may get from this study is that they will get positive feedback on their physical well-being and their everyday functioning. They might show improvements in gross motor skills, physical activity and fitness levels as well as their concentration for academic purposes. Research has shown that children who are more active, especially during school time, are calmer in class and tend to concentrate better. If children are more active during school time, this would possibly enhance their physical activity and fitness levels and improve their fundamental movement skills.

5. PAYMENT FOR PARTICIPATION

Participants will not receive any payment, but their participation will make a valuable contribution towards a Doctoral degree in Sports Sciences.

6. CONFIDENTIALITY

Any information that is obtained during this study and that can be identified with your child will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by safeguarding data and ensuring anonymity of participants throughout the study. The data will be kept safe on the researcher’s laptop, which only the researcher will have access to. This laptop will be password-protected and safely stored in a locked cabinet in an office inside the Department, which will be locked at all times. When the final data and article of this study is handed in, the data will be kept safe at the Department of Sport Science at Stellenbosch University. The researcher will publish an article at the end of the study, but all participants will be kept anonymous.

7. PARTICIPATION AND WITHDRAWAL

Your child can choose whether to be in this study or not. If your child volunteers to be in this study, they may withdraw at any time without consequences of any kind. You and your child may also refuse to answer any questions you do not want to answer and still remain in the study. The investigator may withdraw your child from this research if circumstances arise which warrant such a step or if the researcher is of the view that the child would prefer not to take part, but struggles to communicate it.

8. CONTACT WITH INVESTIGATORS

Content removed on data protection grounds

9. RIGHTS OF RESEARCH SUBJECTS

Content removed on data protection grounds

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

[____] I have been given a copy of this form. The study has been clearly explained above in a language that I understand. I hereby give permission for my child to participate in this study.

____

Name of Subject/Participant

____

Name of Parent / Guardian / Legal Representative (if applicable)

SIGNATURE OF INVESTIGATOR

____________________________________ ____________

Signature of Investigator Date

Consent form (School B)

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STELLENBOSCH UNIVERSITY

CONSENT TO PARTICIPATE IN RESEARCH

The effects of active brain-breaks during a school day on physical activity patterns, fundamental movement skills and executive functioning in Grade 1 children

You are hereby requested to give consent for your child to participate in an experimental research study conducted by Dr E Africa and Odelia van Stryp from the Department of Sport Science at Stellenbosch University. The results will contribute to a Doctoral degree. Your child was selected as a possible participant in this study because he/she is a Grade 1 learner.

1. PURPOSE OF THE STUDY

The main aim of the study is to determine the physical activity patterns of Grade 1 learners by investigating their fundamental movement skills and executive functioning and fitness levels. Executive functioning refers to the ability to execute or finish a task, in other words to get "things" or activities done, for example; to complete your homework or to clean your room. Getting children active from an early age helps to develop healthy physical activity patterns and also encourages them to be more active and this would possibly improve their fundamental movement skills. If children are more active during the day, this would possibly enhance and improve their cognitive function in the classroom and this will lead to better concentration on their academic work.

2. PROCEDURES

This study will take place during the first term of 2019. If your child volunteers to participate in this study, we would ask him/her to partake in the following things:

Phase one

1. To indicate by using pictures what their perceived motor competence are.
2. To take part in an evaluation that will determine their fundamental movement skills and fitness levels.
3. To take part in a game called Head Toes Knees Shoulders that looks at children's cognitive function.
4. To let the researcher, determine their BMI (Body Mass Index).

The total duration of phase one will be between one month, it will take place during the first term of 2019. The researcher will be doing the evaluations at the school.

Phase two

The intervention will take place in the second term from April to June.

After the evaluations in phase one, the children will take part in an intervention. In this phase there will be pre- and post-testing. For the pre-testing, the children's physical activity patterns will be monitored via an accelerometer (small monitor that looks like a watch) that they will wear on their wrists for five consecutive school days during school time. The teachers will place the accelerometers on the children's wrists as soon as they arrive at school and will take it off as soon as school is finished. The accelerometer will indicate how active children are. After pre-testing the classes will be divided into an experimental group and a control group.

Children in the experimental group will be participating in 10-minute active brain-breaks over a six-week period during school time to enhance their physical activity levels. The control group will not be doing the active brain-breaks. If there is an improvement in the physical activity levels of the children in the experimental group, then the active brain-breaks will be implemented with the control group as well. The active brain-breaks will take place in the classroom in between academic work. The activities will consist of a variety of big movements that will enhance and increase their physical activity levels. Children will be participating in two active brain-breaks per day, twice per week. After the intervention, both groups will take part in the post-test. They will wear the accelerometers again for five consecutive school days and they will also be evaluated using a Test for Gross Motor Development as well as the Head Toes

Knees Shoulders game. This will give an indication whether the intervention has enhanced their fundamental movement skills and physical activity levels. Three weeks after the post-testing, the children will participate in a follow-up evaluation, where they will be evaluated with the Test for Gross Motor Development as well as the Head Toes Knees Shoulders game. The reason for this is to assess their fundamental movement skills as well as their cognitive function during the three weeks.

Phase two will take place throughout term two. The researcher will come to the school to do the sessions with the children.

3. POTENTIAL RISKS AND DISCOMFORTS

There are no serious risks involved in the study. All of the evaluations will take place in a safe environment at the school. There will be honours students assisting the researcher during the evaluations to make sure they are safe and doing the activities correctly. The researcher and honours students are trained in First Aid. Your child may be uncomfortable during the higher intensity activities (eg. running as fast as possible). He/she may also experience muscle soreness and sweatiness after the sessions. The researcher will be very sensitive towards the children and if they feel uncomfortable in any way, she will let them stop.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

The benefit that the children may get from this study is that they will get positive feedback on their physical well-being and their everyday functioning. They might show improvements in gross motor skills, physical activity and fitness levels as well as their concentration for academic purposes. Research has shown that children who are more active, especially during school time, are calmer in class and tend to concentrate better. If children are more active during school time, this would possibly enhance their physical activity and fitness levels and improve their fundamental movement skills.

5. PAYMENT FOR PARTICIPATION

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6. CONFIDENTIALITY

Any information that is obtained during this study and that can be identified with your child will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by safeguarding data and ensuring anonymity of the participants throughout the study. The data will be kept safe on the researcher's laptop which only the researcher will have access to. This laptop will be password-protected and safely stored in a locked cabinet in an office inside the Department which will be locked at all times. When the final data and article of this study is handed in the data will be kept safe at the Department of Sport Science at Stellenbosch University.

The researcher will publish an article at the end of the study, but all participants will be kept anonymous.

7. PARTICIPATION AND WITHDRAWAL

Your child can choose whether to be in this study or not. If your child volunteers to be in this study, they may withdraw at any time without consequences of any kind. You and your child may also refuse to answer any questions you do not want to answer and still remain in the study. The investigator may withdraw your child from this research if circumstances arise which warrants such a step or if the researcher is of the view that the child would prefer not to take part but struggles to communicate it.

8. CONTACT WITH INVESTIGATORS

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9. RIGHTS OF RESEARCH SUBJECTS

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SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

[____] I have been given a copy of this form. The study has been clearly explained above in a language that I understand. I hereby give permission for my child to participate in this study.

