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# The Kick-Smart Program: A Randomised Feasibility Trial Evaluating the Feasibility and Efficacy of a Primary-School Based Martial Arts Program Integrating Mathematics, Physical Fitness and Well-Being

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**Abstract**

The objective of this study was to evaluate the feasibility and efficacy of the 'Kick-Smart' martial arts programme using a randomised controlled-trial conducted in one Australian primary school. Kick-Smart involved children 9-11yrs (n= 46) randomised into treatment or wait-list control conditions. Kick-Smart consisted of 2x60min curriculum sessions/week for 6-weeks during school hours. Positive feedback was received from students and teachers regarding program enjoyment, perceived benefits and future plans. Significant treatment effects favouring the Kick-Smart group for muscular fitness and mathematics achievement demonstrates preliminary efficacy. Findings indicate Kick-Smart is feasible for delivery in a primary school setting and effective for improving selected fitness and academic outcomes. Further evidence for the effectiveness of Kick-Smart via a larger randomised control trial is recommended.

**Keywords:** education, physical activity, martial arts, mathematics, well-being, randomised-controlled trial

## 1. Introduction

National physical activity guidelines recommend that children and adolescents engage in at least 60 minutes of moderate to vigorous daily physical activity for achieving good health (Vetter, O'Connor, O'Dwyer, & Orr, 2018). Despite the well published and extensive physiological, psychological and cognitive benefits of physical activity, many children and adolescents worldwide do not acquire the minimum amount required to achieve health benefits (Joschtel et al., 2019)

Physical inactivity has been linked to a large number of preventable health issues, including obesity, hypertension, metabolic disease, (Joschtel et al., 2019), and a range of mental health problems (Biddle, Ciaccioni, Thomas, & Vergeer, 2019; Hanrahan, Rynne, Beckman, & Rossi, 2019). In 2018, metabolic disease and/or childhood obesity was evident in approximately 26% of school-aged Australian children (Vetter et al., 2018). Recently there has been wide scale research investigating relationships between physical activity and cognitive functioning, and mental health in young people (Biddle et al., 2019), with evidence for causal relationships between cognitive function, academic performance, anxiety, and depression emerging (Biddle et al., 2019; Hanrahan et al., 2019). However, investigation into the links between physical activity and mental health issues remains a domain requiring greater documentation among varied populations and settings (Biddle et al., 2019).

Concern over the overcrowding of school curriculums, due to increased demands on primary school teachers brought about by high stakes testing, has been a contributing factor to decreased student physical activity levels throughout the school day (Mavilidi, Lubans, Eather, Morgan, & Riley, 2018). This is concerning, as teachers in NSW, Australia are required to provide 150 minutes of structured physical activity throughout the school week, as per the NSW Schools physical activity policy (NSW Government, 2019). Similarly, in the United States, The National Association for Sport and Physical Education (NASPE) also recommend that all elementary school students participate in "physical education" for a minimum of 150 minutes per week, and a minimum of 225 minutes for middle and high school students (Keener, Goodman, Lowry, Zaro, & Kettel Khan, 2009). It has been suggested that schools may be more willing to prioritise

healthy lifestyle programmes if the aims of said programmes aligned with the schools core business of learning (Mavilidi et al., 2020).

Mental health is at the forefront of wellbeing in young people, with issues such as anxiety and depression representing one of the largest burdens of disease for adolescents globally (Gunnell, Kidger, & Elvidge, 2018). Wellbeing is a multifaceted construct that includes an individual's physical, mental, emotional and social health (Pressman, Kraft, & Bowlin, 2013). A positive state of wellbeing and enjoyment can lead to greater confidence and self-efficacy, broadened abilities to think in innovative, creative ways, and problem solve effectively (Department of Education and Communities, 2015). In this positive context, learning occurs more effectively (Department of Education and Communities, 2015). Biddle et al. (2019) note in their recent study that the evidence for physical activity and mental health (depression, self-esteem) remains less well documented for children and adolescents.

The integration of physical activity across key learning areas of the curriculum may have benefits that reach beyond that of health improvements (Tomporowski, Davis, Miller, & Naglieri, 2008). There is growing evidence to that enhanced physical activity may improve academic performance (Mavilidi et al., 2018; Mavilidi et al., 2020). Furthermore a recent review by Álvarez-Bueno et al. (2017) provide evidence to support the role of physical activity in cognitive development in children and adolescents, and concluded that enhanced academic achievement is positively linked to increased physical activity.

'Martial arts' is a collective term that encompasses the multitude of fighting and self-defence systems developed and implemented around the world (Rousseau, 2019). Despite emerging evidence over the past decade that martial arts training may facilitate positive change in psychological and cognitive outcomes, and evidence for causal relationships between cognitive function, academic performance, anxiety, and depression in children and adolescents is beginning to emerge (Biddle et al., 2019), a recent systematic review (under review) has highlighted a lack of high quality investigations using a randomised control trial (RCT) to gather evidence for the feasibility and utility of school-based martial arts training for school-aged children.

Of a limited quantity of curriculum-based interventions, where physical activity has been used to teach or reinforce academic concepts in primary schools, none to our knowledge, have reported the benefits of a curriculum-based martial arts program on physical fitness, academic achievement, and social and emotional well-being. Therefore, the aim of this distinctive study was to evaluate the feasibility and efficacy of the 'Kick-Smart' programme, for integrating mathematics skills and mental well-being into martial arts lessons in the Primary School, and in turn provide a basis for a larger definitive trial in the future.

