The impact of gymnastics on children's psychological and movement skill development in primary schools

Abstract

Purpose: This study evaluated the effectiveness of an eight week gymnastics curriculum on children's movement competence and their physical self-concept (PSC). Method: 113 children (46% girls, 49 % intervention) with a mean age of 9.4 years (sd = 1.8) participated. Intervention children underwent eight weeks of gymnastics and the comparison group continued with their standard curriculum. Results: age was a significant co-variate, separate analysis was conducted on the lower (grade 2 &4) and upper (grade 6) groups. The lower age group showed significant improvement in favour of the gymnastic group in fundamental movement skills (FMS). The upper age group showed a significant improvement for the control group in general body coordination and FMS. For all grades the PSC showed a significant main effect in favour of the gymnastics group. Conclusion: the gymnastics intervention was found to be of particular benefit for developing children's movement competence and PSC in younger children.

Keywords: fundamental movement skills, general body coordination, physical education, intervention.

Introduction

There appears to be a decline in children's movement skill performance from previous generations (Bardid, Rudd, Lenoir, Polman, & Barnett, 2015; Tester, Ackland, & Houghton, 2014). Children who possess high levels of movement skill have been found to have increased health and physical activity benefits during childhood (Lubans, Morgan, Cliff, Barnett, & Okely, 2010).

Physical Education (PE) offers an excellent opportunity to reverse the current decline. Burton and Miller (1998) have argued that the physical education curriculum should be consistent with a theoretical model of movement competence. To this end, a recent study (Rudd et al., 2015) provided a model of movement competence which included Fundamental Movement Skills (FMS), in the form of locomotor and object control skills, as well as children's general body coordination. A broad model of movement skill competence fits with the growing body of evidence suggesting that children should sample a wide range of movement activities during primary school years (Côté, Lidor, and Hackfort 2009). Children who actively sample many types of sports and activities see benefits to their movement skill performance and psychological outlook, compared to children who have experienced a less diverse range of sporting activities (Bridge and Toms 2013; Côté and Fraser-Thomas 2007; Wall and Côté 2007).

Traditionally, interventions to improve movement skills in the school setting have had a relatively narrow focus, concentrating on the main locomotor and object control skills (Morgan et al. 2013). To align with sampling research a broader approach was taken to investigate if an educational gymnastics based curriculum where children undertook a curriculum of tumbling, jumping, controlled falling and moving in gravity-defying ways improves multiple aspect of movement skill competence. It has been suggested that gymnastics improves all aspects of movement skill competence, including object control skills (Rudd et al. 2016). The improvement in object control skills is important, as these are the more challenging to improve and are deemed the most complex skills to acquire due to sensory demands (Morgan et al. 2013). They are however integral as they have been found to be associated with high levels of physical activity in childhood (Lubans et al. 2010) as well as tracking through to adolescence (Barnett et al. 2010). Further research is needed to understand if this finding can be replicated. It would also be beneficial to know if the improvements in object control skills for lower primary school can be found in upper primary school children following a gymnastics curriculum. This is important, as evidence highlights that a significant number of children leave primary school in Year 6 with inadequate ball skills (Booth et al. 1999; Hardy et al. 2013; Okely and Booth 2004).

There is also a need to understand the psychological effect of a gymnastics curriculum upon primary school children's self concept. The term self-concept is a blanket term and refers to how an individual measures their own competence, attributes and characteristics compared to others (Gallahue, Ozmun & Goodway, 2012). Self-assessment occurs regularly during PE lessons because, as children try new skills, their physical skills are constantly on display to their peers. This can lead to feelings of both success and failure and will directly affect children’s self-concept and its development. (Gehris, Kress, & Swalm, 2010; Goodwin, 1999). In PE, a positive physical self-concept has been found to be associated with higher engagement levels, skill development, and motor learning (Peart, Marsh, & Richards, 2005). It is our suggestion that gymnastics may be especially advantageous to primary school children’s physical self-concept. This is because gymnastics is inherently task-oriented, meaning that skills are practised and developed in a non-pressured environment (Halliburton& Weiss, 2002) with few external distractions. Development of skills in this type of environment has been found to have a greater influence upon children's FMS development (Martin, Rudisill, & Hastie, 2009), as well as having a positive impact upon their physical self-concept (Papaioannou, 1998; Standage, Treasure, Hooper, & Kuczka, 2007). This is not the case for all PE lessons, as many lessons can be inherently competitive and ego-oriented with a focus on winning or losing (Duda, 1996). This pressurised environment can undermine physical self-concept, which in turn can negatively influence skill development in the short and long term (Marsh & Peart, 1988).

