A LONGITUDINAL EFFECT STUDY of classroom-based physical training in young schoolchildren

Trine Møllegaard Muckert
Projektleder
Program for Health Technology, Methodology Development and Ethics, VIA Research Centre for Health and Welfare Technology, VIA University College
trml@skivekommune.dk

Grete Moth, grmo@via.dk
Asbjørn Thalund Binderup, asbi@via.dk

Affiliations: Program for Health Technology, Methodology Development and Ethics, VIA Research Centre for Health and Welfare Technology, VIA University College

ABSTRACT

Objective: The aim of this study was to explore the effect of implementing classroom based physical activity and gross motor testing in 5-8-year-old children.

Design and methods: For testing, a standardized diagnostic test was used to examine children's motor skills at baseline and follow-up. The intervention consisted of 45-minute fun gymnastic sessions focusing on gross motor function guided by a trained teacher three times a week for eight weeks. The McNemar test was used to assess children's motor ability performances before and after intervention sessions.

Results: Overall, a statistically significant positive effect of motor skill training at the level of motor skills was achieved as 14 of the 19 participating children showed improvement (73.7%).

Conclusion: Our results demonstrated the effect of physical activity and gross motor skills on children with motor skill challenges. The pragmatic set-up of the present study underpins the feasibility of interventions testing children's motor skills at the right time and with the right activity.

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Keywords: Motor ability, Children, Physical activity, Motor skills training.

Introduction

Physical activity levels in children have decreased since 1990s [1]. This is problematic because evidence shows that low levels of physical activity in childhood may predict adult activity and behavior, leading to a sedentary life with accompanying life-style-related diseases [2]. Fundamental motor skills may be a prerequisite to children taking part in social physical play. Social play begins in preschool and is crucial for developing social skills and establishing friendships [3].

Children spend more time in school than at home, and the schools may play an important role by helping and encouraging children to be physically active. Examination of the relationship between motor training and motor skills is relevant as motor skills are associated with basic skills development and as enhancing these skills is a core priority for schools [4].

The prevalence of childhood obesity has increased dramatically from 4% in 1957 to 18% in 2016 as children have become more exposed to sedentary activities and increasingly use information technologies [3, 4]. Obesity is associated with negative effects on cognitive functions, including reduced memory and executive functions [7]. Furthermore, it is known that obesity affects motor control capabilities, thereby degrading daily functions and health. Children who are obese or overweight have poorer gross and fine motor control and experience delayed motor development compared with their non-obese or normal-weight peers [8].

The Danish Health Authority (DHA) recommends that children are physically active for a minimum of 60 minutes per day at a level of moderate to high intensity [9] Furthermore, by initiating the national campaign 'Get Moving', the DHA has made efforts to enhance existing knowledge about the importance of physical activity thereby encouraging children and adolescents to become more physically active [10]. These efforts have been ongoing since 2006.

The achievement of milestones in motor development is critical to overall development. Thus, as children grow and develop their motor skills, they increasingly become able to explore and interact with their environment, and through exploration and interaction, they further develop their cognitive, language, and social skills [11]. Studies have found a positive relationship between physical activity and gross motor skills in children aged 3-18 years [12]. Furthermore, studies have shown that some children do not participate in sports or exercise because of poorly developed coordination skills [13], that ⅓ of preschool students have problems with motor learning [14], and that 6-10% felt clumsy during physical activity lessons [13, 14]. This indicates a need for more physical activity and motor training for schoolchildren.

The aim of this study was to explore the effect of implementing classroom-based physical activity and gross motor testing in children.

Methods

Study design and participants

This was an intervention study conducted in the course of three consecutive years from September 2018 to September 2020, including students from kindergarten class to 1th grade from one Danish public school. The students were included in the beginning of the schoolyear. We invited children from kindergarten class to 1th grade, aged 5-8 years.

Measures

Motor test

The children's motor skills were tested at baseline and follow-up using a standardized diagnostic test developed on the basis of an observation checklist; the Motorisk Utveckling som Grund för Inlärning (MUGI), originally constructed as an educational tool [15]. The MUGI was proven to have adequate properties as a screening instrument and had an acceptable level of validity and reliability [16].