____

Name of Subject/Participant

____

Name of Parent / Guardian / Legal Representative (if applicable)

SIGNATURE OF INVESTIGATOR

____ ______________

Signature of Investigator **Date**

Toestemmingsvorm (Skool B)

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INWILLIGING OM DEEL TE NEEM AAN NAVORSING

Die effek van aktiewe brein breke gedurende ’n skooldag op die fisieke aktiwiteitspatrone, fundamentele bewegings vaardighede en uitvoerende funksie van Graad 1 kinders.

U kind word gevra om deel te neem aan ’n eksperimentele navorsingstudie wat uitgevoer word deur Dr Africa en Odelia van Stryp van die Departement Sportwetenskap aan die Universiteit Stellenbosch. Die resultate sal bydrae tot ’n Doktorale graad. U kind is as ’n moontlike deelnemer aan die studie gekies omdat hy/sy ’n Graad 1 leerder is.

1. DOEL VAN DIE STUDIE

Die primêre doel van die studie is om te bepaal wat die effek van aktiewe brein breke gedurende ’n skooldag sal wees op die fisieke aktiwiteitspatrone, fundamentele bewegings vaardighede en uitvoerende funksie van kinders. Die term uitvoerende funksie beteken om aktiwiteite klaar te maak, uit te voer en te voltooi. Voorbeelde van uitvoerende funksie is om jou huiswerk klaar te maak of jou kamer op te ruim. Deur kinders van ’n jong ouderdom af aktief te kry help om gesonde fisieke aktiwiteitspatrone te ontwikkel, wat kinders moontlik sal motiveer om meer aktief te wees en wat hulle fundamentele bewegings vaardighede sal verbeter. As kinders gedurende die skooldag meer aktief is sal dit moontlik hulle kognitiewe funksie in die klaskamer verbeter wat beteken dat hulle beter sal konsentrasie op akademiese werk. Daarom, wil die navorser graag aktiewe brein breke implementeer met Graad 1 leerders.

2. **PROSEDURES**

Hierdie studie sal plaasvind gedurende 2019 in twee verskillende fases. As u kind gewillig is om aan die studie deel te neem, sal ons hom/haar vra om aan die volgende deel te neem:

Fase een

Die volgende sal verwag word van die kinders:

1. Om deur middel van prentjies hulle waargenome motoriese bevoegdheid aan te dui.
2. Om deel te neem aan ’n evaluasie wat hulle fundamentele bewegings vaardighede en fiksheidsvlakke gaan bepaal.
3. Om deel te neem aan ’n speletjie wat gaan fokus op hulle werkgeheue en aandag.
4. Om deel te neem aan ’n assessering om hulle liggaamsmassa-indeks te bepaal.

Fase een sal tussen een tot twee maande (Februarie-Maart) neem en sal gedurende die eerste kwartaal van 2019 plaasvind. Die navorser en opgeleide assistente sal al die evaluasies by die skool doen.

Fase twee

Na die evaluasies in fase een plaasgevind het gaan die kinders deelneem aan ’n intervensie. In die fase gaan daar ’n pre- en post-toetsing plaasvind. Vir die pre-toetsing gaan die kinders se fisieke aktiwiteits patrone bepaal word deur ’n “accelerometer” (klein monitor wat soos ’n horlosie lyk). Kinders gaan die “accelerometer” op hulle gewrigte dra vir vyf aaneenlopende skooldae. Die onderwysers sal die monitor vir die kinders aansit sodra hulle by die skool kom en hulle sal dit weer afhaal as die skool verdaag. Die monitor sal aandui hoe aktief kinders is gedurende die skooldag. Die totale tydperk van hierdie pre-toetsing sal vyf aaneenlopende dae wees. Na die pre-toetsing sal die klasse op verdeel word in ’n eksperimentele en kontrole groep.

Kinders in die eksperimentele groep gaan deelneem aan 10-minute aktiewe brein breke vir 6-weke gedurende skooltyd om hulle fisieke aktiwiteitsvlakke te verbeter. Die kontrole groep gaan nie deelneem aan die aktiewe brein breke intervensie nie. Indien daar na fase twee ’n verbetering in die fisieke aktwiteitsvlakke is van die eksperimentele groep sal aktiewe brein breke geimplementeer word met die kontrole groep. Die aktiewe brein breke gaan plaasvind in die klaskamer tussen akademiese werk. Die aktiwiteite gaan hoofsaaklik bestaan uit ’n verskeidenheid fundamentele bewegings vaardighede wat hulle fisieke aktiwiteitsvlakke sal verbeter en verhoog. Die eksperimentele groep gaan vir 6-weke deelneem aan die intervensie. Die kinders sal deelneem aan twee aktiewe brein breke per dag, twee keer per week.

Na die intervensie sal beide groepe deelneem aan die post-toetsing. Die kinders gaan weer die monitors dra vir vyf aaneenlopende skooldae en hulle gaan ook gevalueer word met die Groot Motoriese Ontwikkelings toets sowel as die Kop Tone Knieë Skouers toets (kyk na kognitiewe funksie). Die evaluasies sal ’n aanduiding gee of die intervensie die kinders se fundamentele bewegingsvaardighede, fisieke aktiwiteitsvlakke sowel as hulle werk geheue verbeter en bevorder het. Drie weke na die post-toetsing gaan die kinders weer gevalueer word met die Groot Motoriese Ontwikkelings toets sowel as die Kop Tone Knieë Skouers toets (kyk na kognitiewe funksie).

Fase twee gaan gedurende die hele derde kwartaal plaasvind. Die navorser sal na die spesifieke skole toe gaan vir die evaluasies en sessies.

3. MOONTLIKE RISIKOS EN ONGEMAKLIKHEID

Daar is geen ernstige risiko’s betrokke by die studie nie. Al die evaluasies en die intervensie sal plaasvind in ’n veilige omgewing by die skool. Daar sal ten alle tye honneurs studente die navorser help gedurende die evaluasies en die intervensie om seker te maak die kinders is veilig en dat hulle die aktiwiteite reg doen. Die navorser en honneurs studente is opgelei in Noodhulp. U kind mag dalk ongemaklik voel gedurende hoë intensiteit aktiwiteite (Bv. Om vinnig te hardloop op een plek). Hy/sy mag dalk spierstyfheid ervaar na die afloop van die sessies en baie warm kry gedurende aktiwiteite. Die navorser sal bewus wees van spesifieke risiko faktore wat die ouer/wettige voog sal aandui in die mediese vorm en ekstra sorg sal gegee word aan die kinders. Die kinders mag dalk ’n bietjie ongemaklik voel met die monitor op hulle gewrigte die eerste dag, dit sal die kinders glad nie negatief affekteer nie. Hulle sal vinnig gewoond raak aan die monitor en dan nie eers agter kom hulle dra dit nie.

Die navorser sal baie bedagsaam/sensitief wees teenoor die kinders indien een van hulle ongemaklik voel kan hulle stop.

4. MOONTLIKE VOORDELE VIR PROEFPERSONE EN/OF VIR DIE SAMELEWING

Die voordele wat die kinders uit hierdie studie sal kry, is dat hulle sal positiewe terugvoering kry op hulle fisieke welstand en hulle alledaagse funksionering. Hulle mag heel moontlik verbeteringe wys in hulle groot motoriese vaardighede, fisieke aktiwiteit sowel as ’n moontlike verbetering in hulle konsentrasie vermoë wat hulle akademies sal help.

Navorsing het bewys dat kinders wat meer aktief is gedurende skooltyd rustiger is in die klaskamer en is ook geneig om beter te konsentreer op hulle akademiese werk. As kinders gedurende skooltyd meer aktief is kan dit moontlik hulle fisieke aktiwiteitsvlakke verbeter en verhoog, hulle sal fikser word en hulle fundamentele bewegings vaardighede sal verbeter.