## 2. Methods

The Kick-Smart program was conducted at one independent school in Newcastle, New South Wales (NSW), Australia, from July-September 2019. Study approval was sought and obtained from the University of Newcastle Research Ethics Committee, and the Principal and teachers from the study school, Information statements, as well as parental and participant consent forms were sent home with students. Only those who returned consent forms signed by both the student and their parent/guardian were permitted to participate in the study. The study design was a randomised controlled trial (RCT), and involved primary school children 9-11yrs. The design, conduct and reporting of the Kick-Smart programme adhered to the Consolidation Standards of Reporting Trials (CONSORT) guidelines (Eldridge et al., 2016) for reporting randomised pilot and feasibility trials. Two classes of Year 5 students were recruited, and the numbers in the pilot trial were based on the class sizes - which were conveniently evenly sized with relatively even numbers of males in and females in each class. Following baseline assessments, a randomisation envelope was prepared by the research team and a independent third party blindly allocated the classes into one of the two groups (by class) into either control or treatment conditions. The control class continued with their regular Physical Education lessons and school sport sessions, programmed by the school, while the treatment group participated in the Kick-Smart program during their class's timetabled Physical Education lessons and school sport sessions.

### *2.1 Intervention Protocol*

The Kick-Smart programme addressed specific outcomes for Personal Development Health and Physical Education (PDHPE) and Mathematics from the NSW Board of Studies PDHPE and Mathematics syllabi (NSW Education Standards Authority, 2012, 2018) using a movement-based learning experience to reinforce mathematics concepts that focussed primarily on single digit addition, subtraction, multiplication, and division. These movement-based experiences involved a variety of aerobic and muscular fitness exercises, and techniques from a range of martial arts including Taekwondo, Karate and Pankration (Table 1).

Each Kick-Smart session was planned to last for 60 minutes and concluded with a discussion on ethical development, focussing on a particular ethical aspect, including self-control; integrity; and courage. Participants attended 2 sessions

per week for 6 weeks (12 in total). Each session was taught by a member of the research team (LB) who is a qualified primary school teacher and martial arts instructor, and all sessions were observed by the classroom teacher and the schools specialist PDHPE teacher. No rewards were offered for taking part in the study.

*2.2 Outcomes*

The primary outcome for this study was feasibility. Process evaluation measures of recruitment, retention, adherence, compliance, and satisfaction were used to assess program feasibility. Secondary outcomes included measures of physical fitness, academic achievement, mental well-being, and cognition, which were assessed with validated tests, many of which have been used in previous studies by the research team.

*2.3 Primary Outcome - Feasibility Analysis*

As shown in Table 2, Recruitment was calculated by the percentage of permission slips returned from the total number of participants invited. Retention was calculated by the percentage of students who completed baseline assessments and follow-up assessments. Adherence was calculated using the average attendance rates of the students over each of the 12 Kick-Smart sessions. Compliance was calculated using the percentage of the number of classes that were carried out as planned. Satisfaction was calculated using the average scores for enjoyment of the program, and enjoyment of each component, from the student feedback questionnaire.

*2.4 Secondary Outcomes*

2.4.1 Physical Fitness

Physical fitness was assessed using standard protocols for the following three measures: cardiorespiratory fitness (CRF) using 20m repeated shuttle run test; muscular fitness using standing broad jump test (explosive leg power), and the 90° push-up test (Henriques-Neto, Minderico, Peralta, Marques, & Sardinha, 2020).

2.4.2 Mental Well-being

Mental well-being was assessed using the Stirling Children's Well-Being Scale (SCWBS), which consisted of 15 items measuring positive emotion (n=6), positive outlook (n=6), and social desirability (n=3) subscales (Liddle & Carter, 2015). Each of the subscales provided a separate score. In addition, each of the subscale scores were added together for a total score.

2.4.3 Cognition

Cognition was assessed using the Trail Making Test (TMT) (Reitan, 1958) – which provides a measure of visual attention, speed, scanning, speed of processing, and mental flexibility. It involved a two-part visual task (Trail A and B) where participants were required to, first draw a line from one point to the next as quickly as possible to connect numbers in ascending order (e.g., 1-2-3, etc.); and second, draw a line from one point to the next as quickly as possible to connect both numbers and letters in an ascending and alternating order (e.g., 1-a-2-b-3-c, etc.) The task was timed and errors recorded, with lower scores indicating greater cognitive performance.

2.4.4 Academic Achievement

Children's achievement in mathematics was assessed using the One Minute Basic Number Fact Test (OMBNFT) (Westwood, 2013). Students completed the four columns of the OMBNFT. Students were allowed one minute per column, with a short break (20-30 seconds) in between columns.

*2.5 Statistical Analysis*

The analyses of efficacy outcomes were performed using IBM SPSS Statistics version 20 and all variables were checked for normality and missing values. Data are presented as mean scores (and standard deviation: SD) for continuous variables. Linear mixed models were used to assess all outcomes for the impact of group (Kick-Smart vs. control), time (treated as categorical with levels at baseline and 6 weeks) and the group-by-time interaction, with these three terms forming the base model. Mixed models are robust to the biases of missing data and provide appropriate balance of Type 1 and Type 2 errors (Mallinckrodt, Watkin, Molenberghs, & Carroll, 2004). Mixed model analyses are consistent with the intention-to-treat principle, assuming the data are missing at random (White, Carpenter, & Horton, 2012). Cohen's d was also calculated, and interpreted as follows: d = 0.2, 'small' effect size; d = 0.5, 'medium' effect size; and d = 0.8, 'large' effect size (Vacha-Haase & Thompson, 2004).