A total of 13 different exercises are included in the MUGI observation checklist; the exercises measure balance, coordination skills, and gross motor control [17]. Three levels are used to evaluate the motor skills; 0, 1, and 2. Level 0 means that an exercise can be done without difficulty, Level 1 means that it involves some difficulty to perform the exercise, and Level 2 means either than the exercise causes great difficulty or cannot be performed [15].

Data collection

The children's motor skills were tested twice a year; baseline measurements were made in the fall before the intervention and follow-up measurements in the spring 12 weeks after the intervention. Substantial efforts were made to ensure that the children were tested at the same time of the day and by the same experienced supervisors.

The observations were conducted in groups of 4-5 children. No fixed instructions were given; instead, emphasis was on ensuring that the teacher made sure that each child understood the task. Two observers, one of whom was one of the researchers (TM), participated along with the physical education teacher who instructed and showed the children what to do. In accordance with the original studies using the MUGI model, children with a score of ten point or higher at the baseline measurements were invited to participate in the intervention [18, 19]. The MUGI observational checklist was completed independently by the two observers.

Intervention

The intervention consisted of three main components: exercises addressing cross-motor skills, dynamic balance, and static balance.

Teachers were asked to provide three 45-minute lessons weekly for 12 consecutive weeks. This produced a weekly total of about 135 minutes/week school-based physical activity, which is slightly less than the minimum 150 minutes/week of physical activity recommended for children by Healthy People 2010 [20] and the DHA [21].

Data management

The raw test data were entered into an Excel file by one of the researchers (TM), and the entry was then compared for consistency by two researchers; any inconsistent data were checked and corrected manually based on the original data file.

Statistical analyses

The statistical analyses were performed using Excel. First, the MUGI scores for each exercise entered by the two researchers were compared to establish the percentage of matching values. Then, the equations used for the McNemar test were entered into the sheet and applied to the data. Only children who had participated in all exercises at baseline and follow-up tests alike were included in the analysis.

Results

The percentage of matches in MUGI score between the two researchers was 91%. Therefore, only the scores entered by researcher TM were used for further analysis.

In all, 48 children were included in the study after written consent had been obtained. Among these, 33 children had their MUGI scores recorded at baseline and follow-up. We found that 19 children (14 boys and five girls) scored ten or more points at baseline and therefore participated in the intervention. Among the 19 children, 14 children improved their gross motor skills following the training sessions (Table 1, se next page), which is a statistically significant change.

Among the 33 children, 14 children scored less than nine points at baseline and therefore did not participate in the intervention (five boys and nine girls). Table 2 presents the result of the McNemar test of this group (see next page).

Discussion

The aim of the present study was to investigate the effect of motor skill training and evaluate the use of the MUGI observation checklist. Overall, our findings revealed a statistically significant positive effect of motor skill training on the level of motor skills.

Interpretation of results and comparison with existing literature

The main finding of the present study underpins that school children's motor skills improve with extended physical activity and motor training [22]. Previous research has found that two lessons of physical activity is insufficient to stimulate any improvement in motor skills [22], which confirms that without testing and increased motor skill training, many children with motor skills deficits will continue having these problems. The intervention in this study consisted of three lessons of training, which seems to be sufficient to improve motor skills in children aged 5-8 years. Furthermore, Dapp et al. (2021) found that engaging in structured physical activity, either exclusively or in combination with unstructured physical activity, benefits children's gross motor development. In contrast, engaging in unstructured physical activity lacks such effectiveness [23].

A good level of motor control in infancy raises the rate of participation in moderate to vigorous physical activity in adulthood but not in organized sports [12]. Furthermore, the level of fundamental movement skills greatly influences the physical activity of children at 6-10 years of age [24]. Likewise, an association exists between gross motor skill competence and physical activity in children aged 3-18 years, and this relationship strengthens with age [25]. This observation is in line with Stodden et al. (2008) who suggested that the relationship between gross motor skills and physical activity grows stronger and more reciprocal with increasing age because of continuing development [26]. Therefore, it is essential to continuously test the motor level in pre-school children to intervene with a view to improving the level of children's motor skills. In Denmark, children are seen annually by a health nurse to monitor their weight, height, and motor development. Therefore, important gains in overall health and learning faculties (e.g. academic skills) may be achieved by establishing a collaboration between health nurses, teachers, and physiotherapists to detect children with decreased motor development and to intervene with motor skill training either at school or in their leisure time.