5. VERGOEDING VIR DEELNAME

Die proefpersone sal egter geen vergoeding kry tydens hierdie studie nie, alhoewel hulle deelname ‘n waardevolle bydrae maak tot ‘n Doktorale graad in Sportwetenskap. Hierdie is ’n vrywillige studie.

6. VERTROULIKHEID

Enige inligting wat deur middel van die navorsing verkry word en wat met u kind in verband gebring kan word, sal vertroulik bly en slegs met u toestemming bekend gemaak word of soos deur die wet vereis. Vertroulikheid sal gehandhaaf word deur middel van beveiliging van die data en die deelnemers sal anoniem bly tydens die studie. Die data sal bewaar word op die navorser se skootrekenaar, wat ’n wagwoord het. Die skootrekenaar sal veilig bewaar word in ’n geslote kabinet in ’n kantoor wat ten alle tye gesluit word binne die Departement. Wanneer die finale artikel oor die studie ingehandig word sal dit veilig bewaar word by die Departement van Sportwetenskap aan die Universiteit van Stellenbosch. Die navorser sal aan die einde van die studie ’n artikel publiseer en alle deelnemers sal anoniem bly.

7. DEELNAME EN ONTTREKKING

U kan self besluit of u kind aan die studie wil deelneem of nie. Indien u kind onwillig is om aan die studie deel te neem, kan u kind ter eniger tyd homself/haarself daaraan onttrek sonder enige nadelige gevolge. U en u kind kan ook weier om op bepaalde vrae te antwoord, maar steeds aan die studie deelneem. Die navorser kan u kind aan die studie onttrek indien omstandighede dit noodsaaklik maak of as die navorser voel die kind wil nie deelneem nie maar sukkel om dit te kommunikeer.

8. IDENTIFIKASIE VAN ONDERSOEKERS

Content removed on data protection grounds

9. REGTE VAN PROEFPERSONE

Content removed on data protection grounds

VERKLARING DEUR PROEFPERSOON OF SY/HAAR REGSVERTEENWOORDIGER

Ek willig hiermee vrywillig in om (my kind) te laat deelneem aan die studie/Ek gee hiermee my toestemming dat die proefpersoon/deelnemer aan die studie mag deelneem. 'n Afskrif van hierdie vorm is aan my gegee.

____

Naam van proefpersoon/deelnemer

____

Handtekening van ouer of regsverteenwoordiger

VERKLARING DEUR ONDERSOEKER

______________________________________ ______________

Handtekening van ondersoeker **Datum**

Toestemmingsvorm (Skool W)

UNIVERSITEIT•STELLENBOSCH•UNIVERSITY
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UNIVERSITEIT STELLENBOSCH
INWILLIGING OM DEEL TE NEEM AAN NAVORSING

Die effek van aktiewe brein breke gedurende ’n skooldag op die fisieke aktiwiteitspatrone, fundamentele bewegings vaardighede en uitvoerende funksie van Graad 1 kinders.

U kind word gevra om deel te neem aan ’n eksperimentele navorsingstudie wat uitgevoer word deur Dr Africa en Odelia van Stryp van die Departement Sportwetenskap aan die Universiteit Stellenbosch. Die resultate sal bydrae tot ’n Doktorale graad. U kind is as ’n moontlike deelnemer aan die studie gekies omdat hy/sy ’n Graad 1 leerder is.

1. DOEL VAN DIE STUDIE

Die primêre doel van die studie is om te bepaal wat die effek van aktiewe brein breke gedurende ’n skooldag sal wees op die fisieke aktiwiteitspatrone, fundamentele bewegings vaardighede en uitvoerende funksie van kinders. Die term uitvoerende funksie beteken om aktiwiteite klaar te maak, uit te voer en te voltooi. Voorbeelde van uitvoerende funskie is om jou huiswerk klaar te maak of jou kamer op te ruim. Deur kinders van ’n jong ouderdom af aktief te kry help om gesonde fisieke aktiwiteits patrone te ontwikkel, wat kinders moontlik sal motiveer om meer aktief te wees en wat hulle fundamentele bewegings vaardigehede sal verbeter. As kinders gedurende die skooldag meer aktief is sal dit moontlik hulle kognitiewe funksie in die klaskamer verbeter wat beteken dat hulle beter sal konsentrasie op akademiese werk. Daarom, wil die navorser graag “active brain-breaks”implementeer met Graad 1 leerders.

2. PROSEDURES

Hierdie studie sal plaasvind gedurende 2019 in twee verskillende fases. As u kind gewillig is om aan die studie deel te neem, sal ons hom/haar vra om aan die volgende deel te neem:

Fase een

Die volgende sal verwag word van die kinders:

1. Om deur middel van prentjies hulle waargeneemde motoriese bevoegdheid aan te dui.
2. Om deel te neem aan ’n evaluasie wat hulle fundamentele bewegings vaardighede en fiksheidsvlakke gaan bepaal.
3. Om deel te neem aan ’n speletjie wat gaan fokus op hulle werkgeheue en aandag.
4. Om deel te neem aan ’n assessering om hulle liggaamsmassa-indeks te bepaal.

Fase een sal tussen een tot twee maande (Februarie-Maart) neem en sal gedurende die eerste kwartaal van 2019 plaasvind. Die navorser en opgeleide assistente sal al die evaluasies by die skool doen.

Fase twee

Na die evaluasies in fase een plaasgevind het gaan die kinders deelneem aan ’n intervensie. In die fase gaan daar ’n pre- en post-toetsing plaasvind. Vir die pre-toetsing gaan die kinders se fisieke aktiwiteitspatrone bepaal word deur ’n “accelerometer” (klein monitor wat soos’n horlosie lyk). Kinders gaan die “accelerometer” op hulle gewrigte dra vir vyf aaneenlopende skooldae. Die onderwysers sal die monitor vir die kinders aansit sodra hulle by die skool kom en hulle sal dit weer afhaal as die skool verdaag. Die monitor sal aandui hoe aktief kinders is gedurende die skooldag. Die totale tydperk van hierdie pre-toetsing sal vyf aaneenlopende dae wees. Na die pre-toetsing sal die klasse op verdeel word in ’n eksperimentele en kontrole groep.Kinders in die eksperimentele groep gaan deelneem aan 10-minute aktiewe brein breke vir 6-weke gedurende skooltyd om hulle fisieke aktiwiteitsvlakke te verbeter. Die kontrole groep gaan nie deelneem aan die aktiewe brein breke intervensie nie. Indien daar na fase twee ’n verbetering in die fisieke aktwiteitsvlakke is van die eksperimentele groep sal intervensie geimplementeer word met die kontrole groep. Die aktiewe brein breke gaan plaasvind in die klaskamer tussen akademiese werk. Die aktiwiteite gaan hoofsaaklik bestaan uit ’n verskeindenheid fundamentele bewegings vaardighede wat hulle fisieke aktiwiteitsvlakke sal verbeter en verhoog. Die eksperimentele groep gaan vir 6-weke deelneem aan die intervensie. Die kinders sal deelneem aan twee aktiewe brein breke per dag, twee keer per week.