The aim of this study was to evaluate the effectiveness of an eight week gymnastics curriculum in developing children's movement skill competency and physical self-concept across a broad primary school age range. It was hypothesised that a gymnastics curriculum would significantly improve all aspects of movement skills competence more than the control group. It was also hypothesised that the gymnastics cohort would experience greater improvements in physical self-perception compared to the control cohort due to the task-oriented nature of the gymnastics curriculum.

Method

Participants

Data was collected in one Melbourne school (Australia) over a whole school term. A total of 113 children, 54% male (56 intervention and 57 control) between the ages of 7-12 (*M* age = 9.4; *SD* 1.8) participated. Written informed consent was obtained from the parents or guardians of each participant. The study was approved by a University Ethics Committee and the Department of Education and Early Childhood Development.

Study Design

In order to investigate the effects of the gymnastics curriculum across the primary school spectrum, Years 2, 4, and 6 were selected in a quasi-experimental design. After consent forms had been collected two classes from each of these years were randomly assigned to either control or intervention. All children underwent pre- and post-assessment testing during weeks 1 and 10 using the Koorperkoodinatoin test fur kinder (KTK; Kiphard & Schilling, 2007) and Test of Gross Motor Development (TGMD-2;Ulrich 2000) to examine changes in movement competence. Children in both the gymnastics and control cohort had a controlled dose of two one hour PE lessons per week for a total of eight weeks.

Measurements

The Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000) assesses proficiency in six locomotor skills (run, hop, slide, gallop, leap, horizontal jump) and six object control skills (strike, dribble, catch, kick, overhand throw, and underhand roll). Each participant completes all 12 skills and is permitted one practice attempt and two assessment trials. During each assessment trial, the assessor marks the skill component as being ‘present’ or ‘absent’.

Koorperkoodinatoin test fur kinder (KTK) was administered according to the manual guidelines (Kiphard & Schilling, 2007). The KTK consists of four outcome-based subtests. Reverse balance (RB) involves participants walking backwards along three different balance beams, with increasing levels of difficulty as the width of the beams reduces from 6 cm to 4.5 cm to 3 cm. Three trials are offered with a maximum score of 8 steps awarded for each beam, creating a maximum score of 72 steps. Hopping for Height (HH) requires participants to hop on one leg over an increasing number of five cm foam blocks to a maximum height of 12 stacked blocks. A successful trial requires participants to stand 1.5 m from the foam blocks, then hop up to, and over, the foam blocks, completing a further two hops on landing. Three trials are given for each height with 3, 2 or 1 point(s) given for a successful performance during the 1st, 2nd and 3rd trial respectively. Continuous Lateral Sideways Jumping (CS) requires participants to complete as many sideways jumps as they can, with feet together, over a wooden slat in 15 seconds. Moving Platforms (MP) involves participants using two wooden platforms to move across the floor. Participants step from one platform to the other, each time moving the vacant platform, with the aim of travelling as far as possible in 20 seconds. Two trials each are provided for CS and MP. The KTK requires little time to set-up and takes approximately 15-20 minutes to administer.

Raw item scores were converted into standardized German normative data (Kiphard & Schilling, 1974 & 2007) which adjusts for age (all items) and sex (HH and CS). The standardized score items were then summed and transformed into a total Movement Quotient (MQ).

Intra rater Reliability

Reliability

Prior to assessments in the field setting, 10 Research Assistants (RAs) received six hours training in testing administration using the same method as reported by Rudd et al. (2016). KTK reliability was assessed using percent agreement, all RAs in training achieved 98% agreement or higher when compared to the gold standard coordination score. For reliability of the TGMD-2 the RAs and lead author subset scores were assessed through intra-class correlation coefficients (ICC) prior to testing in the field at pre- and again at post-assessment. Subtest scores were found to be good for locomotor (Pre - test: ICC = 0.87; 95% CI: 0.69 - 0.93, Post - test: ICC = 0.90; 95% CI: 0.78 - 0.96) and object control (Pre -test: ICC = 0.81; 95% CI: 0.52 - 0.93, Post - test: ICC = 0.88; 95% CI: 0.70 - 0.97).

