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The PLUNGE Randomized Controlled Trial: Evaluation of a Games-Based Physical Activity Professional Learning Program in Primary School Physical Education.

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Abstract

Objective: To evaluate the efficacy of the Professional Learning for Understanding Games Education (PLUNGE) program on Fundamental Movement Skills (FMS), in-class physical activity and perceived sporting competence.

Methods: A cluster-randomized controlled trial involving one year six class **each** from seven primary schools (n = 168; mean age = 11.2 years, SD = 1.0) in the Hunter Region, NSW, Australia. In September (2013) participants were randomized by school into the PLUNGE intervention (n = 97 students) or the 7-week wait-list control (n = 71) condition. PLUNGE involved the use of Game Centered curriculum delivered via an in-class teacher mentoring program. Students were assessed at baseline and 8-week follow-up for three object control FMS (Test of Gross Motor Development 2), in-class physical activity (pedometer steps/minute) and perceived sporting competence (Self-perception Profile for Children).

Results: Linear mixed models revealed significant group-by-time intervention effects (all $p < 0.05$) for object control competency (**effect size: $d = 0.9$**), and in-class **pedometer steps/minute** ($d = 1.0$). No significant intervention effects ($p > 0.05$) were observed for perceived sporting competence.

Conclusions: The PLUNGE intervention simultaneously improved object control FMS proficiency and in-class PA in stage three students.

Keywords: **pedometer**, **primary school**, motor skills, game centred, **teacher development**

Conflict of interest:

The authors declare that there is no conflict of interest.

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The PLUNGE research group acknowledges Dr Wendy Miller for her contribution to all of our lives. RIP Wendy. xx

Introduction

Children who participate in adequate amounts of moderate-to-vigorous physical activity (MVPA) are more likely to enjoy better physical health (Janssen and LeBlanc, 2010), better psychological health (Eime et al., 2013), and report greater physical self-concept (Babic et al., 2014). There is strong evidence from cross-sectional studies of a positive association between fundamental movement skill (FMS) competency and physical activity (PA) levels (including MVPA) in children and adolescents (Lubans et al., 2010, Barnett et al., 2011). Perceived sports competence is considered as a mediator of the reciprocal relationship between FMS competency and PA in young people (Barnett et al., 2008, Barnett et al., 2011), and interventions targeting both perceived and actual FMS competency may assist in preventing the PA decline typically observed during adolescence (Morgan et al., 2013).

It is well recognised that physical education (PE) is the central vehicle responsible for promoting PA within schools (Cox et al., 2010, Eather et al., 2013). Currently, in the primary school context, motor skills are not being taught adequately (Hardy et al., 2011) and activity levels in PE typically do not achieve the recommended 50% of class time in MVPA (Fairclough and Stratton, 2005). Generalist teachers (non PE specialists responsible for all student content) describe PE programs as inadequate for achieving outcomes (Morgan and Hansen, 2008), and report a lack of FMS knowledge (Morgan and Hansen, 2007).

In addition to low teaching efficacy in a PE setting, a skills based pedagogical approach in which skills are taught and practiced in isolation before being integrated into game play (Rink et al., 1996) is used most commonly in PE (Dudley et al., 2011). This process may see a reduction in the focus on motor skill development once game play is initiated, particularly among teachers lacking pedagogical understanding of FMS development and game play constructs. Additionally, in the context of teaching games and sports, a skills based approach is often low in MVPA (Lonsdale et al., 2013), and may inhibit development of perceived competence due to the difficulty of incorporating an isolated skill into the dynamic and complex nature of the game the skill is used in.

A game centred approach (GCA) for teaching PE offers a method of addressing motor skill development, cognitive aspects of how to play games and affective outcomes by situating learning within game play activities (Kirk and MacPhail, 2002). Due to the active nature of game play, this approach also offers the opportunity to promote MVPA during PE lessons. A recent

systematic review of GCA research (Miller, In press) supports the development of: i) motor skills assessed using product based measures within game play, and ii) cognitive factors of game play, when intervention volume is sufficient (around 8 hours). A GCA also displayed a positive effect on the perceived abilities of students; however no studies were identified that focused on the improvement of motor skills using process oriented assessment (FMS), or the ability of this approach to keep students active whilst learning in PE lessons.

The ability to simultaneously improve FMS and in-class PA is a distinct challenge (van Beurden et al., 2003). The primary aim of this study was to evaluate the efficacy of a game centred learning program for the improvement of FMS. A secondary aim was to evaluate the simultaneous improvement of in-class PA and the potential of this approach to improve perceived sporting competence in elementary school students. The Professional Learning for Understanding Games Education (PLUNGE) program was developed to facilitate student outcomes through a teacher professional learning program designed for the development of practical instruction skills, promotion of mastery motivational climate and instruction of game centred approach curriculum. We hypothesized that participants in the PLUNGE intervention, compared to those in the control group, would display more favourable changes in FMS (throw, catch and kick), in-class PA, and perceived athletic competence over the 8-week study period.

Methods

Study design

The PLUNGE intervention was evaluated using a clustered randomized controlled trial in seven schools. The PLUNGE study conformed to the Consolidated Standards of Reporting Trials guidelines (Moher et al., 2010) and was registered with Australia and New Zealand Clinical Trials registry (ACTRN12613000605796). Ethical approval was obtained from the University of Newcastle ethics committee. Written informed consent was provided by students' parents/guardians prior to baseline assessment via return of a consent document sent home with the student. The study was conducted from September to December, 2013 (8 week intervention followed by an 8 week period for the control group).

Sample size

The sample size calculations were based on data from a large scale Australian study of primary school children's FMS (Lubans et al., 2012). Assuming an alpha of 0.05 and power of 80%, it was determined that a total sample size of 144 was needed to detect a between group

difference of 1.5 units (SD = 3.2) for a composite object control competency (throw, catch and kick) using the **Test of Gross Motor Development 2 (TGMD-2) (Ulrich, 2000)**. Based on a recent review of FMS interventions (Morgan et al., 2013), this was considered an achievable target.