Na die intervensie sal beide groepe deelneem aan die post-toetsing. Die kinders gaan weer die monitors dra vir vyf aaneenlopende skooldae en hulle gaan ook gevalueer word met die Groot Motoriese Ontwikkelings toets sowel as die Kop Tone Knieë Skouers toets (kyk na kognitiewe funskie). Die evaluasies sal ’n aanduiding gee of die intervensie die kinders se fundamentele bewegingsvaardighede, fisieke aktiwiteits vlakke sowel as hulle werk geheue verbeter en bevorder het. Drie weke na die post-toetsing gaan die kinders weer gevalueer word met die Groot Motoriese Ontwikkelings toets sowel as die Kop Tone Knieë Skouers toets (kyk na kognitiewe funskie).

Fase twee gaan gedurende die hele tweede kwartaal plaasvind. Die navorser sal na die spesifieke skole toe gaan vir die evaluasies en sessies.

3. MOONTLIKE RISIKO’S EN ONGEMAKLIKHEID

Daar is geen ernstige risiko’s betrokke by die studie nie. Al die evaluasies en die intervensie sal plaasvind in ’n veilige omgewing by die skool. Daar sal ten alle tye honneurs studente die navorser help gedurende die evaluasies en die intervensie om seker te maak die kinders is veilig en dat hulle die aktiwiteite reg doen. Die navorser en honneurs studente is opgelei in Noodhulp. U kind mag dalk ongemaklik voel gedurende hoë intensitiet aktiwiteite (Bv. Om vinnig te hardloop op een plek). Hy/sy mag dalk spierstyfheid ervaar na die afloop van die sessies en baie warm kry gedurende aktiwiteite. Die navorser sal bewus wees van spesifieke risiko faktore wat die ouer/wettige voog sal aandui in die mediese vorm en ekstra sorg sal gegee word aan die kinders. Die kinders mag dalk ’n bietjie ongemaklik voel met die monitor op hulle gewrigte die eerste dag, dit sal die kinders glad nie negatief affekteer nie. Hulle sal vinnig gewoond raak aan die monitor en dan nie eers agter kom hulle dra dit nie. Die navorser sal baie bedagsaam/sensitief wees teenoor die kinders indien een van hulle ongemaklik voel kan hulle stop.

4. **MOONTLIKE VOORDELE VIR PROEFPERSONE EN/OF VIR DIE SAMELEWING**

Die voordele wat die kinders uit hierdie studie sal kry, is dat hulle sal positiewe terugvoering kry op hulle fisieke welstand en hulle alledaagse funksionering. Hulle mag heel moontlik verbeteringe wys in hulle groot motoriese vaardighede, fisieke aktiwiteit sowel as ’n moontlike verbetering in hulle konsentrasie vermoë wat hulle akademies sal help.

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5. **VERGOEDING VIR DEELNAME**

Die proefpersone sal egter geen vergoeding kry tydens hierdie studie nie, alhoewel hulle deelname ‘n waardevolle bydrae maak tot ‘n Doktorale graad in Sportwetenskap.

6. **VERTROULIKHEID**

Enige inligting wat deur middel van die navorsing verkry word en wat met u kind in verband gebring kan word, sal vertroulik bly en slegs met u toestemming bekend gemaak word of soos deur die wet vereis. Vertroulikheid sal gehandhaaf word deur middel van beveiliging van die data en die deelnemers sal anoniem bly tydens die studie. Die data sal bewaar word op die navorser se skootrekenaar, wat ’n wagwoord het. Die skootrekenaar sal veilig bewaar word in ’n geslote kabinet in ’n kantoor wat ten alle tye gesluit word binne die Departement. Wanneer die finale atrikel oor die studie ingehandig word sal dit veilig bewaar word by die Departement van Sportwetenskap aan die Universiteit van Stellenbosch. Die navorser sal aan die einde van die studie ’n artikel publiseer en alle deelnemers sal anoniem bly.

7. **DEELNAME EN ONTTREKKING**

U kan self besluit of u kind aan die studie wil deelneem of nie. Indien u kind onwillig is om aan die studie deel te neem, kan u kind ter eniger tyd homself/haarself daaraan onttrek sonder enige nadelige gevolge. U en u kind kan ook weier om op bepaalde vrae te antwoord, maar steeds aan die studie deelneem. Die navorser kan u kind aan die studie onttrek indien omstandighede dit noodsaaklik maak of as die navorser voel die kind wil nie deelneem nie maar sukkel om dit te kommunikeer.

8. IDENTIFIKASIE VAN ONDERSOEKERS

Content removed on data protection grounds

9. REGTE VAN PROEFPERSONE

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VERKLARING DEUR PROEFPERSOON OF SY/HAAR REGSVERTEENWOORDIGER

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____

Naam van proefpersoon/deelnemer

____

Handtekening van ouer of regsverteenwoordiger

VERKLARING DEUR ONDERSOEKER

____ _______________

Handtekening van ondersoeker Datum

APPENDIX B

Assent form

	STELLENBOSCH UNIVERSITY

PARTICIPANT INFORMATION LEAFLET AND ASSENT FORM

TITLE OF THE RESEARCH PROJECT: Active brain-breaks during a typical school day to explore changes in physical activity patterns of neuro-typical 6-7 year old children.

RESEARCHERS NAME(S): Dr E Africa and Odelia van Stryp

ADDRESS: Department of Sport Science, Stellenbosch University

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What is RESEARCH?

Research is something we do to obtain **NEW KNOWLEDGE** about the way things (and people) work. We use research projects to help us find out more about children and teenagers and the things that affect their lives and their health. We do this to try and make the world a better place!

What is this research project all about?

This research project is about finding out how active you are during school time. We will first do a few evaluations to see what you can do. After that we will be doing fun exercises in the classroom to help and improve your physical activity levels to get you more active and to improve your big muscle movements. After all the fun exercises in the classroom we will be doing some evaluations again.

Why have I been invited to take part in this research project?

I would like to work with children in the age group of 6-7 years old and you are one of them.

Who is doing the research?

This teacher sitting in front of you is from the Stellenbosch University and she is a Kinderkineticist who works with children through playful and fun activities. I am going to do research on all of the friends who are here with you and we are going to play and have fun together. I also have a few friends who will help me with everything.

What will happen to me in this study?

You will be showing me how active and fit you are. We will be doing a lot of fun activities in the classroom. All of these exercises will improve the way you feel on a daily basis.

Can anything bad happen to me?

Nothing bad can happen to you. You may just be a little out of breath while doing the exercises and your muscles may be a bit stiff from all the fun and games. You may also sweat during the activities.

Can anything good happen to me?

You are going to have a fun session with us. You are going to play with your friends and we are going to work on getting you stronger, fitter and more active during school time.

Will anyone know I am in the study?

Your name and details will be confidential and no one will know.

Who can I talk to about the study?

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What if I do not want to do this?

If you don't want to take part in this research and play together you do not have to. Whenever you feel like you do not want to participate you can just tell us, you will not get into trouble and no one would be mad at you.

Do you understand this research study and are you willing to take part in it?

YES NO

Has the researcher answered all your questions?

YES NO

Do you understand that you can pull out of the study at any time?

YES NO

Signature of Child

Date

Inwilligingsvorm

	UNIVERSITEIT STELLENBOSCH

INLIGTINGSTUK EN TOESTEMMINGSVORM VIR DEELNEMERS

TITEL VAN NAVORSINGSPROJEK: "Active brain-breaks" gedurende 'n tipiese skool dag om veranderinge in die fisieke aktiwiteitspatrone van 6-7 jarige neuro-tipiese kinders te verken.