Anthropometry

Height and weight were measured to an accuracy of 0.1 cm and 0.1 kg respectively. Height was assessed using a Mentone PE087 portable stadiometer (Mentone Educational Centre, Melbourne, Australia) and weight was assessed using a SECA 761 balance scale (SECA GmbH & Co. KG., Birmingham, UK). Height and weight values were used to calculate body mass index (BMI) [BMI = weight (kg) / height^2 (m^2)].

Physical-Self Description Questionnaire short form (PSDQ-s)

The physical self-description questionnaire short form (PSDQ-s) (Marsh, Martin, & Jackson, 2010) comprises nine factors specific to physical self-concept: appearance, activity, coordination, body fat, flexibility, health, endurance, sport, strength, and two global scales – global physical and global self-esteem. The PSDQ-s has good validity and reliability in primary school children (Ling et al. 2015) and also in an Australian cohort (Marsh et al. 2010). Marsh et al. (2010) reported in a sample of children cronbach alphas between .57 and .90 and in the present study alphas ranged between .68 and .91 for pre- and post-testing.

Procedure

The PSDQ-s was completed one day prior to the actual movement competency testing. A research assistant helped Year 2 and 4 children with question comprehension where required.

All motor competence assessments were conducted by 10 trained assessors in a large sports hall. For the physical assessment, children were barefooted and wore their regular PE attire. First, children’s anthropometric measurements (height, weight and grip strength) were taken and then their motor competence was assessed with the KTK and TGMD-2.

Groups of five participants moved in rotation around four skill stations and one anthropometric station. The TGMD-2 was divided between two stations, a locomotor skills station (run, hop, slide, gallop, leap, horizontal jump) and an object control skills station (strike, dribble, catch, kick, overhand throw, and underhand roll). The four KTK tasks were divided into two stations with the RB and CS tasks on one station and MP and HH tasks at the other station. Before undertaking each task, children were shown both live and pre-recorded demonstrations.

Intervention Cohort Curriculum

LaunchPad is designed for children aged under 12 years and its resources are divided into three levels: KinderGym aimed at children aged 0-5 years; GymFun for children aged 5-7 years; and GymSkills for children aged 8-10 years. For this study the GymSkills curriculum was extended to 8-12 years; the rationale for this was that Grade 6 children have poor movement competency (Hardy et al., 2010; Tester, Ackland, & Houghton, 2014) and would most likely benefit from the intervention. All LaunchPad lessons have five teaching sections that follow a set sequence: warm-up, brain challenge, main activity, circuit and cool down. Importantly, each of these sections contains clear content descriptors of what should be taught and each section has a recommended timeframe for how long the specific section should be taught. While these resources are broadly age related they are not age dependent. This means that deliverers should use age as a guide to the selection of resources but the deciding factor should be a child's actual competence level. Each set of resources contains a set of chronological lesson plans, with each lesson building upon the previous one, with skill cards to complement the lesson plans (see Table 1).

*** Insert Table 1 here ***

Control cohort curriculum

The control cohort received eight two-hour lessons of their normal physical education curriculum. This was conducted during the summer term with athletics scheduled in the curriculum (see Table 2).

*** Insert Table 2 here ***

Fidelity

Six out of the 16 lessons were observed (weeks 2, 4 and 6) using a teacher observation checklist adapted from the school's teacher peer assessment tool. The checklist included general teacher initiated behaviour and traits, lesson preparation, lesson presentation, safety and behaviour management. Lessons were observed and graded on a four point Likert scale with 1= poor, 2 = fair, 3 = good, and 4 = excellent.

Data analysis

Data were analysed using SPSS Statistics 20 for Windows. Alpha levels were set at $p < 0.05$ and considered statistically significant for all analyses. Multivariate analysis of co-variance (MANCOVA) was conducted on the difference score (post-test – pre-test) for the KTK (RB, MP, HH, CS). The main factor under investigation was condition (intervention vs. control) with age, sex and BMI included as covariates. Univariate analysis of covariance (ANCOVA) was conducted on the difference scores for KTK Motor Quotient (MQ), total fundamental movement skills (combined object control and locomotive raw scores), locomotive and object control subtest scores separately and the summed PSDQ-s. In this instance, age was found to be a significant covariate, so separate analysis was conducted on the lower year groups (Years 2 & 4) and upper year groups (Year 6).

Results

The retention rate for the assessment of movement competence was 100%. However, for physical self-concept 13 children were unable to complete post-testing due to non-attendance. Table 3 provides summed scores for the KTK, TGMD-2 and PSDQ-s (see Table 3). All observed lessons were graded as good to excellent.