Recruitment and Participants

Ten primary schools selected randomly from Newcastle Maitland Catholic Diocese **Schools**, NSW Australia, were invited to participate in the study. One teacher of a year 5 – 6 class (10 – 12 years of age) from each consenting school was invited to participate in the study. **To maintain generalizability of results to the majority of generalist primary school teachers, a teacher was excluded from the study if they held an external sports coaching qualification.** All students from the classes of consenting teachers were invited to participate, with parental consent required for involvement in the assessment protocols.

Randomization and blinding

With the positive relationship between Socio-economic-status (SES) and FMS (Booth et al., 2006.), and the inverse relationship between SES and PA (Van der Horst et al., 2007), schools were stratified into low (<970), medium (>970 and <1000) and high (>1000) socio-economic groups using the Australian Bureau of Statistic's Socio-Economic Indexes for Areas. Schools matched within these strata (minimum two schools per strata) were randomly assigned after baseline assessment to the intervention condition or a usual practice (wait-list control) condition by an independent 3rd party using a coin toss. **Teachers in the control condition were asked to teach from the Games and Sports strand of the syllabus (Board of Studies NSW, 2007a) from baseline to follow-up assessment to match the strand of the intervention curriculum.** Assessors were blinded to treatment conditions at post-test assessments with the exception of the first author, who performed the intervention fidelity assessment.

Intervention

Students were exposed to the PLUNGE intervention through a 7-week professional learning program designed for the development of practical instruction skills, promotion of a mastery climate and use of game centred curriculum. The theoretical framework for student outcomes was achievement goal theory (Nicholls, 1989), as a mastery climate within lessons has shown to promote high activity levels (Parish and Treasure, 2003), higher pedometer step counts (Wadsworth et al., 2013), and beliefs that effort and ability lead to success (Cury et al., 1996 , Papaioannou, 1998).

The goal was to create an effective learning environment promoting a mastery motivation climate by moving the focus of activities away from performance outcomes (scoring and winning) towards a class focus on the game process (Ames, 1992, Meece, 1991). In addition, the focus was on personal learning and improvement (Cecchini Estrada et al., 2011), process outcomes within activities (Ames, 1992, Meece, 1991) and positive peer recognition of effort, particularly in situations involving failure (Clifford et al., 1988). In an attempt to coordinate curriculum and instructional goals of the class (Ames, 1992, Marshall, 1988), the design of activities aimed to provide diversity of challenge among varied abilities (Nicholls, 1989, Marshall and Weinstein, 1984), and allowed individual focus on development of process related aspects of tasks (Ames, 1992, Meece, 1991).

Professional learning

1. Teacher information session

This session was based on the training model of professional learning, in which content was delivered to teachers in a passive manner, with controlled, standardized content delivery (Kennedy, 2005). Content delivered in this one day (6 hour) theory-based session is outlined in Table 1.

2. Teacher mentoring

For the first 5 weeks of the 7-week program, teachers received consultation regarding the presentation of the game centred curriculum, and in-class scaffolding and feedback of curriculum delivery from a member of the research team (Table 1). Mentoring served to ensure teachers understood the format and purpose of the designed lessons, and for teachers to observe, implement and trouble shoot the theoretical content with an academic partner within the authentic context of their classroom. The mentoring model (Kennedy, 2005, Rhodes and Beneicke, 2003) is underpinned by situated learning theory (Lave and Wenger, 1991) and moves to contextualize the theoretical content presented to teachers.

Curriculum

Lesson content for the 7-week intervention period (Table 2) was developed by the research team. Content was designed around progressive increases in the complexity of challenge experienced by students (Porter and Magill, 2010), with learning situated within game play (Kirk and MacPhail, 2002). The intervention began with low complexity target activities

that were in turn modified to include peer interaction before movement into invasion style games for continued increase in the complexity of challenge faced by students.

Measures

All measurements were completed at the study schools using the same instruments at each time point. The primary outcome was object control proficiency (combined throw, catch and kick) at 8 week follow-up. Object control was specifically targeted as these skills are more strongly associated with adolescent PA levels (Barnett et al., 2009, Cohen et al., 2014). Object control skills were measured using selected scales from the TGMD-2 (Ulrich, 2000). Skills were filmed for evaluation, and one assessor evaluated all skills. Assessor training included rating of children performing each FMS on a video previously rated by a panel of experts (>95% agreement rate required). Five percent of the sample at each assessment time point was repeat rated for intra-rater reliability (99% and 98% agreement respectively), and against ratings from a member of the research team for quality control purposes (Kappa = 0.98; 95% CI - 0.97 to 0.99). FMS were examined as continuous variables.

In-class physical activity level (steps/minute)

Pedometers (Yamax Digi-walker CW700) were employed for comparison of in-class PA levels (steps/minute) for each student. Measurement occurred during two lessons from the Games and Sports strand (Board of Studies NSW, 2007a) prior to the intervention period and during weeks 6 and 7 of the intervention period to compare PA of the developed curriculum relative to the control condition. Evaluated classes were normal length PE lessons for the schools (45 – 60 minutes). A pedometer functionality routine (30 steps taken with a result within 3 steps) was performed with students prior to the beginning of each recorded lesson (pedometer swapped if not acceptable), and lesson time was recorded from the completion of the pedometer check until the point at which the teacher declared the lesson finished. Scruggs (2013) cut point steps/minute intervals were employed to determine achievement or non-achievement of PA guidelines within PE lessons. Three steps/min cut points (< 33%, 33 – 50%, and > 50%) were established for the Yamax pedometer with values of < 63.50, 63.50 – 82.90 and > 82.90 steps/min used respectively.

