DOCTORAL THESIS

Developing a simple tool for screening the health and motor performance-related fitness of children.

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Developing a simple tool for screening the health and motor performance-related fitness of children.

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ABSTRACT

The health and fitness of Australian children, including the onset of overweight and obesity, largely as a result of increasing sedentary behaviour, decreasing physical activity and poor dietary intake, can and will impact on Australia’s future health, education, economic and social prosperity. It is therefore important to enhance opportunities for Australia’s children to be physically active and as fit and as healthy as possible. Although much attention has been given to healthy eating and increasing physical activity in order to maintain or improve the health and wellbeing of Australian children, little attention has been given to motor proficiency as a determinant of physical activity in children. It is proposed that in order to curtail the current levels of child overweight and obesity, children must develop adequate motor proficiency and cardiorespiratory fitness, as these two attributes will likely enhance a child’s ability to participate in age-appropriate physical activity. It is therefore essential to develop systems and tools that will identify early, those children who have poor health-related fitness with motor incompetency as a possible contributing factor. This thesis aimed to develop a simple tool for accurately screening the health and motor performance-related fitness of children to guide the referral process to physiotherapy for early intervention of motor incompetency. In doing so, the KidFit Screening Tool was developed using a number of methodological approaches, over three (3) stages.

The initial stage included a ‘needs assessment’ that started with understanding the literature around the impact of childhood overweight and obesity in Australian and global contexts, as well as determining the current and potential role of physiotherapists in preventing and dealing with this chronic condition. The review of the literature (Chapter 2) suggests that physiotherapists are skilled to deal with motor incompetence (a factor associated with overweight and obesity) but despite this, the national survey of Australian physiotherapists (Chapter 3) demonstrated little engagement by Physiotherapists with overweight or obese children for a number of
reasons that were predominantly related to individual workplace service models and policy (e.g. ‘...not prioritized by service’). The tools and outcome measures being used by physiotherapists were specifically investigated as part of this survey to help inform the development of the screening tool. Notably, less than half of Physiotherapists surveyed, assessed the motor skills of overweight and obese children and this was also attributed to the environment and service models where physiotherapists worked. This survey data provided insight into the reasons why physiotherapists were providing only limited services to overweight and obese children and these factors require consideration regarding the utility of the KidFit Screening Tool.

The second stage of this doctoral research involved the development of a pilot screening tool, which was based on the available literature regarding the health and motor performance-related fitness impairments of overweight and obese children. This pilot screening tool, along with a number of additional previously validated health and motor proficiency measures were used during data collection with a total of 260 children aged 5 to 17 years. The series of studies undertaken in this second stage of the doctoral research, explored the relationship between motor proficiency and health-related fitness measures and examined the psychometric properties of the newly designed measures within the KidFit Screening Tool. Prior to data collection a quality assurance step was undertaken to ensure that all persons collecting data (Physiotherapists and PE Teachers) were appropriately trained in taking each of the measures and the inter-tester reliability was assessed for each of the newly designed measures (Chapter 4). The absolute agreement between testers was very high (CA > 0.9) for each of the measures supporting the notion that adequately trained PE teachers and physiotherapists were appropriate to assist with data collection for this research and could potentially assist with screening the health and motor performance-related fitness of children on a larger scale. Chapter 5 examined the relationship between children’s motor proficiency and health-related fitness to further inform the development of the KidFit Screening Tool. Significant predictive relationships ($r^2>0.6, p<0.01$) were revealed between motor proficiency and BMI, waist...
circumference and VO$_2$peak. These results indicate that motor proficiency should be a focus of investigation for children with poor health-related fitness. In Chapter 6 the concurrent and predictive validity of the Modified Shuttle Test-Paeds (MSTP) was investigated. A significant and strong correlation was found between VO$_2$peak and the MSTP ($r^2=0.749$, $p<0.001$) suggesting it is a valid measure of cardiorespiratory fitness with a high predictive validity for estimating VO$_2$peak in children. The MSTP was therefore included in the refined KidFit Screening Tool as a health-related fitness measure. In Chapter 7 the test-retest reliability and the concurrent validity of the Speed and Agility Motor Screen (SAMS) as a motor performance-related fitness measure for children was investigated. The SAMS had strong test-retest reliability (ICC=0.87) and strong predictive validity for determining gross-motor ability with overweight/obese children ($r^2=0.641$, $p=0.001$). Based on these psychometric properties, the SAMS was also included in the refined KidFit Screening Tool for feasibility testing.