Table 1. Kick-Smart Programme Summary

| Week | Lesson | Martial arts focus | Ethical focus | NSW PDHPE syllabus outcomes | NSW Mathematics Syllabus outcomes |
|---|---|---|---|---|---|
| 1 | 1 | Movement / Self-Preservation | Courage | PD3-4, PD3-7, PD3-8, PD3-9, PD3-10, PD3-11 | MA3-4NA, MA3-1WM, MA3-2WM |
| | 2 | Movement / Parkour | Respect | PD3-3, PD3-4, PD3-7, PD3-8, PD3-9, PD3-10, PD3-11 | MA3-6NA, MA3-1WM, MA3-3WM |
| 2 | 3 | Self-Defence (e.g. escaping wrist grabs) | Integrity | PD3-1, PD3-3, PD3-4, PD3-5, PD3-7, PD3-8, PD3-9, PD3-10 | MA3-6NA, MA3-5NA, MA3-2WM |
| | 4 | Blocking/ deflecting/ dodging basic attacks | | PD3-1, PD3-3, PD3-4, PD3-7, PD3-8, PD3-9, PD3-11 | MA3-2WM, MA3-1WM, MA3-6NA |
| 3 | 5 | Blocking/ deflecting/ dodging basic attacks | Self-Control | PD3-2, PD3-3, PD3-4, PD3-7, PD3-8, PD3-9, PD3-10, PD3-11 | MA3-1WM, MA3-5NA, MA3-6NA |
| | 6 | Striking (with arms) | | PD3-2, PD3-3, PD3-4, PD3-5, PD3-7, PD3-8, PD3-9, PD3-10, PD3-11 | MA3-1WM, MA3-2WM, MA3-5NA, MA3-6NA |
| 4 | 7 | Striking (with legs) | Loyalty | PD3-3, PD3-4, PD3-8, PD3-9, PD3-10, PD3-11 | MA3-1WM, MA3-2WM, MA3-6NA |
| | 8 | Team-building | Teamwork | PD3-4, PD3-5, PD3-6, PD3-7, PD3-8, PD3-9, PD3-10 | MA3-1WM, MA3-3WM, MA3-5NA, MA3-6NA |
| 5 | 9 | Wrestling/Grappling | Honesty | PD3-3, PD3-4, PD3-5, PD3-7, PD3-8, PD3-9, PD3-10, PD3-11 | MA3-1WM, MA3-6NA |
| | 10 | Wrestling/Grappling | | PD3-3, PD3-4, PD3-5, PD3-7, PD3-8, PD3-9, PD3-10, PD3-11 | MA3-1WM, MA3-6NA |
| 6 | 11 | MMA | Perseverance | PD3-2, PD3-4, PD3-5, PD3-8, PD3-9, PD3-10, PD3-11 | MA3-1WM, MA3-2WM, MA3-3WM, MA3-5NA |
| | 12 | Martial Acrobatics | | PD3-2, PD3-4, PD3-8, PD3-9, PD3-10, PD3-11 | MA3-1WM, MA3-5NA |

NSW PDHEPE Syllabus Outcomes: PD3-1: identifies and applies strengths and strategies to manage life changes and transitions; PD3-2: investigates information, community resources and strategies to demonstrate resilience and seek help for themselves and others; PD3-3: evaluates the impact of empathy, inclusion and respect on themselves and others; PD3-4: adapts movement skills in a variety of physical activity contexts; PD3-5: proposes, applies and assesses solutions to movement challenges; PD3-6: distinguishes contextual factors that influence health, safety, wellbeing and participation in physical activity which are controllable and uncontrollable; PD3-7: proposes and implements actions and protective strategies that promote health, safety, wellbeing and physically active spaces; PD3-8: creates and participates in physical activities to promote healthy and active lifestyles; PD3-9: applies and adapts self-management skills to respond to personal and group situations; PD3-10: selects and uses interpersonal skills to interact respectfully with others to promote inclusion and build connections; PD3-11: selects, manipulates and modifies movement skills and concepts to effectively create and perform movement sequences. NSW Mathematics Syllabus Outcomes: MA3-1WM: describes and represents mathematical situations in a variety of ways using mathematical terminology and some conventions; MA3-2WM: selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations; MA3-3WM: gives a valid reason for supporting one possible solution over another; MA3-4NA: orders, reads and represents integers of any size and describes properties of whole numbers; MA3-5NA: selects and applies appropriate strategies for addition and subtraction with counting numbers of any size; MA3-6NA: selects and applies appropriate strategies for multiplication and division, and applies the order of operations to calculations involving more than one operation

## 3. Results

The flow of participants through the study is displayed in Figure 1. In general, a total of forty-eight (n=48) students were given information statements and consent forms. Forty six (n=46) children from Grade 5 (mean age =10.95 ± 0.39 years; Female = 23, Male = 23) were deemed eligible and randomised at the class level (intervention: 21 students, 11 males, 10 females; control: 25 students, 12 males, 13 females).

### *3.1 Primary Outcome*

Process evaluation results (Table 2) show a recruitment rate of 92% with 46 out of 48 students returning signed consent forms to participate in the study. From the 46 recruited participants, 44 students completed baseline assessments and follow-up assessments (96% retention). Student attendance rates were high (85.66% adherence), however, this may be attributed to the sessions being held within curriculum time. Scores on the evaluation survey completed by the 21 students (100% of participants) in the intervention group showed that students rated the Kick-Smart programme >4 out of 5 for enjoyment, perceived benefits, and future plans - indicating high to very high satisfaction rates. Both teachers completed and returned the teacher evaluation questionnaire of the programme. Both teachers agreed or strongly agreed

when asked if they felt confident that they could deliver some of the content ($\overline{x}$=4.5). Both agreed that after some professional development sessions, they could confidently deliver the Kick-Smart programme ($\overline{x}$=4). Both teachers strongly believed the programme was of value ($\overline{x}$=5). The teachers also indicated strongly that they would implement the programme in the future ($\overline{x}$=4.5), and strongly agreed that the activities were targeted at the right level ($\overline{x}$=5). A total of 10 of the 12 sessions were completed as intended (83.33% compliance). Additionally, no injuries were sustained by any of the participants – indicating a degree of safety surrounding the sessions.