Athletic competence

The athletic competence sub-scale of Harter (2012)'s self-perception profile for children (SPPC) was used to provide a measure of physical self-perception. This instrument involves six

items and uses a four-choice structured alternative format to minimize socially desirable responses, each scored from 1 (low self-perception) to 4 (high self-perception). Children choose which side of a statement they agree with more (E.g. Some kids do very well at all kinds of sports BUT Other kids don't feel that they are very good when it comes to sports), and respond either "Sort of True for Me" or "Really True for Me" for the chosen statement. The mean of the six items was examined as a continuous variable. Internal consistency of the athletic competence subscale was $\alpha = .83$.

Instruction classification and intervention fidelity

Evaluation of the style of instruction used by the teachers was performed using lesson observation scales (Turner and Martinek, 1992). Two PE lessons per teacher were observed by the lead researcher prior to and at the end of the intervention period (weeks 6 and 7). The lesson was judged against three skill based statements and four game based statements to obtain the percentage of agreement for each of these sets of statements (E.g. lesson agreement with one of four game based statements and two of three skill statements = 25% game agreement and 66% skills agreement, indicating a greater skills based lesson focus). These agreement values were used to indicate: i) if the style of instruction undertaken at each time period was in line with a skill based or game centred approach, and ii) if the fidelity of the instruction undertaken by the intervention group teachers was in line with the true nature of the intervention.

Analysis

Statistical analyses were completed using PASW Statistics 21 (SPSS Inc. Chicago, IL) software and alpha levels were set at $p < 0.05$. All variables were checked for normality and satisfied the criteria. Independent samples t-tests were used to compare differences between groups at baseline. Linear mixed models were fitted to compare intervention and control groups for continuous variables. Group (intervention or control), time (baseline and 8 weeks) and group-by-time interaction were assessed as fixed effects within the model. Potential gender effects were explored using a group-by-time-by-gender interaction term in the mixed model. However, as there were no significant interactions for any of the outcomes, this term was removed from the final models. To examine potential clustering effects at the school level, school was included as a random intercept within the model. Differences of means and 95% confidence intervals (CIs) were determined using the linear mixed models. Analyses included all randomized participants.

Cohen (1988)'s d was used to determine effect sizes ($d = (M1 - M2) / \sigma$ pooled), and chi-squared (χ^2) tests for categorical variables.

Results

The flow of participants through the study process is reported in Figure 1. A total of seven schools were recruited, with one teacher from each school consenting to involvement. In total, 168 students (mean age = 11.16 years [SD = 0.95, range 10 – 13]) from the recruited classes provided parental consent and were assessed at baseline, with four schools randomised to the intervention ($n = 97$) and three to the control ($n = 71$) condition. In terms of retention, measurements were obtained on 98% of the sample at 8-week follow-up in December 2013 ($n = 165$).

There were no significant differences ($p < 0.05$) between control and intervention groups at baseline for age, object control proficiency or athletic competence variables. Participants in the control group displayed significantly higher ($p < 0.05$) catch and greater in-class PA (step/min) at baseline than those in the intervention group (Table 3). Neither group displayed any participants undertaking greater than 50% MVPA (> 85.8 steps/min) at baseline whilst in-class (Table 4). The intervention group displayed the majority of students (96%) experiencing less than 33% of class time in MVPA (< 63.5 steps/min), with significantly less participants ($\chi^2 = 23.41$, $df = 1$, $P < 0.001$) within the 33 – 50% zone than the control group.

Intervention fidelity

Baseline coding of lesson observation scales displayed similar code agreement among intervention and control groups (Control: 13% game / 83% skills; Intervention: 13% game / 63% skill), indicating that the observed lessons were in greater agreement with a skills based format. At follow-up, control group instruction remained in preference of a skills approach (21% game / 72% skills), whereas the intervention group had shifted to greater agreement with game centred instruction (75% game / 0% skills), in line with the intention of the intervention.

Changes in primary outcomes

Table 5 displays the mean change in object control proficiency by group. There was a significant treatment effect for change in object control skills at 8-week follow-up (adjusted mean difference = 4.0, $P < 0.001$, $d = .96$).

Changes in secondary outcomes

There was a significant treatment effect for in-class PA (adjusted mean difference = 16.0 steps/min, $P < 0.001$, $d = 1.02$). The distribution of intervention group participants in step zones changed dramatically, with a large proportional increase (28%) in the 33-50% MVPA step zone and a small proportional increase (4.6%) in the $> 50\%$ MVPA step zone (Table 4). The positive change in distribution for the intervention group approached significance ($\chi^2 = 5.90$, $df = 2$, $P = 0.052$). There was no significant treatment effect observed for the athletic competence variable (adjusted mean difference = -0.1, $P = 0.399$, $d = -.17$).

Discussion

There is a dilemma between keeping children active in PE and furthering their development of FMS (van Beurden et al., 2003), with only two studies previously undertaking this: SPARK (McKenzie et al., 1998, Sallis et al., 1997) and MIGI (van Beurden et al., 2003). Improvements in process (van Beurden et al., 2003) and product (McKenzie et al., 1998) assessed motor skill competency have been obtained previously using professional development of primary school teachers. The PLUNGE investigation displays that improvements in FMS are not necessarily dependant on intervention volume (Morgan et al., 2013), with the PLUNGE program far shorter than SPARK (McKenzie et al., 1998) or MIGI (van Beurden et al., 2003) at 6 and 12 months respectively.

In-class PA improved by 47% in the PLUNGE intervention group. SPARK (Sallis et al., 1997), MIGI (van Beurden et al., 2003) and the present study produced significant improvements in in-class PA. The post-test mean of 60 steps/minute in the present investigation is marginally below the threshold value of 63.5 steps/minute to obtain one third of a class in MVPA, and is in line with 34.7% MVPA reported by van Beurden et al (2003). The novel aspect of the PLUNGE intervention was that the active games formed the environment in which motor and game skill learning were situated (Kirk and MacPhail, 2002). This lies in contrast to previous interventions separating motor skill development activities from game or fitness based activities, which are used to obtain increased volumes of intense PA (McKenzie et al., 1998, Sallis et al., 1997, van Beurden et al., 2003).