Strengths and limitations

To our knowledge, this is the first study comprising a test of all children from kindergarten class to 1th grade and implementing structured physical activity for children with a decreased level of motor skills.

One strength of the present study is its proximity to 'real life situations' compared with studies performed out of context [27]. Furthermore, The MUGI observational checklist is simple and easy to use and can be used to test more than one child simoultaneously [28]. MUGI can also serve as a screening instrument that provides valuable information for the planning of small-group physical exercise lessons and motor training [18]. The MUGI exercises and the tools used are recognizable from the physical education lessons and measure motor skills that are needed for performing practical everyday tasks [28]. The MUGI observational checklist enjoys good consistency between teachers and physiotherapist with a intraclass correlation of 0.84 and an intertester reliability for teachers of 0.75 [18], which is in line with the findings in the present study showing a 91% match between the MUGI results of the two testers. This confirms that the test is easy to use and may be recommended for use in schools when screening children for motor difficulties.

The effect of the intervention may have been influenced by many environmental factors, including parental or other support, siblings' physical activity, participation in community sports, opportunities to exercise [29], and the quality of experience in school-based physical education [30]. Motor skills may be influenced and improved at any time growing up [31].

One source of weakness of this study was the limited number of participating children. Furthermore, the intervention was not determined in advance but was adjusted to the children's motor level. This may be seen as either a limitation or a strength because, when playing with children, it is essential to focus on mixed play involving various types of activities which makes it possible to develop motor elements such as strength, durability, agility, speed, balance, and coordination [32]. Goal-oriented play can underpin the

Table 1: Results of the McNemar test of differences between baseline and follow-up for the 19 children that scored 10 points or more.

12 children reduced their MUGI score to below 10 on the follow-up	
7 children continued to have a MUGI score of 10 or more on the follow-up	
Chi-square	10,0833
Alpha	0,05
Critical value	3,84146
P-value	0,0015

Table 2: Results of the McNemar test of differences between baseline and follow-up for the 14 children that scored below10 points.

2 children increased their MUGI score to of 10 or more on the follow-up	
12 children continued to have a MUGI score below 10 on the follow-up	
Chi-square	0,5
Alpha	0,05
Critical value	3,841459
P-value	0,4795

development of multilateral skills, helping to build basic physical abilities. This may be achieved through basic movement, such as walking on a balance beam, using moving sticks, jumping goalposts, and throwing balls, all of which form part of children's educational and learning experiences and may easily be implemented in preschool or in children's leisure time, illustrated by the activities that are part of the MUGI observational checklist and the intervention in the present study.

The external validity of this study is good because the findings can be applied to other schools and to a broader context.

The 4-6-year age range is considered the golden age for improving children's gross and fine motor skills wherefore this age is the right time to test their motor skills to maximize their motor development [33]. Children who only play passively, by e.g., playing with touch screen of their smartphones, have been shown to experience a motor skills decrease [34], and inactivity may have also have an impact on fat accumulation, contributing to obesity [35].

Conclusion

Our results showed the effect of physical activity and gross motor skills in a pragmatic set-up. The pragmatic set-up of the present study underpins the feasibility of interventions testing children's motor skills at the right time and with the right activity.

Generally, the MUGI observational checklist enjoys good consistency between teachers and physiotherapist, which is underpinned by the findings in this study. Therefore, the test may be recommended for use in schools when screening children for motor difficulties.

More longitudinal research is warranted with a larger sample of children and schools to explore the effect of implementing classroom-based physical activity and gross motor testing in children.

En komplet litteraturliste findes på side 38.

Author contributions

TMM designed the experiment in collaboration with the school. TMM and HM collected the data. ATB conducted the required data analysis. All authors (TMM, ATB, and GM) contributed to the data analysis and to the drafting of the manuscript, and all authors have approved the final version of the manuscript.

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