The final stage of this doctoral research involved a modest feasibility study (n=57) to test the diagnostic accuracy of the KidFit Screening Tool for identifying children with and without health and motor performance-related fitness impairments (Chapter 8). The KidFit Screening Tool, uses designated cut-off values for the two measures included (i.e. the SAMS and the MSTP) and ROC analysis revealed moderate to high accuracy for identifying children with and without: overweight/obesity (AUC: 0.895); poor motor skills (AUC: 0.822) and poor cardiovascular fitness (AUC: 0.912). These results address the main aim of this PhD research program, providing an accurate screening tool that can be used by those who work with children to guide decisions regarding referral to specialised services for detailed investigation of motor proficiency as an underlying contributor to a child’s poor health-related fitness. Future studies beyond this doctoral research are planned to develop normative data for the KidFit Screening Tool and to test its generalisability and utility to a wider population of Australian children and adolescents.
DECLARATION BY AUTHOR

This thesis is submitted to Bond University in fulfilment of the requirements of the degree of Doctor of Philosophy. This thesis represents my own original work towards this research degree and contains no material which has been previously submitted for a degree or diploma at this University or any other institution, except where due acknowledgement is made.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include material which to a substantial extent has been submitted for the award of any other degree or diploma of a university of institution of higher learning.

Nikki R Milne
PhD Candidate

Date: 18th December, 2014.
DECLARATION OF CONTRIBUTIONS TO CO-AUTHORED WORKS CONTAINED IN THE THESIS

All co-authors on the chapters/papers indicated below have approved these papers for inclusion in Nikki Milne’s doctoral thesis.

Declaration: Milne was responsible for the design of the study, data collection, data analysis, writing, editing and submitting the abstract and poster. Low Choy (previous PhD supervisor) supervised the design and data collection for the study. Low Choy and Steele (Faculty statistician at the time) guided the analysis of data and reviewed the progressive drafts of the abstract and poster prior to presentation.

Declaration: Milne was responsible for the design of the study, data collection, data analysis, writing, editing, and submitting the article. Low Choy (previous PhD supervisor) supervised the design and data collection for the study. Low Choy, Leong, Hughes and Hing guided the analysis of data, reviewed the progressive drafts of the paper and provided detailed feedback.

Declaration: Milne was responsible for the design of the study, data collection, data analysis, writing, editing, and submitting the article. Leong and Hing supervised the
design of the study, guided the data collection and analysis, reviewed the progressive drafts of the paper and provided detailed feedback. Professor Nancy Low Choy (previous PhD supervisor) supervised the initial study design and Dr Michael Simmonds (Accredited Exercise Physiologist), assisted with the technical components of measuring peak oxygen uptake with participants.

Milne N, Simmonds MJ, Hing W. (2014). Modified Shuttle Test-Paeds: a valid cardiorespiratory fitness measure for children. *Declaration: Milne was responsible for the design of the study, data collection, data analysis, writing, editing, and submitting the article. Simmonds and Hing supervised the design of the study, guided the data collection and analysis, reviewed the progressive drafts of the paper and provided detailed feedback. Associate Professor Elaine Beller and Dr Robin Orr provided advice regarding the statistical analysis of data.*

Milne N, Hing W. (2015). Validating the Speed and Agility Motor Screen (SAMS) as a motor performance-related fitness measure for children. *Journal of Australian Strength and Conditioning.* Full paper submitted. *Declaration: Milne was responsible for the design of the study, data collection, data analysis, writing, editing, and submitting the article. Hing supervised the design of the study, guided the data collection and analysis, reviewed the progressive drafts of the paper and provided detailed feedback. Associate Professor Elaine Beller, Dr Robin Orr and Dr Allan Abbott provided advice regarding the statistical analysis of data.*
STATEMENT OF CONTRIBUTIONS BY OTHERS TO THE THESIS AS A WHOLE

Professor Nancy Low Choy (previous PhD supervisor) assisted in the original development of the research objectives, formulation of the research methodology and interpretation of the data for the survey of physiotherapists regarding child obesity practices.