The result observed was still well short of the 82.9 steps/minute required to reach 50% MVPA in-class (Scruggs, 2013). Infusion of fitness activities could be considered in future curriculum versions for improvement of MVPA targets (Lonsdale et al., 2013), but this practice would have to be balanced with the risk of a reduction on outcomes promoting longer term PA

behaviours. The PLUNGE intervention promotes FMS as the foundation for a physically active lifestyle (Lubans et al., 2010), and cognition of game play for the development of skilled sports performers (Janelle and Hillman, 2003), with these aspects situated within active game based activities. Early development of FMS in conjunction with game play skills may better prepare students for future sports activities involving information processing, decision making and skill performance (such as high school PE and community sports).

No previous investigation of in-class **PA** change using teaching strategies has included a measure of perceived competence. The present investigation saw no change in perceived athletic competence. As young people become more aware of their abilities as they get older (Babic et al., 2014), detecting change in the age group involved in this investigation may be problematic. A ceiling effect (Stone et al., 1998) may have contributed to the result in this study, with relatively high baseline values. **The alternative hypothesis that student skills did not improve enough to elicit a response in self-perception is offered.**

Teaching using a student centred approach adds a level of difficulty to PE lessons (Pill, 2011), with teacher concern stemming from a lack of confidence and a belief that lessons may be less ordered than if delivered in a 'traditional' skills based format (Brooker et al., 2000). Quantitative process evaluation was not undertaken in this investigation, however the fidelity and in-class PA results indicate that teachers were able to: i) successfully present the GCA curriculum after the mentoring process, and ii) teach GCA based lessons that were more active than their baseline lessons from the same syllabus strand.

With regard to sustainability, whilst initially very intensive (one full day and five sessions in-class), the PLUNGE model could be implemented via a trained mentor working with several schools, with ongoing support reduced dramatically after the initial mentoring of teachers. This process would promote longer term PE quality and PA outcomes through ongoing teacher support (Armour and Duncombe, 2004), and may be viable as an isolated intervention, or as part of a multi-component school program.

Limitations

Several limitations must be recognized: **i) Randomization, whilst designed to account for clustering, resulted in differences between groups at baseline; ii) The PLUNGE program was designed to promote a mastery climate. Whilst the positive effects observed shadow findings**

from interventions promoting mastery climates for the development of FMS (Martin et al., 2009) and in-class PA (Wadsworth et al., 2013), no measure of the motivational climate was undertaken in this investigation; iii) Due to budget constraints, in-class PA was not measured across all lessons during the study period; iv) Changes in game play abilities were not assessed in this study. Improvements in game play abilities have previously been reported from game based interventions (Gray and Sproule, 2011, Nathan and Haynes, 2013), and improvement of game play abilities as a potential mediator of participation in PA is of interest; v) Quantitative process evaluation was not undertaken. Interview data was obtained regarding teacher interaction with the professional learning program and views on the feasibility of the approach, however it is beyond the scope of this manuscript to provide analysis of these data; and vi) The intervention period was relatively short with retention of teaching behaviours and in-class PA not investigated. It is suggested that the longer term sustainability of the positive efficacy observed should be tested with future investigations of a larger scale for longer periods (Lai et al., 2014).

Conclusion

PLUNGE was the first intervention to focus on professional learning of generalist primary school teachers in the use of game centred approach curriculum. Results indicate professional learning using education and situated mentoring with a focus on a game-centred pedagogical approach was efficacious at developing student FMS and increasing in-class PA in grade 6 primary school students. The PLUNGE professional learning model is seen as valid approach at a classroom level for the improvement of FMS and in-class PA.