NAVORSER(S): Dr E Africa en Odelia van Stryp

ADRES: Departement Sportwetenskap, Stellenbosch Universiteit.

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Wat is navorsing?

Deur navorsing leer ons hoe dinge (en mense) werk. Ons gebruik navorsingsprojekte of -studies om meer uit te vind oor kinders en tieners se gesondheid.

Waaroor gaan hierdie navorsingsprojek?

Hierdie navorsingsprojek gaan oor om uit te vind hoe aktief is jy gedurende skoolure. Ons gaan eers 'n paar assesserings doen om te kyk wat jy alles kan doen. Na dit gaan ons oefeninge in die klaskamer doen wat jou gaan help om meer fisiek aktief te wees gedurende die dag asook om jou groot spiere sterker te maak. Na al die oefeninge wat ons in die klaskamer gedoen het, gaan ons weer 'n paar evaluerings doen.

Hoekom vra julle my om aan hierdie navorsingsprojek deel te neem?

Ek wil graag met kinders tussen 6-7 jaar oud werk en jy val in hierdie groep.

Wie doen die navorsing?

Die juffrou wat voor jou sit is van Stellenbosch Universiteit. Ek is ’n Kinderkinetikus wat met kinders werk deur speletjies te speel. Ek gaan met jou en al die maatjies in die klas werk. Ek het ook ’n paar maats wat my gaan help met alles wat ons gaan doen.

Wat sal in hierdie studie met my gebeur?

Jy gaan vir my wys hoe aktief en fiks jy is deur pret aktiwiteite in die klaskamer te doen. Al hierdie aktiwiteite gaan poog om jou elke dag beter laat voel.

Kan enigiets fout gaan?

Jy gaan glad nie seerkry tydens die sessies nie. Jy mag dalk uitasem raak en jou spiere kan seer voel na afloop van die aktiwiteite Jy gaan dalk ook sweet nadat ons gespeel het.

Watter goeie dinge kan in die studie met my gebeur?

Jy gaan ‘n baie lekker sessie saam met ons hê. Jy gaan lekker speel saam met jou maatjies en ons gaan daaraan werk om jou spiere sterker te maak.

Content removed on data protection grounds

Wat gebeur as ek nie wil deelneem nie?

As jy nie wil deelneem nie, hoef jy nie. Jy kan ook enige tyd vir ons sê as jy nie meer wil saamspeel nie. Jy sal nie in die moeilikheid kom as jy nie meer saam wil speel nie, niemand sal vir jou kwaad wees nie.

Verstaan jy hierdie navorsingstudie, en wil jy daaraan deelneem?

JA NEE

Het die navorser ál jou vrae beantwoord?

JA NEE

Verstaan jy dat jy kan ophou deelneem net wanneer jy wil?

JA NEE

____________________________ ______________________________

Naam van Kind/Handtekening Datum

APPENDIX C

Active brain-breaks Intervention

(10-minutes per session)

SESSION 1: Run & Catch

WARM UP (Repeat x5):

Children:

- Make 2 pairs
- Hook their left and right arms
- Skip in a small circle on one place

When the instructor blows the whistle, children need to freeze and execute the commands given by the instructor.

Commands:

- high five,
- touch your head with your friend's head,
- touch the ground and jump up,
- shake your body,
- turn around twice.

ACTIVITY 1: RUN

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
Instructor: Use green, orange & red cards ***Green card:*** Run as fast as possible on the spot ***Orange card:*** *Jog on the spot* ***Red card:*** *Stop or freeze*	Children stand behind their chairs - They have to run on the spot as fast as possible. - On the whistle, children need to sit on the chair. Children have to clap their hands while running.

ACTIVITY 2: CATCH

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
- Each child receives a bean bag - They have to throw the bean bag up in the air and catch it. ***Aim***: to catch bean bag with both hands. * 1 minute to do as many as possible.	- Form small groups in the class (about 6 in a group) - Throw the bean bag to each other in a circle.

COOL DOWN:

Children have to march on the spot, while holding their bean bag.

When the instructor blows the whistle, children need to freeze and execute the commands given by the instructor.

Commands:

- Touch your friends head with the beanbag
- Touch your friends back with the beanbag
- Touch your friends feet with the beanbag
- Wave goodbye

SESSION 2: Run & Catch

WARM UP (Repeat x5):

Children:

- Place both hands on the ground and perform 10 mountain climbers
- When the instructor blows the whistle, children need to turn on their backs, and shake their hands and feet.

ACTIVITY 1: RUN

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
- Each child receives a colour block or circle. - They have to stand behind the block or circle and run on the spot. - On the command: Jump in the block and balance on their toes.	- Each child receives a colour block or circle. - They have to stand behind the block or circle and run on the spot. - On the command: Jump in the block, tap your right elbow on your left knee and vice versa.

ACTIVITY 2: CATCH

Variation 1 (Repeat x 2)	**Variation 2** (Repeat x 2)
- Form groups of nine and make a circle. - Children have to catch a small ball in front of their body. ***Aim***: to not trap the ball.	- Form groups of nine and make a circle. Children have to catch a bean bag with one hand.

COOL DOWN:

Children have to stand on the spot, bend down on their haunches, and walk forward with their hands. Their feet need to stay on the same place, if their bodies are straight; they need to move their hands back to their feet. Afterwards they have to stand up and reach for the roof.

Repeat x 2

SESSION 3: Run & Catch

WARM UP (Repeat x 5):

Children: • Place both hands and feet on the ground, in a crab position. • They need to move their feet up and down as fast as possible. • When the instructor blows the whistle, children need to turn and lie flat on their stomachs, open their arms to the side and lift up their legs (aero plane).

ACTIVITY 1: RUN

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
- Each child receives a colour block or circle. - They have to stand behind the block or circle and run on the spot. - On the command: Jump in the block and keep on running. - While they are running, tap your left elbow on your right knee and vice versa.	- Each child receives a colour block or circle. - They have to stand behind the block or circle and perform high knees on the spot. - On the command: Jump in the block, balance on your toes and high five a friend.

ACTIVITY 2: CATCH

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
- Children receive a small cone and a bean bag. - Place the bean bag in the cone. - Hold the cone and throw the bean bag up in the air and catch it with the cone.	- Children receive a small cone and a bean bag. - Place the bean bag in the cone. - Hold the cone with the non-dominant hand and throw the bean bag up in the air and catch it with the cone.

COOL DOWN:

Children have to stand on the spot, bend down on their haunches, and walk forward with their hands. Their feet need to stay on the same place, if their bodies are straight; they need to move their hands back to their feet. Afterwards they have to stand up, hang their arms down, and swing their arms sideways (leaves of a tree). Repeat x 2

SESSION 4: Run & Catch

WARM UP (Repeat x5):

Children: • Make 2 pairs • Hook their left and right arms • Skip in a small circle on one place
When the instructor blows the whistle, they need to stop and change direction.

ACTIVITY 1: RUN

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)

- Each child receives a colour block or circle. - They have to stand behind the block or circle and run on the spot. - On the command: Jump in the block, stand still and keep on using your arms (like you are running).	- Each child receives a colour block or circle. - They have to stand behind the block or circle and perform high knees on the spot and use their arms. - On the command: Jump in the block, and they have to touch their toes.

ACTIVITY 2: CATCH

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
- Children have to make pairs. - Give each child a small cone one bean bag per pair. - They have to throw and catch the bean bag with the cone.	- Children have to make pairs. - Give each child a small cone one bean bag per pair. - They have to throw and catch the bean bag with the cone by using their non-dominant hand.