Professor Roger Hughes, Associate Professor Gary Leong and Professor Wayne Hing (current PhD supervisors) have assisted with formulation of research methodology and interpretation of the data for subsequent studies within this research higher degree. These supervisors have also provided thesis guidance through review of the manuscript, editorial assistance and detailed comments and feedback.

Dr Michael Simmonds, assisted with supervising the design of one of the studies in this thesis document, assisted with the data collection and analysis of peak oxygen uptake for children in this study as an Accredited Exercise Physiologist and reviewed the progressive drafts of the manuscript for the related study, through to journal submission.

I as the PhD candidate developed the objectives, wrote the ethics applications, recruited the participants, conducted the research studies, conducted and interpreted the statistical analysis and wrote and edited the thesis following feedback from supervisors.
PUBLICATIONS AND CONFERENCE PRESENTATIONS

a) Publications

Abstracts:


Papers:


**b) Conference presentations by the candidate directly related to this Thesis**

**Poster Presentations:**


Podium Presentations (presenting author underlined):


NOTE: Awarded Best Podium Presentation, Paediatric Stream.
ADDITIONAL PUBLICATION BY THE AUTHOR RELEVANT TO THE THESIS
BUT NOT FORMING PART OF IT

a) Publications

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Paediatric, Obesity, Overweight, Cardiorespiratory, Motor Proficiency, Fitness, Health, Children, Adolescents, Screening, Physiotherapy.

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AUTHOR’S CONFIRMATORY STATEMENTS

The opinions expressed in this study are those of the author and do not necessarily reflect those of Bond University.

The National Statement of Ethical Conduct in Human Research (developed jointly by the National Health and Medical Research Council, Australian Research Council and the Australian Vice Chancellors Committee, March 2007) has been adhered to during the conduct of this research.
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### LIST OF ABBREVIATIONS AND GLOSSARY OF TERMS