*** Insert Table 3 here ***

Koorperkoordination Test Fur Kinder

The MANCOVA for the four KTK raw test scores did not show a condition main effect (Wilk's λ =.96; p = .42; η^2p = .04). However, age was a significant covariate (Wilks' λ = .84; p = .001; η^2p = .16) whereas sex (P = .97) and BMI (P = .51) did not influence the findings. The ANCOVA for the KTK MQ did not show a condition main effect (F(1,112) = 3.40; p = .07; η^2p = .03). Age and sex were not included in this analysis as the process of standardising the scores accounts for this. BMI did not influence findings (p > .05).

Fundamental movement skills

The ANCOVA for the Total FMS summed score did not show a significant condition main effect (F(1,76) = 2.10; p =.15; η^2p = .09). Age was a significant co-variate (F(1,76) = 5.1; p =.05; η^2p = .04) whereas both sex and BMI did not influence the findings (p > .05). The ANCOVA for locomotive skills did not show a significant condition main effect (F(1,76) = 2.70; p = .38 η^2p=.03, Age, sex and BMI did not influence the findings (p >.05). Finally, the ANCOVA for object control skills provided a near significant condition main effect F(1,76) = 3.14; p =.06; η^2p = .03). Near significant differences were also observed for age (p >.06), but there were no differences for sex or BMI (p > .05). Due to age being a significant covariate in the KTK raw and overall FMS score, and approaching significance for the object control skills, it was decided to examine results separately for the lower year and upper year children.

Results for lower primary (Years 2 and 4)

Kooperkoodination Test Fur Kinder. The MANCOVA for the KTK did not show a condition main effect (Wilks' λ = .84; p = .50; η^2p = .04). BMI and sex did not influence results (p > .05). The ANCOVA for the KTK MQ did not show a condition main effect either (F(1,76) = .21; p = .65; η^2p = .03). In addition, BMI and sex did not influence the findings (p > .05).

Fundamental movement skills. Summed FMS score ANCOVA showed a significant condition main effect (F(1,76) = 7.8; p =.006; η^2p = .09) with the intervention cohort showing larger gains; neither sex nor BMI influenced the findings (p > .05). The ANCOVA for locomotive skills subset score did not show a condition main effect F(1,76) = 1.3; p =.24; η^2p = .02). BMI and sex did not influence the findings (p > .05). The object control skills were largely responsible for the significance in total FMS score, as the ANCOVA for object control skills did show a significant main effect in favour of the intervention cohort (F(1,76) = 4.52; p =.04; η^2p = .06).

Results for upper primary (Year 6)

The MANCOVA for the KTK showed a condition main effect (Wilks' λ = .56; p = .008; η^2p = .44). Follow-up ANCOVA showed larger gains in the control cohort in comparison to the intervention cohort. The ANCOVA for the KTK MQ showed a significant condition main effect (F(2,26) = 4.42; p = .045; η^2p = .15) with the control cohort showing larger improvements. BMI and sex did not influence the findings (p > .05).

Total FMS ANCOVA showed a significant condition effect in favour of the control cohort F(1,26) = 9.5; *p* = .005; η2p = .27). BMI and sex did not influence the findings (*p* > .05). The ANCOVA for locomotive skills subset score also showed a significant condition main effect (F(1,26) = 11.5; *p* = .002; η2p = .31). BMI and sex did not influence the findings (*p* > .05). ANCOVA for object control skills did not show a significant main effect (F(1,26) = 4.41; *p* =.52; η2p = .02).

Physical self-description questionnaire- s (overall)

The ANCOVA for the total score of the PSDQ showed a significant condition main effect (F(1,97) = 6.12; *p* = .02; η^2p = .06) with the intervention cohort showing larger gains in overall PSDQ scores compared to the control cohort which showed a decrease in PSDQ scores. BMI and sex did not influence the findings (*p* > .05).

Lower primary (Years 2 and 4). ANCOVA for the PSDQ showed a significant condition main effect (F(1,66) = 5.8; *p* = .02; η^2p = .08) with the intervention cohort showing larger gains. BMI and sex did not influence the findings (*p* > .05).

Upper primary (Year 6). The ANCOVA for the PSDQ did not show a significant condition main effect for upper primary school children (F(1,28) = 1.61x; *p* =.22; η^2p = .05). BMI and sex did not influence the findings (*p* > .05).