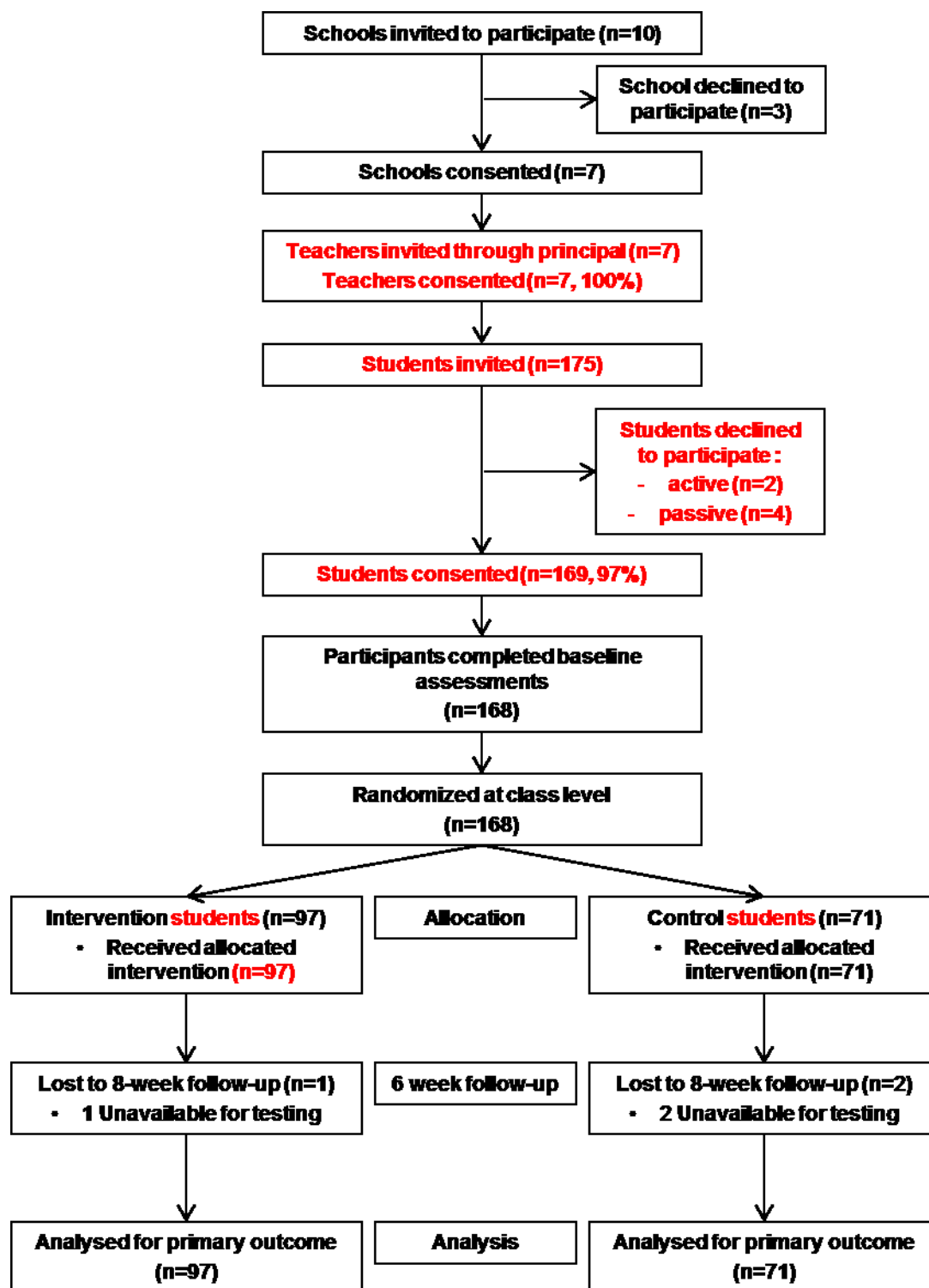


Figure 1. Participant recruitment and retention (Australia from September to December 2013)

Table 1. *PLUNGE intervention components (Australia from September to December 2013)*

Professional development content	In-class mentoring content
<p>Instructional (in-class theory)</p> <ul style="list-style-type: none"> - Connection of a Game Centered Approach to the existing NSW Personal Development Health and Physical Education syllabus (Board of Studies NSW, 2007b) - Develop motor skills, cognition of game play and socio-cultural (team-work, co-operation, etc..) outcomes within game play - The use of questioning to assist student cognition - Active Learning Time (ALT) - Classroom management for improved ALT - Identification and use of Teachable Moments in PE classes - Development of a learning environment to foster mastery motivation <p>Theoretical:</p> <ul style="list-style-type: none"> - Physical activity research findings - Theoretical grounding: achievement goal theory (Nicholls, 1989) - Game Centered Approach research overview - Game Centered Approach comparison to a direct instruction methodology - Mastery motivation within P.E classes: <ul style="list-style-type: none"> - Diversity of challenge (Nicholls, 1989, Marshall and Weinstein, 1984) - Individual development of process related aspects of learning tasks (Ames, 1992, Meece, 1991) - Coordination of curriculum and instructional motivational goals (Ames, 1992, Marshall, 1988) 	<p>Structural:</p> <ul style="list-style-type: none"> - Establishing expectations - Efficient game setup and instruction - Classroom management during stoppages <p>Promotion of learning:</p> <ul style="list-style-type: none"> - Developing effective game environments - Game appreciation - Use of questioning to identify learning focus (motor skill, game cognition or socio-cultural) - Promoting cognition - Throw, catch and kick skills - Establish equity based constraints - Recognizing teachable moments <p>Class environment:</p> <ul style="list-style-type: none"> - Positive support of classmates - Contribution by all - Fun and fair games - Diminishing over-competitive behavior/reaction <p>Motivational:</p> <ul style="list-style-type: none"> - Promote personal improvement of process outcomes within activities (Ames, 1992, Meece, 1991) - Promotion of class focus of the game process, not the result (Ames, 1992, Meece, 1991) - Help students establish a class version of a quality game performance (Nolen and Haladyna, 1990) - Promote positive peer recognition of effort, particularly in situations involving failure (Clifford et al., 1988) - Provide private recognition of effort and improvement (Garner, 1990)

Table 2. *PLUNGE curriculum overview (Australia from September to December 2013)*

Week	Curriculum
Week 1: Throw, catch, kick	<p>Aim: Develop current throw, catch and kick skills and begin game appreciation process and development of constructive classroom environment</p> <p>Emphasis: Target games rather than invasion games to develop physical skills in a game like environment, without the pressure of invasion games</p> <p>Tactical complexity: Low (target games)</p> <p>Style of activities: Partner</p>
Week 2: Moving targets	<p>Aim: Develop current throw, catch and kick skills whilst tracking moving players (movement of ball to moving players / off ball support)</p> <p>Emphasis: Target games rather than invasion games to develop skills in a game like environment, without the pressure of invasion games</p> <p>Tactical complexity: Increases to target games with increasing amounts of interaction between players / no defense</p> <p>Style of activities: Partner and small group activities (groups of 3)</p>
Week 3: Attacking a target	<p>Aim: Use of propulsion skills to attack a target without the pressure of defenders attacking the ball</p> <p>Emphasis: Use of physical and game skills to out-do the defender of the target</p> <p>Tactical complexity: Increases to small group target games with defense of the target</p> <p>Style of activities: Small group activities (groups of 3 - 5)</p>
Week 4: Finding space - 1	<p>Aim: Develop the ability to support attacking play with off ball movement</p> <p>Emphasis: Movement into space to create options for the player who has the ball</p> <p>Tactical complexity: Increases to possession games where defenders are trying to obtain the ball, but the attack to defense ratio is high (3 attack to 1 defender)</p> <p>Style of activities: Small group activities (groups of 3 - 6)</p>
Week 5: Finding space - 2	<p>Aim: Develop the ability to support attacking play with off ball movement</p> <p>Emphasis: Movement into space to create options for the player who has the ball</p> <p>Tactical complexity: Increases to possession games where attack to defense ratio is equal (3 attack to 3 defenders) and modified invasion games (5 attack to 2 defender)</p> <p>Style of activities: Medium group activities (groups of 6 - 10)</p>
Week 6: Attacking play (Throw and catch)	<p>Aim: Develop the combination of on and off ball skills when creating attacking raids using throw and catch skills (invasion)</p> <p>Emphasis: Execution of throwing skills and recycling support</p> <p>Tactical complexity: Increases to modified invasion games where attack to defense ratio is equal (3 attack to 3 defenders)</p> <p>Style of activities: Medium group activities (groups of 6 - 12)</p>
Week 7: Attacking play (Kick)	<p>Aim: Develop the combination of on and off ball skills when creating attacking raids using kicking skills</p> <p>Emphasis: Execution of kicking skills and recycling support</p> <p>Tactical complexity: Decreases to possession and modified invasion games with high attack/defense ratio (5 attack to 2 defender)</p> <p><i>Note. Complexity decreases due to the emphasis on kick skills.</i></p> <p>Style of activities: Medium group activities (groups of 6 - 12)</p>