Table 2. Feasibility results (Australia, 2019)

***Student feasibility***

| | Recruitment | Retention | Adherence | Satisfaction | Compliance |
|---|---|---|---|---|---|
| **Maximum score** | 48 | 46 | 12 | 5 | 12 |
| **Results** | 46 | 44 | 10.2792 | 4.4 | 10 |
| **Score as %** | 92% | 96% | 85.66% | 88% | 83.33% |

***Satisfaction subscale***

| | Perceived Benefits | Enjoyment of the program | Future plans | Enjoyment of components | $\overline{x}$ of all sections |
|---|---|---|---|---|---|
| **Maximum score** | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| $\overline{x}$ **Results** | 4.1 | 4.4 | 4.0 | 4.3 | 4.2 |

***Staff feasibility results***

| Question | Max. Score | $\overline{x}$ results | Score as % |
|---|---|---|---|
| I am confident that I could deliver some of the Kick-Smart activities | 5.0 | 4.5 | 90% |
| I am confident that, after some professional development sessions, I could confidently deliver the Kick-Smart Program | 5.0 | 4.0 | 80% |
| I believe the Kick-Smart program was of value | 5.0 | 5 | 100% |
| I would implement the Kick-Smart program in the future | 5.0 | 4.5 | 80% |
| I think the activities were targeted at the right level | 5.0 | 5 | 100% |

As shown in Table 2, Results from student feasibility measures and questionnaire, and staff feasibility questionnaire

*3.2 Secondary Outcomes*

As displayed in Table 3, the Kick-Smart class scored higher than the control class in almost every area that was assessed at baseline. For example, the Kick-Smart class was more physically fit in each of the three tested areas: Beep Test (laps) (22.51 ± 13.46), compared to the control class (13.37 ± 15.51); the 90° Push-Up (9.34 ± 9.54), compared to the control class (7.50 ± 7.83); and the Standing long Jump (m) (1.33 ± .212), compared to the control class (1.30 ± .234). Of note however, the control class was more competent in the OMBNFT (addition) (24.92 ± 5.19) compared to the Kick-Smart group (22.92 ± 5.71).

3.2.1 Physical Fitness

Effect Linear mixed models showed significant group-by-time effects favouring the Kick-Smart group upon follow-up assessment. Statistically significant improvements were found on the 90° Push-Up Test [adjusted mean difference = 8.17 (95% CI, 4.01 to 12.33), p=0.000, d = 1.31], indicating a positive impact on upper body muscular endurance. A significant effect was found in favour of the control group for The Beep Test (CRF) [adjusted mean difference = -9.16 (95% CI, -15.77 to -2.55), p=0.008, d = 0.89]. No significant effects were found for the Standing Long Jump (ELP) [adjusted mean difference = -0.02 (95% CI, -.08 to .05), p=0.661, d=0.14].

3.2.2 Well-being

No statistically significant results or change scores were found in any section of the Stirling Children's Well-Being Scale.

3.2.3 Cognition

Although no statistically significant change was observed in cognition, a small change score (d=0.23) was observed in the Trail Making Test A, in favour of the control group.

### 3.2.4 Academic Performance

Effect Linear mixed models showed significant group-by-time effects favouring the Kick-Smart group upon follow-up assessment. Statistically significant improvements were found in the addition section of the One Minute Basic Number Fact Test (OMBNFT) [adjusted mean difference = 4.74 (95% CI, 2.52 to 6.95), p=0.000, d = 1.29]. Additionally, results from OMBNFT-Multiplication approached significance [adjusted mean difference = 1.77 (95% CI, -.04 to 3.60), p=0.055, d= 0.53], showing a medium sized change score, also favouring the Kick-Smart group.