**ABS** – Australian Bureau of Statistics  
**AIHW** – Australian Institute of Health and Welfare  
**ANOVA** – Analysis of Variance statistic, for analysing between group means  
**AUC** – Area Under the Curve (related to ROC Analysis)  
**APA** – Australian Physiotherapy Association  
**APA NPG** – Australian Physiotherapy Association, National Paediatric Group  
**BEEP Test** – Australian version of the 20m Modified Shuttle Run Test  
**BMI** – Body Mass Index  
**BMI Z** – Body Mass Index (standard deviation from BMI for age)  
**BOTMP** – Bruininks Oseretsky Test of Motor Proficiency  
**BOT2** – Bruininks Oseretsky Test of Motor Proficiency (2\textsuperscript{nd} Edition)  
**BP** – Blood Pressure  
**BUHREC** – Bond University Human Research Ethics Committee  
**CA** – Cronbach’s Alpha statistic  
**CDC** – Centres for Disease Control and Prevention  
**CI** – Confidence Interval  
**Concurrent Validity** – a statistical method to assist with defending the use of a test for predicting another outcome. Concurrent validity can be demonstrated when the test being examined, correlates highly with another measure that has previously been validated.  
**CRF** – Cardiorespiratory Fitness  
**CV** - Cardiovascular  
**CVD** – Cardiovascular Disease  
**DCD** – Developmental Coordination Disorder  
**Diagnostic Accuracy** – a statistical method used to examine how well a measure discriminates between having and not having a condition.  
**DF** – Degrees of Freedom
DXA – Dual Energy X-ray Absorptiometry
ECG - Electrocardiogram
ER – Efficiency Ratio
FFM – Fat Free Mass
FM – False Negative
FP – False Positive
GAS – Goal Attainment Scale
Go4Fun – NSW modified MEND Program go4fun@betterhealthcompany.org
GP – General Practitioner
HDL – High density lipoprotein
Health-related Fitness - Cardiorespiratory endurance, muscular strength and endurance, body composition and flexibility
HPE teacher – Health and Physical Education teacher
HR – Heart Rate
HTWR – Height Weight Ratio
HW – hypertriglyceridemic waist
ICC – Intra-class Correlation Coefficient statistic
IMT – Intima-media thickness
Inter-tester Reliability – the degree of agreement between testers
IOTF – International Obesity Task Force
KidFit Screening Tool – A screening measure of exercise capacity made up of the MSTP and the SAMS
LDL – Low density lipoprotein
LR+ - Positive likelihood ratios
LR- - Negative likelihood ratios
MD Team – Multidisciplinary team
MEND – Mind, Exercise, Nutrition….Do it! http://au.mendcentral.org
MMT – Maastricht’s Motor Test
MMT – Milne Motor Test (NOTE: The name of this test was changed to SAMS during the write up phase of this thesis).
MSTP – Modified Shuttle Test Paeds
NCDS – National Chronic Disease Strategy
NHMRC – National Health and Medical Research Council
NPG – National Paediatric Group (of the APA)
NSMDA – Neuro Sensory Motor Developmental Assessment
NSW – New South Wales
NVP – Negative Predictive Value
OT – Occupational Therapist
PA – Physical Activity
PACER – Progressive Aerobic Cardiovascular Endurance Run
PDAY – Pathobiological Determinants of Atherosclerosis in Youth Study
PDMS-2 – Peabody Developmental Motor Scale, 2\textsuperscript{nd} Edition.
Performance-related Fitness - Balance, coordination, speed, agility and power, which all reflect the performance aspect of physical fitness
PE teacher – Physical Education teacher
Paediatric Physiotherapist – A physiotherapist who is specifically trained or experienced at working with children and families.
PPV – Positive Predictive Value
Predictive Validity – a statistical method used to assess the extent to which the result of a measure/test can predict the score or result on a criterion measure.
PT - Physiotherapist
QLD - Queensland
QOL – Quality of Life
RERpeak – peak respiratory exchange ratio
ROC Analysis – Analysis of the Receiver Operating Characteristic or ROC Curve. The ROC curve is analysed by plotting the true positive rate against the false positive rate at various threshold settings.
RSDP – Resting Diastolic Blood Pressure
RSBP – Resting Systolic Blood Pressure
SAMS – Speed and Agility Motor Screen
SCFE – Slipped Capital Femoral Epiphysis
SD – Standard Deviation
SE – Standard Error
SES – Socioeconomic status
SLS – Single leg stance
SLSEC – Single Leg Stance Eyes Closed
SLSEO – Single Leg Stance Eyes Open
SPSS – Statistical Package for the Social Sciences
SS – Standard Score (related to the BOT2)
T2DM – Type 2 diabetes mellitus

Test-retest Reliability – the consistency or variability in repeated measurements taken by a single person using the same instrument.

TP – True Positives
TPS – Total Point Score (relating to subtests within the BOT2)
TN – True Negative
ULFT – Upper Limb Flexibility Test
US – United States of America
VO₂ – Oxygen Consumption
VO₂max – Maximal Oxygen Consumption
VO₂peak – Peak Oxygen Consumption
VT – Ventilatory Threshold
VT1 – First Ventilatory Threshold: a marker of intensity where lactate begins to accumulate in the blood.
VT2 – Second Ventilatory Threshold: a marker of intensity where the lactate has quickly accumulated in the blood, where the person needs to breath heavily to compensate. Also known as the lactate threshold
WC – Waist Circumference
WC-IC – Waist Circumference measured at the iliac crest
WC-U – Waist Circumference measured at the umbilicus
WCPT – World Confederation for Physical Therapy
**WHO** – World Health Organisation

**WHTR** – Waist circumference to height ratio

**20m MSRT** – 20 metre Modified Shuttle Run Test