Table 3. *Baseline characteristics of PLUNGE participants randomized to the intervention and control groups (Australia from September to December 2013)*

Characteristics	Control		PLUNGE intervention		P
	(n = 71)		(n = 97)		
	Mean	SD	Mean	SD	
Age (years)	11.20	0.61	11.12	1.28	0.521
Gender (Male) n (%)	34	(51)	38	(43)	
<i>Fundamental movement skills</i>					
Object control competency ^a	11.54	3.39	10.57	2.94	0.059
Throw ^b	2.33	2.15	2.10	1.83	0.478
Catch ^c	3.91	0.90	3.56	1.10	0.026*
Kick ^b	5.38	1.85	4.98	1.99	0.201
<i>In-class physical activity</i>					
Steps per minute	50.35	16.88	40.24	11.61	0.00*
<i>Physical self-perception</i>					
Athletic competence ^d	3.11	0.77	3.06	0.72	0.855

Notes. * Significance at $p < 0.05$.

^a Values range 0 – 22.

^b Values range 0 – 8.

^c Values range 0 – 6.

^d Values range 0 – 4.

Table 4. *Step zones from baseline to follow-up assessment in intervention and control groups (Australia from September to December 2013)*

Assessment period	Treatment group	Step zones (steps/min)			Total
		<33% (< 63.50)	33 - 50% (63.50 – 82.90)	>50% (> 82.90)	
Baseline	Control	78.0%	22.0%	0.0%	100%
	Intervention	96.0%	4.0%	0.0%	100%
Follow-up	Control	75.1%	23.4%	1.5%	100%
	Intervention	63.4%	32.0%	4.6%	100%

Table 5. *PLUNGE Intervention effects (Australia from September to December 2013)*

Outcome	Treatment group		Adjusted mean difference between groups (95% CI) ^a	Group * Time P	Effect size (Cohen's d)
	Mean change from baseline (95% CI)				
	Control (n = 71)	PLUNGE intervention (n = 97)			
<i>Fundamental movement skills</i>					
Object control competency	-0.27 (-1.13 – 0.58)	3.65 (2.91 – 4.39)	4.02 (2.86 – 5.18)	< 0.001*	0.96
Throw	-0.16 (-0.67 – 0.36)	1.91 (1.47 – 2.36)	2.11 (1.42 – 2.80)	< 0.001*	0.88
Catch	-0.41 (-0.72 – -0.10)	0.64 (0.38 – 0.91)	1.05 (0.64 – 1.47)	< 0.001*	0.75
Kick	0.28 (-0.20 – 0.75)	1.03 (0.62 – 1.44)	0.81 (0.17 – 1.46)	0.018*	0.40
<i>In-class physical activity</i>					
Steps/min	0.78 (-2.14 – 3.70)	19.04 (16.57 – 21.50)	16.01 (11.85 – 20.30)	< 0.001*	1.02
<i>Physical self-perception</i>					
Athletic competence	-0.04 (-0.08 – 0.16)	-0.11 (-0.21 – 0.01)	-0.08 (-0.23 – 0.08)	0.399	-0.17

Notes. * Significance at $p < 0.05$.

^a Between group difference of change score (intervention minus control).