Discussion

The aim of this study was to examine the efficacy of a gymnastics curriculum on the development of movement skill performance and physical self-concept in primary school children compared to the school's standard PE curriculum. Overall, no difference was found between the two curricula in terms of improvements in actual movement competence when combining all grades, although the gymnastics cohort showed significant improvement in physical self-concept for all children compared to children participating in the standard PE curriculum.

Age was found to be a significant covariate for actual movement skill competency on both overall FMS and general body coordination variables. When examining the findings for the upper and lower primary children separately, it was found that the lower primary school children responded more positively to the gymnastics intervention than upper primary school children. In particular, children who participated in the gymnastics curriculum demonstrated a significant improvement in total FMS score, object control skills and in their physical self-concept compared to the control cohort.

The improvement in the lower primary intervention group in total FMS was mainly due to improvements in object control skills. This is in line with Rudd et al. (2016) which also found children with a mean age of 8 years showed significant improvement in object control skills compared to a control group after a gymnastics intervention. This current study reinforces a possible transfer between gymnastics and the development of more complex fundamental skills. The improvement in object control skills is essential as these skills have been associated with increased fitness and physical activity outcomes later in life (Barnett et al., 2008; Stodden, Gao, Goodway, & Langendorfer, 2014; Vlahov, Baghurst, & Mwavita, 2014).

The upper school (Year 6) did not reflect the lower school's results. The upper school control group showed significant improvements in locomotive skills and general body coordination, but there was no difference between the cohorts for object control skills. The athletics curriculum involved many activities which focused on locomotor skills and this may explain the apparent enhancement in this set of skills. Another factor that may have influenced the lack of development in the gymnastics cohort was the gymnastics curriculum was not sufficiently challenging for year 6 children, meaning that the task they were doing was too easy to acquire FMS and general coordination beyond what they already possessed. This hypothesis is reinforced when it is considered that the curriculum was designed for children up to the age of 10 and the average age in the year 6 group was 12. It had previously been decided there was sufficient justification for including year 6 children as it was felt the curriculum may have been beneficial to them, due to the poor levels of movement skills reported in the literature (Booth et al. 1999; Hardy et al. 2013; Okely and Booth 2004).

In this study, all children in the gymnastics cohort showed significant improvement in physical self-concept compared to the standard PE curriculum. A potential reason for the improvement is that gymnastics is non-competitive and may therefore lead to a less-threatening learning environment, which is more aligned to a task oriented mastery climate which, has been associated with positive student outcomes (Papaioannou, 1998, Standage et al., 2007; Martin., et al 2009). Children in the lower primary school who undertook the gymnastics curriculum demonstrated the simultaneous development of physical self-concept and movement skill competence. Marsh et al., (2006) suggest that such balanced improvement will foster long term benefits to a child's self-belief and movement skill competence. Conversely, the upper primary school gymnasts also improved their self-concept although no actual movement skill improvement was observed. In accordance with Marsh et al., (2006), it is likely that these children will experience only short-term benefits in self-belief and movement skill competency since there is not a balance between the children's self-concept and motor skill performance; hence the importance of having a curriculum that meets children's development needs.

This study has highlighted the increasing need for PE teachers and schools to implement an evidence based approach to the assessment/ evaluation of the taught PE curriculum, with a focus on how it is impacting upon the individual child's motor skills and psychological development. This is of paramount importance given the growing body of evidence of decreasing levels of movement skill performance being found in children (Bardid et al. 2015; Tester et al. 2014)

Conclusion and Future Study

This paper further highlights the importance of gymnastics for lower primary school children's movement skill development. In particular, it reinforces the potential of gymnastics to help children perform complex movement skills such as object control skills. This paper also underpins the positive psychological benefits of young children undertaking gymnastics through improved physical self-concept. The lack of skill improvement for the older children who undertook the gymnastics curriculum is worthy of further investigations and it is recommended that these children should be taught an appropriately challenging curriculum. It would, in particular, be interesting to see if the gymnastics curriculum could be made more relevant to the older primary school years. A limitation was not collecting socio-economic and ethnic demographics data at the individual level as,without this information, we cannot be certain the sample was representative of the wider school population. Future studies should also explore longitudinal follow up to see if following a gymnastics curriculum in the lower primary school has lasting benefits to long-term self-concept and movement skill competency (Lai et al., 2014).

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