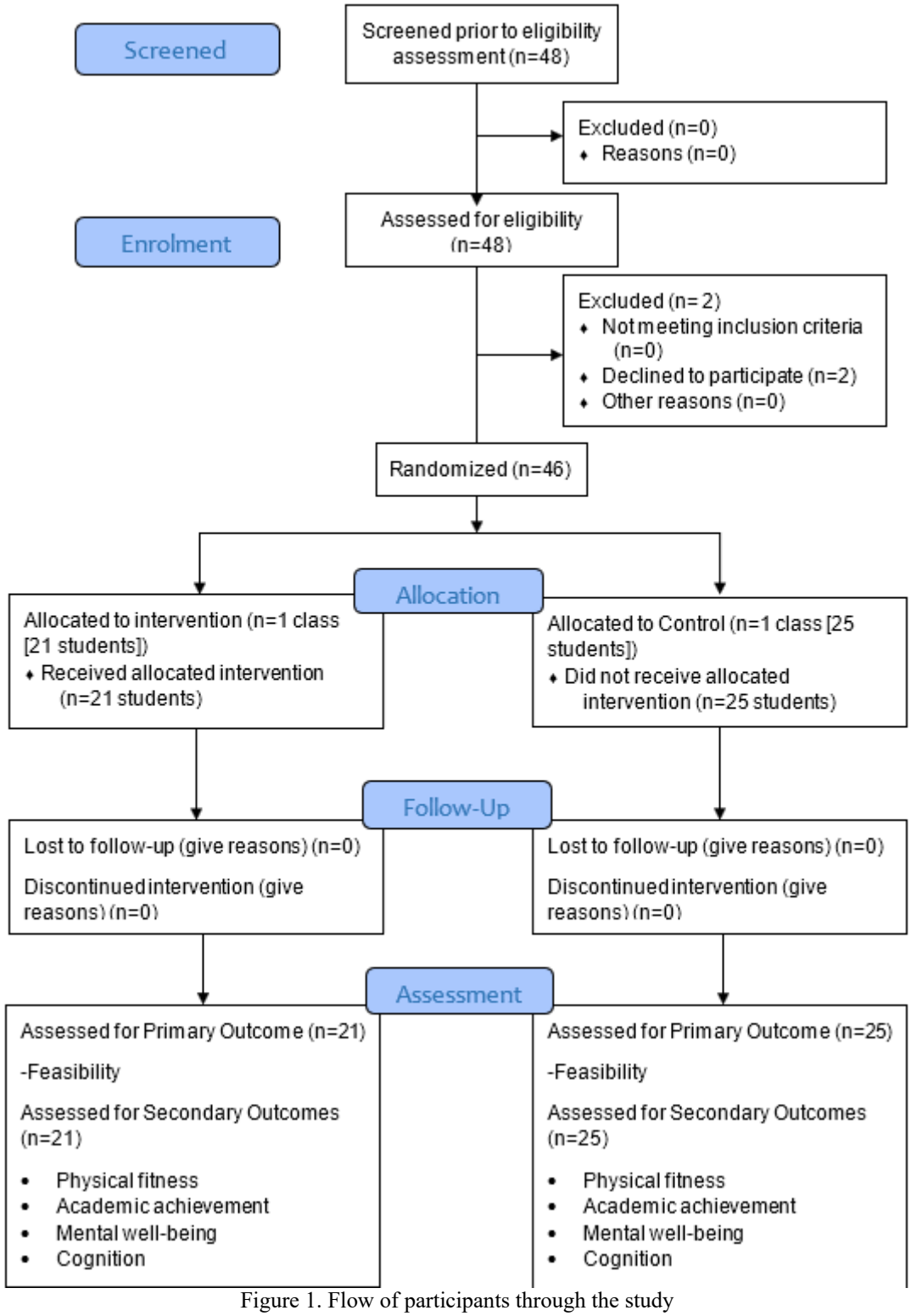


Figure 1. Flow of participants through the study

Table 3: Kick-Smart Study intervention effects (by treatment group) – All Outcomes (Australia, 2019)

| Measure | Control Group (n =25) | | | | KICK-SMART (n=21) | | | | Adjusted Difference in Change (95% CI)[a] | Group*Time P value | Cohen's d Effect Size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Baseline | SD | 6-week posttest | SD | Baseline | SD | 6-week posttest | SD | | | |
| Beep Test (laps) | 13.37 | 15.51 | 26.88 | 13.55 | 22.51 | 13.46 | 26.85 | 15.41 | -9.16 (-15.77 - -2.55) | 0.008 | 0.89 |
| 90° Push-Up | 7.50 | 7.83 | 7.27 | 6.64 | 9.34 | 9.54 | 17.27 | 14.18 | 8.17 (4.01-12.33) | 0.000 | 1.31 |
| Standing long Jump (m) | 1.30 | .234 | 1.33 | .27 | 1.33 | .212 | 1.34 | .18 | -0.02 (-.08 -.05) | 0.661 | 0.14 |
| OMBNFT (+) | 24.92 | 5.19 | 25.57 | 5.75 | 22.92 | 5.71 | 28.31 | 4.07 | 4.74 (2.52 – 6.95) | 0.000 | 1.29 |
| OMBNFT (-) | 20.26 | 7.91 | 22.58 | 7.43 | 20.84 | 8.24 | 23.43 | 7.44 | 0.26 (-2.40 – 2.93) | 0.842 | 0.06 |
| OMBNFT (x) | 18.29 | 7.96 | 19.55 | 6.10 | 19.60 | 8.16 | 22.63 | 7.92 | 1.77 (-.04 – 3.60) | 0.055 | 0.53 |
| OMBNFT (÷) | 12.22 | 10.33 | 12.91 | 9.25 | 14.35 | 8.48 | 15.99 | 8.79 | 0.95 (-1.99 – 3.88) | 0.518 | 0.12 |
| Positive Emotion | 23.01 | 4.30 | 22.19 | 3.63 | 23.00 | 3.91 | 22.55 | 4.39 | 0.38 (-1.88 – 2.64) | 0.737 | 0.03 |
| Positive Outlook | 22.51 | 3.83 | 22.92 | 2.47 | 22.60 | 3.89 | 23.39 | 3.70 | 0.38 (-1.88 – 2.65) | 0.734 | 0.11 |
| Social Desirability | 9.98 | 1.92 | 10.29 | 1.39 | 10.68 | 2.27 | 10.79 | 2.31 | -0.20 (-1.33 - .93) | 0.726 | 0.11 |
| SCWBS Total Score | 55.51 | 7.62 | 55.42 | 6.45 | 56.26 | 8.42 | 56.66 | 8.87 | 0.49 (-3.78 – 4.76) | 0.818 | 0.00 |
| Trail Making Test A | 35.97 | 10.53 | 30.49 | 9.50 | 29.37 | 6.40 | 25.061 | 8.63 | 1.17 (-2.90 – 5.23) | 0.566 | 0.23 |
| Trail Making Test B | 83.67 | 26.38 | 62.51 | 21.15 | 82.95 | 30.36 | 64.58 | 22.66 | 2.80 (-13.49 – 19.09) | 0.731 | 0.17 |