COOL DOWN:

Children have to stand on the spot, bend down on their haunches, and walk forward with their hands. Their feet need to stay on the same place, if their bodies are straight; they need to move their hands back to their feet. Afterwards they have to sit down with their legs straight, and their hands need to reach for their toes.

Repeat x 2

SESSION 5: Gallop & Throw

WARM UP (Repeat x5):

Children:

- Perform hopscotch on the spot, by alternating a double and single leg hop.

When the instructor blows the whistle, they need to stop and balance on one leg for two seconds.

ACTIVITY 1: GALLOP

Variation 1 (Repeat x 5)	**Variation 2** (Repeat x 3)
- Children have to pair up; each pair receives a material band. - One child stands in the band, elbows tucked in, the other child stands behind their friend, holding their elbows. - The child in front swings their arms forward and backwards in a rocking motion. - On the whistle, they need to switch.	- Stand on the carpet. - Instructor will use arrows. - Children have to step in the direction of the arrow, and jump with their other leg to the leading foot.

ACTIVITY 2: THROW

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
- Children have to form pairs. - The instructor indicates which foot to use. - Children have to try and step on their friends' foot, while simultaneously protect their own. - On the whistle, they need to change feet.	- Children have to form pairs and face each other. - Step forward with the preferred foot, touch their own backs, with the preferred throwing arm, and give their friend a high five.

COOL DOWN:

Children have to sit on the floor, lift their feet off the floor and hold them in the air for 5 seconds, then relax and lie flat on the floor. Repeat x 2

SESSION 6: Gallop & Throw

WARM UP (Repeat x5):

Children: • Stand on the spot, jump with feet together from side to side.
When the instructor blows the whistle, they need to stop and make windmills with their arms.

ACTIVITY 1: GALLOP

Variation 1 (Repeat x 5)	**Variation 2** (Repeat x 3)
- Children have to make groups of 4/5, and stand in a line behind each other. - While holding each other's elbows, they need to swing their arms forward and backwards and use their upper bodies. - The child in front swings their arms forward and backwards in a rocking motion. - On the whistle, they need to switch.	- Children stand behind a colour block or circle. - They will step on to the block with their leading foot. - In a jumping action, kick the leading foot towards the front of the block and land with the other foot on the block.

ACTIVITY 2: THROW

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
- Children have to form pairs. - The instructor indicates which foot to use. - Children have to try and step on their friends' foot, while simultaneously protect their own. - On the whistle, they need to perform scissor jumps.	- Children receive a piece of cotton wool. - They will hold it in their preferred throwing hand, they have to touch their backs, and throw the cotton wool forward with their arms touching their hip.

COOL DOWN:

Children have to stand on the spot, reach up for the sky while standing on their tippy toes and stretch their arms out; then they have to reach down and make a ball with their bodies by giving themselves a big hug. Repeat x 2

SESSION 7: Gallop & Throw

WARM UP (Repeat x 3):

Children: • Stand hop on the spot.
When the instructor blows the whistle, they need to stop and follow a sequence of commands: nod, clap and shake your hips.

ACTIVITY 1: GALLOP

Variation 1 (Repeat x 3)
- Children stand behind a colour block or circle. - They have to step on the block with their leading foot. - In a jumping action, kick the leading foot towards the front of the block and land with the other foot on the block.

ACTIVITY 2: THROW

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
- Children have to form pairs. - Each pair receives one bean bag. - They have to underarm throw the bean bag to each other for 1 minute. ***Aim***: swing arm back.	- Form small groups of 5/6. - Children have to underarm throw the bean bag to each other.

COOL DOWN:

Children have to sit on their haunches on the floor, take a big breath in and lift their arms above their head. As they breathe out, they need to lower their hands and make a child's pose on the floor. Repeat x 2

SESSION 8: Gallop & Throw

WARM UP (Repeat x 5):

Children: • Run on the spot.
When the instructor blows the whistle, they need to stop and lift a leg up and clap hands underneath their leg for 5 seconds.

ACTIVITY 1: GALLOP

Variation 1 (Repeat x 3)
- Children will have no block or circle. - In a jumping action, kick the leading foot towards the front and land with the other foot where the front foot started. - The instructor will show an arrow, and children have to gallop in that direction. - Only one gallop at a time.

ACTIVITY 2: THROW

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
- Children have to make pairs. - Each pair will have one bean bag. - Children perform a lunge and simultaneously underarm throw the bean bag to their friend. The friend needs to catch the bean bag.	- Children receive a piece of cotton wool. - They will hold it in their preferred throwing hand, touch their backs, and throw the cotton wool forward with their arms touching their hip.

COOL DOWN:

Each child has to stand facing a friend with a cone placed between them. Follow the commands: • Touch your ear • Touch your feet • Touch your knees • Touch the cone – they need to see who can grab the cone first. Repeat x 2

SESSION 9: Leap & Roll

WARM UP (Repeat x5):

Children: • Stand behind a block or circle.
When the instructor blows the whistle, they need to run around the block or circle, when the whistle is blown twice, they need to change direction.

ACTIVITY 1: Leap

Variation 1 (Repeat x 20 seconds x 2)	**Variation 2** (Repeat x 3)

- Children perform ski (one foot in front, other foot behind, alternate feet while hopping) hops on the spot. Jump while alternating feet. When one foot is up, it needs to be accompanied by the opposite arm.	- Children stand behind a beacon. - On the whistle, they need to jump over the beacon as far as possible. - They must land on one foot.

ACTIVITY 2: ROLL

Variation 1 (Repeat x 3)
- Children have to make pairs, face each other (1 meter apart). One child holds the tennis ball. - On the command, the child needs to bend down and roll the ball to their friend. - On the command, swap the ball to the other child. ***Aim***: Swing back the arm

COOL DOWN:

Children have to lie on their backs and hold their legs against their stomach like a little ball. They have to roll from side to side. On the command, they have to jump up, reach out to the sky while standing on their toes. Repeat x 2

SESSION 10: Leap & Roll

WARM UP (Repeat x5):

Children: • Pair up with a friend. • Hook arms in. • Skip in a small circle.
When the instructor blows the whistle, they need to touch their toes, ears, mouth or knees.

ACTIVITY 1: LEAP

Variation 1 (Repeat x 1 minute x 2)
- Children stand behind a block or circle. - Stand on one foot, hop over the block and land on the opposite foot. - Turn around and do the same.

ACTIVITY 2: ROLL

Variation 1 (Repeat x 3)	**Variation 2** (Repeat x 3)
- Children have to make pairs. - Each pair receives one tennis ball. - Child with the ball has to roll the ball as accurately as possible to their friend. ***Aim***: Swing back the arm and keep the ball flat on the ground.	- Children form groups of 5/6. - Roll the ball to each other in the group. - Before rolling the ball, call the name of the child you are rolling the ball to.

COOL DOWN:

Children have to make groups of 5/6. Together they will sing “ring-around-the-rosie”, and fall down. Repeat x 2

SESSION 11: Leap & Roll

WARM UP (Repeat x5):

Children: • Receive a bean bag. • Stand with their feet against each other. • Bend down and rotate the bean bag as fast as possible around your feet.

ACTIVITY 1: Leap

Variation 1 (Repeat x 10 per leg)	**Variation 2** (Repeat x 3)
- Children receive a bean bag. - Stand behind the bean bag on one foot. - Press the dominant foot as hard as possible on the ground, swing the non-dominant foot over the bean bag and land on the dominant foot. - Change feet.	- Children stand on both feet behind a bean bag. - Leap over the bean bag, by landing on the opposite foot. - Make use of arms.