References

- AMES, C. 1992. Classrooms: Goals, Structures, and Student Motivation. *Journal of Educational Psychology*, 84, 261-271.
- ARMOUR, K. M. & DUNCOMBE, R. 2004. Teachers' continuing professional development in primary physical education: lessons from present and past to inform the future. *Physical Education and Sport Pedagogy*, 9, 3-21.
- BABIC, M., MORGAN, P. J., PLOTNIKOFF, R. C., LONSDALE, C., WHITE, R. L. & LUBANS, D. R. 2014. Physical activity and physical self-concept in youth: Systematic review and meta-analysis. *Sports Medicine*.
- BARNETT, L. M., MORGAN, P. J., VAN BEURDEN, E., BALL, K. & LUBANS, D. R. 2011. A reverse pathway? Actual and perceived skill proficiency and physical activity. *Medicine and Science In Sports and Exercise*, 43, 898-904.
- BARNETT, L. M., MORGAN, P. J., VAN BEURDEN, E. & BEARD, J. R. 2008. Perceived sports competence mediates the relationship between childhood motor skill proficiency and adolescent physical activity and fitness: A longitudinal assessment. *International Journal of Behavioral Nutrition & Physical Activity*, 5, 1-12.
- BARNETT, L. M., VAN BEURDEN, E., MORGAN, P. J., BROOKS, L. O. & BEARD, J. R. 2009. Childhood Motor Skill Proficiency as a Predictor of Adolescent Physical Activity. *Journal of Adolescent Health*, 44, 252-259.
- BOARD OF STUDIES NSW 2007a. *Personal Development, Health and Physical Education K-6: Syllabus*, Sydney, Board of Studies NSW.
- BOARD OF STUDIES NSW 2007b. *Personal Development, Health and Physical Education: Syllabus*, Sydney, Board of Studies NSW.
- BOOTH, M. L., OKELY, A. D., DENNEY-WILSON, E., HARDY, L., YANG, B. & DOBBINS, T. 2006. NSW Schools Physical Activity and Nutrition Survey (SPANS) 2004: full report. NSW: Department of Health, Sydney.
- BROOKER, R., KIRK, D., BRAIUKA, S. & BRANSGROVE, A. 2000. Implementing a game sense approach to teaching junior high school basketball in a naturalistic setting. / L'enseignement du basketball dans les colleges d'enseignement secondaire: encourager le sens du jeu dans un cadre naturel. *European Physical Education Review*, 6, 7-26.
- CECCHINI ESTRADA, J. A., GONZÁLEZ-MESA, C. G., MÉNDEZ-GIMÉNEZ, A. & FERNÁNDEZ-RÍO, J. 2011. Achievement goals, social goals, and motivational regulations in physical education settings. *Psicothema* 23, 51-57
- CLIFFORD, M. M., KIM, A. & MCDONALD, B. A. 1988. Responses to failure as influenced by task attribution, outcome attribution, and failure tolerance. *The Journal of Experimental Education*, 57, 19-37.
- COHEN, J. 1988. *Statistical power analysis for the behavioral sciences*, Hillsdale, NJ, Lawrence Erlbaum Associates.
- COHEN, K., MORGAN, P. J., PLOTNIKOFF, R. C., CALLISTER, R. & LUBANS, D. R. 2014. Fundamental movement skills and physical activity among children living in low-income communities: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity*, 11, 49.
- COX, M., SCHOFIELD, G. & KOLT, G. S. 2010. Responsibility for children's physical activity: Parental, child, and teacher perspectives. *Journal of Science and Medicine in Sport*, 13, 46-52.

- CURY, F., BIDDLE, S., FAMOSE, J., GOUDAS, M., SARRAZIN, P. & DURAND, M. 1996. Personal and situational factors influencing intrinsic motivation of adolescent girls in school physical education: A structural equation modeling analysis. *Educational Psychology*, 16, 305-315
- DUDLEY, D., OKELY, A., PEARSON, P. & COTTON, W. 2011. A systematic review of the effectiveness of physical education and school sport interventions targeting physical activity, movement skills and enjoyment of physical activity. *European Physical Education Review*, 17, 353-378.
- 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. *Preventive Medicine*, 56, 12-9.
- EIME, R. M., YOUNG, J. A., HARVEY, J. T., CHARITY, M. J. & PAYNE, W. R. 2013. A systematic review of the psychological and social benefits of participation in sport for children and adolescents: informing development of a conceptual model of health through sport. *International Journal of Behavioral Nutrition & Physical Activity*, 10, 98-118.
- FAIRCLOUGH, S. J. & STRATTON, G. 2005. Physical activity levels in middle and high school physical education: A review. *Pediatric Exercise Science*, 17, 217-236.
- GARNER, R. 1990. When children and adults do not use learning strategies: Toward a theory of settings. *Review of Educational Research*, 60, 517.
- GRAY, S. & SPROULE, J. 2011. Developing pupils' performance in team invasion games. *Physical Education and Sport Pedagogy*, 16, 15-32.
- HARDY, L. L., KING, L., ESPINEL, P., COSGROVE, C. & BAUMAN, A. 2011. NSW Schools Physical Activity and Nutrition Survey (SPANS) 2010: Full Report. Sydney: NSW Ministry of Health.
- HARTER, S. 2012. *Manual for the self-perception profile for children*, Denver, University of Denver.
- JANELLE, C. M. & HILLMAN, C. H. 2003. Expert performance in sport: current perspectives and critical issues. In: STARKES, J. L. & ERICSON, K. A. (eds.) *Expert performance in sports*. Champaign, IL: Human Kinetics.
- JANSSEN, I. & LEBLANC, A. G. 2010. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition & Physical Activity*, 7, 40-55.
- KENNEDY, A. 2005. Models of continuing professional development: A framework for analysis. *Journal of In-Service Education*, 31, 235-250.
- KIRK, D. & MACPHAIL, A. 2002. Teaching games for understanding and situated learning: Rethinking the bunker-thorpe model. *Journal of Teaching in Physical Education*, 21, 177-192.
- LAI, S., COSTIGAN, S., MORGAN, P., LUBANS, D., STODDEN, D., SALMON, J. & BARNETT, L. 2014. Do School-Based Interventions Focusing on Physical Activity, Fitness, or Fundamental Movement Skill Competency Produce a Sustained Impact in These Outcomes in Children and Adolescents? A Systematic Review of Follow-Up Studies. *Sports Medicine*, 44, 67-79.
- LAVE, J. & WENGER, E. 1991. *Situated learning: legitimate peripheral participation*, Cambridge, Cambridge University Press