## 4. Discussion

The aim of this study was to evaluate the feasibility and efficacy of the 'Kick-Smart' programme, for integrating mathematics skills and mental well-being into PE curriculum specific martial arts lessons in the Primary School. Feasibility measures showed that the program was highly enjoyable for students, and rated highly by their class teachers. These results parallel the findings of other school-based physical activity programs (Mavilidi et al., 2018). Over-all, the Kick-Smart programme was delivered as intended. However, the sessions were designed to run for 60 minutes, and due to timetabling of the test school, the sessions only ran for 40-50 minutes. Additionally, booking issues with the hall that the sessions were taught in resulted in two sessions being taught either outdoors, or in a small room with inadequate space to complete the activities as intended. These changes required minor variations to the lessons, as well as unsettled behaviour from students, however this allowed for an opportunity to run these sessions in a smaller area (classroom), which proved successful. This in turn showed that the program, or aspects of the program, are able to be taught within regular classrooms, and thus allows for greater generalisability for teachers wanting to run this program in the future.

The results of this study showed statistically significant group-by-time effects, and effect sizes favouring the Kick-Smart group in muscular fitness. This aligns with the findings of Cicović, Pržulj, Stojiljković, and Kocić (2011), who found improvements in repetitive strength (among other areas), in favour of martial arts participation; and that of Eather, Morgan, and Lubans (2013), whose curriculum based PDHPE program for Stage 3 primary school children, run once per week for one school term, also found improvements in muscular fitness. The correlation of these results further supports the impact that physical activity and martial arts-based intervention programs can have on the physical fitness of children. These findings are important, as previous studies have shown an inverse relationship between muscular fitness and cardiovascular disease, adiposity, and metabolic risk factors in children and adolescents (Smith et al., 2014). Results from the beep test and standing long jump test showed greater improvements in the control class. It is noteworthy that the control class participated in their regular PDHPE classes through the course of the intervention. The control class spent the term performing drills from, and playing the game of touch football – which often requires explosive leg strength and cardiovascular fitness for movements such as jogging, sprinting and dodging – which may explain the increase in cardiovascular endurance and explosive leg strength seen in the control class. Importantly, the Kick-Smart class did not experience a deterioration in any of the fitness assessments.

Although not all areas of the One Minute Basic Number Facts assessment improved to a statistically significant level, it is important to note that the control class did not experience a deterioration in any of these areas, and the average score for each improved to a higher level than the control class, significantly or otherwise. Additionally, the meta-analysis conducted by Álvarez-Bueno et al. (2017) found that physical activity benefits numerous aspects of academic achievement, particularly mathematics-related skills, reading, and composite scores in youth. Albeit the results from the subtraction, multiplication and division sections of the OMBNFT did not reach significance, the similarity of the findings from this study is noteworthy, as it adds further support to this field of research, and further supports the suggestion that school-based martial arts, or physical activity programs can effectively improve a range of physiological and academic outcomes in a way that is enjoyable for the students, and supported by teachers, which has been seen in

other studies of similar nature (Mavilidi et al., 2020). One may suggest that a longer intervention may yield statistically significant results in these area.

The programme did not have a statistically significant impact on well-being, however, it is noteworthy that both classes experienced a deterioration in one area of the SCBWS (Positive Emotion). As seen in Table 3, the Kick-Smart group experienced less of a drop in this area (-0.45) than the control class (-0.82) did, which may indicate a positive effect of the intervention. Although this is a null-finding, it is noteworthy that the majority of the participants scored high in well-being at baseline, which may have acted as a ceiling effect and limiting the potential for further improvements. This is consistent with the ceiling effect explanation for the null findings for previous child and adolescent physical activity and well-being research (Schmalz, Deane, Birch, & Davison, 2007; Walters & Martin, 2000) for well-being outcomes such as self-esteem. For example, Schmalz et al. (2007) noted that most female participants reported high levels of self-esteem at baseline, thus decreasing the ability to identify a positive association between physical activity and self-esteem. A variety of other factors may have influenced the wellbeing of the Kick-Smart participants, for example, students may have had a negative social experience in their classroom or peer group, some may have had negative interactions at home, perhaps with parents not supporting or recognising the child's own perspective of their current wellbeing – i.e. feeling stressed (Department of Education and Communities, 2015). Despite these null findings, other studies have shown that school-based physical activity interventions can positively influence youth well-being (Costigan, Lubans, Lonsdale, Sanders, & del Pozo Cruz, 2019), which suggests that further research in this area is needed.

Another conspicuous outcome was the cognitive test (Trail Making Test A) resulting in a small positive change score in favour of the control class. This again, may be attributed to activities the control class participated in throughout their school day. As this was such a small study, it may be suggested that a larger study may yield different results.

*4.1 Strengths, Limitations and Recommendations*

This is a unique and innovative program that specifically integrates physical fitness, wellbeing and academic achievement within the primary school PDHPE and Mathematics curriculums. The study used trained observers and assessors for all baseline and follow-up assessments. Additionally, retention rates were expectedly high, which is an obvious benefit of school-based curriculum interventions. The reason being, unless a child leaves the school, they remain in the study for the entire duration. There are some key limitations that should be highlighted. It is worth noting that the programme was delivered by the researcher, a qualified primary school teacher, with several years teaching experience, and extensive martial arts knowledge, which may have contributed to the positive results of the study. Further studies will need to evaluate the effectiveness of classroom teachers in delivering the programme to assess both the sustainability and useability of the programme in the school setting. The single biggest barrier to the integration of this program may be teachers own beliefs, perceptions and attitudes towards martial arts. It has been shown that social support provided by classroom teachers arbitrates changes in children's physical activity behaviours. It therefore seems imperative that teachers have input into the planning of subsequent studies. A recent systematic review has highlighted the need for teachers to act as agents of change and to be involved in the delivery of future programmes to improve the cost effectiveness, sustainability and feasibility of programmes (Erwin, Fedewa, Beighle, & Ahn, 2012). A key part of this will need to be attaining an understanding of teachers' beliefs, perceptions and attitudes towards martial arts and the integration of such into school settings. Furthermore, professional learning that concentrates on up-skilling teachers in this area will be needed. It is possible that factors outside the intervention may have been responsible for the greater increase in the 20m repeated shuttle run test results among participants in the control group from baseline to follow-up. Despite this being a group RCT, the intervention was carried out in a single school and the analysis could not take into account clustering. Whilst the authors cannot be sure as to why there was a greater improvement among the control group, it is worth noting that the control group were participating in regular PDHPE lessons, which were based on touch football. Activities from these sessions may or may not have influenced the cardiorespiratory endurance of the control group.