ACTIVITY 2: ROLL

Variation 1 (Repeat x 3)
- Children have to make pairs, face each other (1 meter apart). One child holds the bean bag. - On the command, the child needs to bend down in a lunge, swing arm back throw the bean bag between the friends feet.

COOL DOWN:

A game of “simon says” will be played, whenever the command “fall” is instructed, the children need to fall down. Repeat x 2

SESSION 12: Leap & Roll

WARM UP (Repeat x5):

Children: • Pair up, each pair receives on bean bag. • Face each other and place the bean bag on the ground**.**
The instructor will call out body parts to touch, when they hear the command "bean bag", they need to see who can grab it first.

ACTIVITY 1: LEAP

Variation 1 (Repeat x 5 per leg)	**Variation 2** (Repeat x 5)
- Children receive a colour dot and a square. - Stand in the square. - Jump on the dot by landing on one foot. - Switch legs.	- Children receive a medium size cone. - Stand behind the cone and jump over it, start on one leg and land on the other leg.

ACTIVITY 2: ROLL

Variation 1 (Repeat x 4)
- Children receive a bean bag. - On the command, the child needs to bend down in a lunge with the bean bag in one hand. - In the lunge position, take the bean bag over the head and place it in the other hand, get back up.

COOL DOWN:

Each child receives a bean bag and they have to trace the outside of their body by starting from one foot, bringing it up to the shoulder, over the head and down to the other foot. Repeat x 2

SESSION 13: Slide & Strike

WARM UP (Repeat x5):

Children: • Stand on a colour dot.
Instructor**: Use green, orange & red cards** *Green card:* **Jump on and off the dot in a square formation** *Orange card:* ***March with high knees on the dot*** *Red card:* ***Stop or freeze*** On the whistle – the instructor will call out a number and children have to form groups with that number of children and return to their dots.

ACTIVITY 1: SLIDE

Variation 1 (Repeat x 5)	**Variation 2** (Repeat x 5)
- Children receive a colour dot/square and stand on it. - Instructor will call out a sequence (2-1-1). - Children need to jump the sequence (2-both legs & 1 – one leg).	- Children receive a colour dot/square. - Stand on the left side of the square. - Step with the right leg on the dot/square, with a jump bring the left leg towards the right leg. - Step out of the block with the right leg, and perform it again by starting with the left leg.

ACTIVITY 2: STRIKE

Variation 1 (Repeat x 5)
- Children receive a bat (ice-cream stick) and a circle. - Stand behind circle, step with one foot on the circle (opposite the dominant hand). - Perform a striking motion, swing the bat backwards and follow through over the shoulders.

COOL DOWN:

Each child receives a bean bag, then they have to sit on the ground, place the bean bag on their heads, lift up the legs and see how long they can keep that position. Repeat x 2

SESSION 14: Slide & Strike

WARM UP (Repeat x5):

Children: • Receive a bean bag. • Balance bean bag on head, while turning around in a small circle.
When the instructor blows the whistle, they need to find a friend and jump up and down as fast as possible.

ACTIVITY 1: SLIDE

Variation 1 (Repeat x 5)
- Children have to make groups of 5/6, make a circle and hold hands. - They have to slide right or left (listen to the instructions).

ACTIVITY 2: STRIKE

Variation 1 (Repeat x 4)	**Variation 2** (Repeat x 3)
- Children pair up and face each other. - They will receive an ice-cream stick and dot. - They will step onto the dot and practice the correct swing.	- Children receive an ice-cream stick and dot. - They have to step on the dot and practice moving their weight forward and backwards.

COOL DOWN:

Form two long lines, then children will do the Mexican wave. As they go down, they have to reach for their toes. Repeat x 2

SESSION 15: Slide & Strike

WARM UP (Repeat x5):

Children: • Children divide up into two teams. • They have to stand in a line next to each other. • They have to pass a bean bag to each other in the line while standing on one leg. Once they have passed the bean bag, they have to sit down on the ground.
When the instructor blows the whistle, they need to find a friend and jump up and down as fast as possible.

ACTIVITY 1: SLIDE

Variation 1 (Repeat x 5)	**Variation 2** (Repeat x 5)
- Children receive a bean bag. - They have to perform two right leg hops and go into a side lunge, then two left leg hops and go into a side lunge. - When they do the lunge, they have to touch their foot with the bean bag.	- Children have to pair up. - They have to stand next to each other. - They have to perform two slides away from each other and give a clap after the last one. - Perform two slides back to each other and give each other a high five.

ACTIVITY 2: STRIKE

Variation 1 (Repeat x 5)
- Children receive an ice-cream stick and a dot. - Practice transferring weight forward and backwards when striking. - Stand with opposite foot to dominant hand on dot (sideways rotated position). - Rock forward and backwards on front and back leg. - Perform striking motion once all the weight is at front foot. ***Aim***: Swing the arm back and keep the ball flat on the ground.

COOL DOWN:

Children will play the "yes", "no" game. When they answer "yes" to a question they have to stand up, and when they answer "no" they have to sit down. Repeat x 2

SESSION 16: Slide & Strike

WARM UP (Repeat x5):

Children:

- Divide into two teams and make a line.
- The person in front will pass a soft ball through their legs to the person behind them.
- As soon as the child has passed the ball, they need to sit down.

ACTIVITY 1: SLIDE

Variation 1 (Repeat x 3)
- Children form groups of 5/6, and make a circle. - They have to slide in the instructed direction. On the command "stop", children have to freeze. - When they start to slide again, they have to change direction.

ACTIVITY 2: STRIKE

Variation 1 (Repeat x 5)	**Variation 2** (Repeat x 2)
- Children receive a dot. - Stand with one foot on the dot, slightly rotated. - Children have to hug themselves and practice rotating their hips. - Perform the striking motion while hugging themselves.	- Children receive an ice-cream stick and a dot. - Step on the dot, swing the stick back while performing three small swings and then follow the full striking action through.

COOL DOWN:

Children will play the robot clap-game. *Commands:* • Green dot – clap hands hard • Yellow dot – clap softer • Red dot – no clapping Repeat x 2

SESSION 17: Jump & Dribble

WARM UP (Repeat x5):

Children: • Pair up, receive a bean bag. • Stand with backs against each other.
On the instructors commands, pass the bean bag as follow: • Underneath the legs • Above the heads • Sideways

ACTIVITY 1: JUMP

Variation 1 (Repeat x 5)	**Variation 2** (Repeat x 5)
- Children receive a bean bag. - They have to jump on and off the bean bag. - On the whistle they have to stand on their toes on the bean bag.	- Children have to pair up, one colour square per pair. - They have to hook their arms in and stand in the square. - They have to jump (feet together) out of the square and back in while keeping their arms engaged.

ACTIVITY 2: DRIBBLE

Variation 1 (Repeat x 5)
- Children pair up and receive one tennis ball. - The one child needs to tickle the ball around their feet and bounce it to their friend. The partner must do the same.

COOL DOWN:

Children have to turn around on the spot. On the whistle they have to balance on one leg with their hands on their hips. Repeat x 2

SESSION 18: Jump & Dribble

WARM UP (Repeat x5):

Children: • Pair up; receive a bean bag. • Stand on one leg with backs against each other.
On the instructors commands, pass the bean bag as follow: • Underneath the legs • Above the heads • Sideways

ACTIVITY 1: JUMP

Variation 1 (Repeat x 3)
- Children receive a bean bag and they have to place it on the ground before them. - They have to stand on the bean bag and jump in the direction of the arrow. - Land as softly as possible.