- LONSDALE, C., ROSENKRANZ, R. R., PERALTA, L. R., BENNIE, A., FAHEY, P. & LUBANS, D. R. 2013. A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. *Preventive Medicine*, 56, 152-161.
- 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.
- LUBANS, D. R., MORGAN, P. J., WEAVER, K., CALLISTER, R., DEWAR, D., COSTIGAN, S., FINN, T., SMITH, J., UPTON, L. & PLOTNIKOFF, R. C. 2012. Rationale and study protocol for the supporting children's outcomes using rewards, exercise and skills (SCORES) group randomized controlled trial: A physical activity and fundamental movement skills intervention for primary schools in low-income communities. *BMC Public Health*, 12, 427.
- MARSHALL, H. H. 1988. In pursuit of learning-oriented classrooms. *Teaching and Teacher Education*, 4, 85-98.
- MARSHALL, H. H. & WEINSTEIN, R. S. 1984. Classroom Factors Affecting Students' Self-Evaluations: An Interactional Model. *Review of Educational Research*, 54, 301-325.
- MARTIN, E. H., RUDISILL, M. E. & HASTIE, P. A. 2009. Motivational climate and fundamental motor skill performance in a naturalistic physical education setting. *Physical Education and Sport Pedagogy*, 14, 227-240.
- MCKENZIE, T. L., ALCARAZ, J. E., SALLIS, J. F. & FAUCETTE, F. N. 1998. Effects of a physical education program on children's manipulative skills. *Journal of Teaching in Physical Education*, 17, 327-341.
- MEECE, J. 1991. The classroom context and children's motivational goals. In: MAEHR, M. & PINTRICH, P. (eds.) *Advances in achievement motivation research*. Greenwich, CT: JAI Press.
- MILLER, A. In press. Games centered approaches in teaching children & adolescents: Systematic review of associated student outcomes. *Journal of Teaching in Physical Education*.
- MOHER, D., HOPEWELL, S., SCHULZ, K. F., MONTORI, V., GÖTZSCHE, P. C., DEVEREAUX, P. J., ELBOURNE, D., EGGER, M. & ALTMAN, D. G. 2010. CONSORT 2010 explanation and elaboration: Updated guidelines for reporting parallel group randomised trials. *BMJ*, 340.
- MORGAN, P. J., BARNETT, L. M., CLIFF, D. P., OKELY, A. D., SCOTT, H. A., COHEN, K. & LUBANS, D. R. 2013. Fundamental Movement Skill Interventions in Youth: A Systematic Review and Meta-analysis. *Pediatrics*, 132, e1361-e1383.
- MORGAN, P. J. & HANSEN, V. 2007. Recommendations to Improve Primary School Physical Education: Classroom Teachers' Perspective. *The Journal of Educational Research*, 101, 99-111,128.
- MORGAN, P. J. & HANSEN, V. 2008. Classroom Teachers' Perceptions of the Impact of Barriers to Teaching Physical Education on the Quality of Physical Education Programs. *Research Quarterly for Exercise and Sport*, 79, 506.
- NATHAN, S. & HAYNES, J. 2013. A move to an innovative games teaching model: Style E Tactical (SET). *Asia-Pacific Journal of Health, Sport & Physical Education*, 4, 287-302.
- NICHOLLS, J. G. 1989. *The competitive ethos and democratic education* Cambridge, MA, Harvard University Press.

- NOLEN, S. B. & HALADYNA, T. M. 1990. Personal and environmental influences on students' beliefs about effective study strategies. *Contemporary Educational Psychology*, 15, 116-130.
- PAPAIOANNOU, A. 1998. Students' perceptions of the physical education class environment for boys and girls and the perceived motivational climate. *Research Quarterly for Exercise and Sport*, 69, 267-75.
- PARISH, L. E. & TREASURE, D. C. 2003. Physical activity and situational motivation in physical education: Influence of the motivational climate and perceived ability. *Research Quarterly for Exercise and Sport*, 74, 173-82.
- PILL, S. 2011. Teacher engagement with teaching games for understanding-game sense in physical education. *Journal of Physical Education and Sport*, 11, 115-123.
- PORTER, J. M. & MAGILL, R. A. 2010. Systematically increasing contextual interference is beneficial for learning sport skills. *Journal of Sports Sciences*, 28, 1277-1285.
- RHODES, C. & BENEICKE, S. 2003. Professional development support for poorly performing teachers: challenges and opportunities for school managers in addressing teacher learning needs. *Journal of In-Service Education*, 29, 123-140.
- RINK, J. E., FRENCH, K. N. E. & TJEERDSMA, B. L. 1996. Foundations for the learning and instruction of sport and games. *Journal of Teaching in Physical Education*, 15, 399-417.
- SALLIS, J. F., MCKENZIE, T. L., ALCARAZ, J. E., KOLODY, B., FAUCETTE, N. & HOVELL, M. F. 1997. The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. *Sports, Play and Active Recreation for Kids. American Journal of Public Health*, 87, 1328-34.
- SCRUGGS, P. W. 2013. Pedometer steps/min in physical education: does the pedometer matter? *Journal of Science and Medicine in Sport*, 16, 36-9.
- STONE, E. J., MCKENZIE, T. S. L., WELK, G. J. & BOOTH, M. L. 1998. Effects of physical activity interventions in youth: Review and synthesis. *American Journal of Preventive Medicine*, 15, 298-315.
- TURNER, A. & MARTINEK, T. J. 1992. A comparative analysis of two models for teaching games (Technique Approach and Game-Centered (Tactical Focus) Approach). *International Journal of Physical Education*, 29, 15-31.
- ULRICH, D. A. 2000. *Test of Gross Motor Development Examiner's Manual*, Austin, Texas, Pro.Ed.
- VAN BEURDEN, E., BARNETT, L. M., ZASK, A., DIETRICH, U. C., BROOKS, L. O. & BEARD, J. 2003. Can we skill and activate children through primary school physical education lessons? "Move it Groove it" - a collaborative health promotion intervention. *Preventive Medicine*, 36, 493-501.
- VAN DER HORST, K., PAW, M. J. C. A., TWISK, J. W. R. & VAN MECHELEN, W. 2007. A brief review on correlates of physical activity and sedentariness in youth. *Med Sci Sports Exerc*, 39, 1241-50.
- WADSWORTH, D. D., ROBINSON, L. E., RUDISILL, M. E. & GELL, N. 2013. The Effect of Physical Education Climates on Elementary Students' Physical Activity Behaviors. *Journal of School Health*, 83, 306-313.