It is important to note that many interventions do not last beyond the study period. In efforts to increase ecological validity, providing teachers with training and professional learning may be of use, so that they may continue to deliver lessons that integrate martial arts and physical activity in a flexible way that can be adjusted to the needs of their class. Insufficient time, limited professional development opportunities and access to resources have been reported by a group of teachers as the main barriers to providing classroom-based physical activity to Australian students (Macdonald, Milne, Pope, & Orr, 2019). The successful integration of multiple Key Learning Area outcomes into a single program, such as the Kick-Smart programme, may be an effective approach to addressing the issue of over-crowded curriculums, and improving physical fitness throughout the school week (Mavilidi et al., 2018).

Based on the flow of the program, and feedback and discussions with teachers and researchers, it may be useful to program the lessons to run for a maximum of 45-50 minutes, rather than the originally intended 60 minutes. This may be more applicable for primary school setting, as it may fit within timetable teaching sessions with greater ease. A further recommendation may be to utilise a different measure of wellbeing in future studies, as this did not yield any significant results.

## 5. Conclusions

Preliminary findings indicate that Kick-Smart is feasible for delivery in primary schools, and is effective for improving fitness and mathematics outcomes. Building further support for effectiveness of Kick-Smart via a larger RCT in varied locations and school settings is recommended.

## 6. Practical implications

- Martial arts may be a viable catalyst to improve fitness and academic outcomes in school-aged children.
- A school-based martial arts program that targets NSW Syllabus outcomes can be enjoyable for children
- Teachers may be willing to implement a school-based martial arts program in their schools and classrooms
- Teachers may view martial arts as a valuable topic to include in schools and classrooms

## 7. Other Information

### *7.1 Ethical Approval*

This study was approved by the Human Research Ethics Committee at the University of Newcastle, Australia. Approval number: H-2019-0057.

### *7.2 Protocol*

The protocol for this trial is currently unavailable.

### *7.3 Funding*

This project did not receive any funding.

## References

Álvarez-Bueno, C., Pesce, C., Cavero-Redondo, I., Sánchez-López, M., Garrido-Miguel, M., & Martínez-Vizcaíno, V. (2017). Academic Achievement and Physical Activity: A Meta-analysis. *Pediatrics, 140*(6). https://doi.org/10.1542/peds.2017-1498

Biddle, S., Ciaccioni, S., Thomas, G., & Vergeer, I. (2019). Physical activity and mental health in children and adolescents: An updated review of reviews and an analysis of causality. *Psychology of Sport and Exercise, 42*, 146-155. https://doi.org/10.1016/j.psychsport.2018.08.011

Cicović, B., Pržulj, D., Stojiljković, D., & Kocić, J. (2011). THE INFLUENCE OF BASIC PREPARATIONS ON THE DEVELOPMENT OF THE MOTOR AND FUNCTIONAL ABILITIES OF JUDOISTS. *Activities in Physical Education & Sport, 1*(2), 117-122. Retrieved from http://ezproxy.newcastle.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=79563700&site=ehost-live&scope=site

Costigan, S. A., Lubans, D. R., Lonsdale, C., Sanders, T., & del Pozo Cruz, B. (2019). Associations between physical activity intensity and well-being in adolescents. *Prev Med, 125*, 55-61. https://doi.org/10.1016/j.ypmed.2019.05.009

Department of Education and Communities. (2015). *The Wellbeing Framework for Schools*. Sydney, NSW Retrieved from https://www.det.nsw.edu.au/wellbeing/about/16531_Wellbeing-Framework-for-schools_Acessible.pdf

Eather, N., Morgan, P. J., & Lubans, D. R. (2013). Improving the fitness and physical activity levels of primary school children: results of the Fit-4-Fun group randomized controlled trial. *Prev Med, 56*(1), 12-19. https://doi.org/10.1016/j.ypmed.2012.10.019

Eldridge, S. M., Chan, C. L., Campbell, M. J., Bond, C. M., Hopewell, S., Thabane, L., & Lancaster, G. A. (2016). CONSORT 2010 statement: extension to randomised pilot and feasibility trials. *Bmj, 355*, i5239. https://doi.org/10.1136/bmj.i5239

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. https://doi.org/10.1080/15377903.2012.643755

Gunnell, D., Kidger, J., & Elvidge, H. (2018). Adolescent mental health in crisis. In: British Medical Journal Publishing Group. https://doi.org/10.1136/bmj.k2608

Hanrahan, S., Rynne, S., Beckman, E., & Rossi, T. (2019). Participants' physical activity levels and evaluations of a school sport programme in Papua New Guinea. *European Physical Education Review, 25*(1), 3-20. https://doi.org/10.1177/1356336X17700164

Henriques-Neto, D., Minderico, C., Peralta, M., Marques, A., & Sardinha, L. B. (2020). Test–retest reliability of physical fitness tests among young athletes: The FITescola® battery. *Clinical Physiology and Functional Imaging, 40*(3), 173-182. https://doi.org/10.1111/cpf.12624

Joschtel, B., Gomersall, S. R., Tweedy, S., Petsky, H., Chang, A. B., & Trost, S. G. (2019). Objectively measured physical activity and sedentary behaviour in children with bronchiectasis: a cross-sectional study. *BMC Pulmonary Medicine, 19*(1), 7. https://doi.org/10.1186/s12890-018-0772-8

Keener, D., Goodman, K., Lowry, A., Zaro, S., & Kettel Khan, L. (2009). *Recommended community strategies and measurements to prevent obesity in the United States: Implementation and measurement guide.* Atlanta, GA: U.S.: Centers for Disease Control and Prevention.