ACTIVITY 2: DRIBBLE

Variation 1 (Repeat x 2 x 1 minute)	**Variation 2** (Repeat x 5)
- Children receive a tennis ball. - They have to bounce and catch the ball with two hands. - Bounce ball at waist level.	- Children have to pair up and face each other. - Bounce the ball to the partner's feet. - Bounce the ball with one hand and catch with two.

COOL DOWN:

Children will perform star jumps.
Commands:
- Green dot – star jumps very fast
- Yellow dot – star jumps in slow motion
- Red dot – freeze

Repeat x 2

SESSION 19: Jump & Dribble

WARM UP (Repeat x5):

Children:
- Receive a bean bag.
- Throw and catch the bean bag until the whistle blows.

On the instructors commands, do the following with the bean bag:
- Place the bean bag on your head.
- Put the bean bag on the ground and jump over it.
- Hold the bean bag in the air and walk in a circle.

ACTIVITY 1: JUMP

Variation 1 (Repeat x 8)	**Variation 2** (Repeat x 5)
- Children receive a bean bag, place it on the ground. - They have to bend down and pick the bean bag up and jump as high as possible while turning 180 degrees and then place the bean bag down. - On the whistle they have to stand on their toes on the bean bag.	- Children receive a colour square. - They have to perform fast feet behind the square. - On the whistle they have to jump as far as possible over the square.

ACTIVITY 2: DRIBBLE

Variation 1 (Repeat x 5)
- Children receive one tennis ball and a square. - They have to dribble the ball around the square with one hand. - On the whistle they have to change direction.

COOL DOWN:

Children have to lie on their backs and move their legs as if they are riding a bicycle. On the command: • Stand in tree pose. • Jump as high as possible • Stand on your toes. Repeat x 2

SESSION 20: Jump & Dribble

WARM UP (Repeat x5):

Children: • Pair up, receive a bean bag. • Hop on one leg.
On the whistle, do the following commands with the bean bag: • Touch your friends shoulder • Put the bean bag on a friends head • Rotate the bean bag around your body

ACTIVITY 1: JUMP

Variation 1 (Repeat x 3)
- Children receive a bean bag and they have to place it on the ground before them. - They have to make a little egg with their body. - On the whistle, they have to jump over the bean bag turn around and make an egg.

ACTIVITY 2: DRIBBLE

Variation 1 (Repeat x 4)	**Variation 2** (Repeat x 5)
- Children pair up and receive a tennis ball. - They have to face each other. - One child will bounce the ball and, on the whistle, the other child needs to catch the ball.	- Children have to make groups of 5/6 and stand in a line. - Each group receives one ball. - Child in front bounces the ball x4, run to the back of the line and rolls the ball to the front for the next person to start.

COOL DOWN:

Children have to pair up, sit down and face each other. They have to hook their feet in and do a sit-up, when they come up, they can high five each other. Repeat x 4

SESSION 21: Hop & Kick

WARM UP (Repeat x5):

Children: • Perform jumping jumps.
On the instructor's commands, they need to make a little egg.

ACTIVITY 1: HOP

Variation 1 (Repeat x 5)	**Variation 2** (Repeat x 5)
- Children receive a bean bag, place it on the ground. - The presenter will use green dot (balance on dominant leg on beanbag for 5 seconds) and red dot (heel-to-toe position behind bean bag).	- Place a few ropes on the ground. - Children have to balance on the ropes. - On the whistle, balance on non-dominant leg.

ACTIVITY 2: KICK

Variation 1 (Repeat x 2)
- Children receive a small cone and stand behind it. - Children have to run on the spot and on the whistle, kick/knock over the cone with the dominant foot.

COOL DOWN:

Children have to be on all fours on the ground (bear). On the command: • Lift up right leg. • Lift up right arm. • Lift up right arm and leg. Repeat x 2

SESSION 22: Hop & Kick

WARM UP (Repeat x5):

Children: • Perform scissor jumps (demonstrate if they do not know what it is).
On the instructor's commands, they need to balance on their toes.

ACTIVITY 1: HOP

Variation 1 (Repeat x 5)	**Variation 2** (Repeat x 5)
- Place a bean bag in front of each child. - Instructor will use a green dot and a red dot. - Green dot – jump like a frog. - Red dot – balance on non-dominant leg on bean bag.	- Place a few ropes in circles on the ground. - Children have to walk on their toes on the circle. - On the whistle, balance in a heel to-toe-position.

ACTIVITY 2: KICK

Variation 1 (Repeat x 2)
- Children receive a small cone and stand behind it. - Children have to balance on non-dominant leg, and on the whistle, kick/knock over the cone with the dominant foot.

COOL DOWN:

Children have to be in a crab position on the ground. On the command: • Lift up right leg. • Lift up right arm. • Lift up right arm and leg. Repeat x 2

SESSION 23: Hop & Kick

WARM UP (Repeat x5):

Children: • Make circles of 3 or 4 children per group. • They have to run in the circle.
On the instructor's commands, they need to jump like a frog.

ACTIVITY 1: HOP

Variation 1 (Repeat x 5)	**Variation 2** (Repeat x 5)
- Each child receives a block/circle. - Hop on dominant leg on the block. - On the whistle, stand heel-to-toe on the block.	- Each child receives a small cone and stands behind the cone. - Children have to balance on their dominant leg and hop over the cone with their dominant leg.

ACTIVITY 2: KICK

Variation 1 (Repeat x 2)
- Children receive a small cone and stand behind it. - Children have to run on the spot. - On the whistle, they need to balance on their non-dominant leg and kick/knock over the come with their dominant leg.

COOL DOWN:

Children have to walk like a caterpillar. Repeat x 2

SESSION 24: Hop & Kick

WARM UP (Repeat x5):

Children: • Perform hopscotch on the spot.
The instructor will give a sequence such as – 2-1-1.

ACTIVITY 1: HOP

Variation 1 (Repeat x 5)	**Variation 2** (Repeat x 5)
- Place 6 blocks on the ground. - Children have to make 5 lines behind the blocks. - Hop with dominant leg in each block. - Children waiting in the line have to stand in the heel-to-toe position.	- Form groups of 5/6 and make a circle. - Bunny hops in the circle. - On the first whistle, start hopping on one leg, second whistle balance on toes.

ACTIVITY 2: KICK

Variation 1 (Repeat x 2)
- Children have to pair up, and each pair receives a tennis ball. - Children have to kick the ball to their friend, stop the ball and kick it back.

COOL DOWN:

Children have to lie on their stomachs and open their arms and lift their legs up for 10 seconds. Repeat x 2

APPENDIX D

Western Cape Education Department Permission Letter

Content removed on data protection grounds

APPENDIX E

Ethics Clearance Letter (Stellenbosch University)

Content removed on data protection grounds

Ethics Clearance Letter (Coventry University)

Certificate of Ethical Approval

Applicant: Odelia Roodt

Project title:

The effects of active brain-breaks during a school day on physical activity patterns, fundamental movement skills and executive functioning in Grade 1 children

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

Date of approval:

03 October 2019

Project Reference Number: P94100

APPENDIX F

Insurance letter

Content removed on data protection grounds

APPENDIX G

Language editor letter

Content removed on data protection grounds