Liddle, I., & Carter, G. F. A. (2015). Emotional and psychological well-being in children: the development and validation of the Stirling Children's Well-being Scale. *Educational Psychology in Practice, 31*(2), 174-185. https://doi.org/10.1080/02667363.2015.1008409

Macdonald, K., Milne, N., Pope, R., & Orr, R. M. (2019). *Facilitators and barriers for providing classroom-based physical activity to students in the early years of primary school: A pilot survey.* Paper presented at the TRANSFORM 2019 Physiotherapy Conference. https://doi.org/10.1007/s10643-020-01076-y

Mallinckrodt, C. H., Watkin, J. G., Molenberghs, G., & Carroll, R. J. (2004). Choice of the primary analysis in longitudinal clinical trials. *Pharmaceutical Statistics, 3*(3), 161-169. https://doi.org/10.1002/pst.124

Mavilidi, M. F., Lubans, D. R., Eather, N., Morgan, P. J., & Riley, N. (2018). Preliminary Efficacy and Feasibility of the "Thinking While Moving in English": A Program with Integrated Physical Activity into the Primary School English Lessons. *Children (Basel, Switzerland), 5*(8), 109. https://doi.org/10.3390/children5080109

Mavilidi, M. F., Lubans, D. R., Miller, A., Eather, N., Morgan, P. J., Lonsdale, C., . . . Riley, N. (2020). Impact of the "Thinking while Moving in English" intervention on primary school children's academic outcomes and physical activity: A cluster randomised controlled trial. *International Journal of Educational Research, 102*, 101592. https://doi.org/10.1016/j.ijer.2020.101592

NSW Education Standards Authority. (2012). *Mathematics K-10 Syllabus*. Retrieved from https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/mathematics/mathematics-k-10

NSW Education Standards Authority. (2018). *Personal Development, Health and Physical Education K-10 Syllabus*. Sydney: NSW Education Standards Authority Retrieved from file:///C:/Users/c3184314/Documents/Teaching/pdhpe-k-10-syllabus-2018-pdf.pdf

NSW Government. (2019). *Sport and Physical Activity Policy*.

Pressman, S. D., Kraft, T., & Bowlin, S. (2013). Well-Being: Physical, Psychological, Social. In M. D. Gellman & J. R. Turner (Eds.), *Encyclopedia of Behavioral Medicine* (pp. 2047-2052). New York, NY: Springer New York.

Reitan, R. M. (1958). Validity of the Trail Making Test as an Indicator of Organic Brain Damage. *Perceptual and Motor Skills, 8*(3), 271-276. https://doi.org/10.2466/pms.1958.8.3.271

Rousseau, R. (2019). What Are Martial Arts? Retrieved from https://www.liveabout.com/what-are-martial-arts-2307702

Schmalz, D. L., Deane, G. D., Birch, L. L., & Davison, K. K. (2007). A longitudinal assessment of the links between physical activity and self-esteem in early adolescent non-Hispanic females. *The Journal of adolescent health : official publication of the Society for Adolescent Medicine, 41*(6), 559-565. https://doi.org/10.1016/j.jadohealth.2007.07.001

Smith, J. J., Eather, N., Morgan, P. J., Plotnikoff, R. C., Faigenbaum, A. D., & Lubans, D. R. (2014). The Health Benefits of Muscular Fitness for Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Medicine, 44*(9), 1209-1223. https://doi.org/10.1007/s40279-014-0196-4

Tomporowski, P. D., Davis, C. L., Miller, P. H., & Naglieri, J. A. (2008). Exercise and children's intelligence, cognition, and academic achievement. *Educational psychology review, 20*(2), 111. https://doi.org/10.1007/s10648-007-9057-0

Vacha-Haase, T., & Thompson, B. (2004). How to Estimate and Interpret Various Effect Sizes. *Journal of Counseling Psychology, 51*(4), 473-481. https://doi.org/10.1037/0022-0167.51.4.473

Vetter, M., O'Connor, H., O'Dwyer, N., & Orr, R. (2018). Learning "Math on the Move": Effectiveness of a Combined Numeracy and Physical Activity Program for Primary School Children. *Journal of Physical Activity & Health, 15*(7), 492-498. https://doi.org/10.1123/jpah.2017-0234

Walters, S. T., & Martin, J. E. (2000). Does aerobic exercise really enhance self-esteem in children? A prospective evaluation in 3rd–5th graders. *Journal of Sport Behavior, 23*(1), 51-60.

Westwood, P. (2013). *Learning and Learning Difficulties: Approaches to Teaching and Assessment*: Taylor & Francis. https://doi.org/10.4324/9780203823767

White, I. R., Carpenter, J., & Horton, N. J. (2012). Including all individuals is not enough: Lessons for intention-to-treat analysis. *Clinical Trials, 9*(4), 396-407. https://doi.org/10.1177/1740774512450098