The European Proceedings of
Social & Behavioural Sciences
EpSBS

Future Academy ISSN: 2357-1330

https://dx.doi.org/10.15405/epsbs.2018.07.52

# ECCE 2018
# VII International Conference Early Childhood Care and Education

## ASSOCIATIONS OF LEARNING OUTCOMES FOR THE PHYSICAL ACTIVITY OF PRIMARY SCHOOL STUDENTS

Irina Kliziene (a)*, Gintautas Cibulskas (b), Laura Kimantiene (c), Ginas Cizauskas (d), Sarunas Klizas (e)
*Corresponding author

(a) Associate Professor, Institute of Social Sciences and Humanities, Kaunas University of Technology, Donelaicio str. 73, LT- 44239 Kaunas, Lithuania, +370 682 39370
(b) Associate Professor, Institute of Social Sciences and Humanities, Kaunas University of Technology, Donelaicio str. 73, LT- 44239 Kaunas, Lithuania, +370 611 35142
(c) MSc, Institute of Social Sciences and Humanities, Kaunas University of Technology, Donelaicio str. 73, LT- 44239 Kaunas, Lithuania, +370 610 30187
(d) Lecture, Department of Mechanical Engineering, Kaunas University of Technology, Studentu str. 56, LT-51424 Kaunas, Lithuania, +370 611 37605
(e) Associate Professor, Department of Health Psychology, Lithuanian University of Health Sciences, Kaunas, Lithuania, +370 645 09909

### *Abstract*

The results of our survey within Trends in International Mathematics and Science Study conducted in 2015 show that only a quarter of Lithuanians reach the highest international achievement level in mathematics. The present study aims to identify links between the physical activity of primary schoolchildren, educational factors influencing it and learning outcomes. The experimental group includes 50 girls and boys aged 6–7 years old, and the control group includes 48 girls and boys the same age. The methodology is based on the DIDSFA model (dynamic exercise, intense motor skills repetition, differentiation, reduction of parking and seating, physical activity distribution in the classroom). Physical activity assessment is carried out with the help of the Children's Physical Activity Questionnaire. Academic achievements are gauged according to the distribution of mathematical learning achievements specified by curriculum content. Statistically significant differences are found in the analysis of average MET per boy in the experimental group (1417.59 MET, min/week) in comparison with that of the girls in the same group (1000.38 MET, min/week, $p < 0.05$). The tasks for phenomena, equations and inequalities in the experimental group reveal 0.92±0.42 for the girls and 0.87±0.45 for the boys. There are no statistically significant differences ($p>0.05$). The findings of our study attach evidence and details to the assumption that there are associations between physical activity and academic achievement of primary schoolchildren. It is a linear association with physical fitness test and mathematic test scores. No variable have any significant association with gender or academic test outcome.



**Keywords:** Physical activity, mathematical achievements, academic achievements, primary education.

https://dx.doi.org/10.15405/epsbs.2018.07.52
Corresponding Author: Irina Kliziene
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

## 1. Introduction

Recent investigations have argued that children are one of the most dynamic parts of inhabitants in the population. The United Nations Convention on the Rights of the Child mentions the need to ensure the child's physical, mental and social development on a sustainable basis. It has been found that the child's physical activity (PA) is a multi-component phenomenon. Within the present study, it has been found that on the average 8% of daytime are spent in the physically active environment. It has been established that physical activity increases the flexibility of children's brain and plays a particularly important role in the development of children's cognitive functions (Tomporowski et al., 2008). One of the important cognitive functions is memory that manipulates information and regulates thinking and behaviour (Diamond, 2013). It is also one of the indicators of children's learning achievements. The application of physical activity at schools is very important. Primary school can increase the physical activity of children from moderate to intensive; for example, the time of the breaks (Powell et al., 2016) during physical education lessons (McKenzie & Lounsbery, 2014). Low physical activity and long sitting, for example, during lessons and immobility during breaks result in poorer learning achievements for children (Syväoja et al., 2013). Those children, whose physical activity level increases by the age of 11years old, achieve better learning outcomes at the age of 11, 13 and 16 (Booth et al., 2014). The results of the research provide evidence that fostering physical activity and active lifestyle can improve boys' reading skills during the first school year (Haapala et al., 2017). The most important factors for primary school students are physical education and the educational environment at school.

## 2. Problem Statement

The development of higher skills is highlighted in the main strategic education documents. The results of the survey within Trends in International Mathematics and Science Study (TIMSS) conducted in 2015 show that only a quarter of Lithuanians reach the highest international achievement level in mathematics. One of the important cognitive functions is memory, which manipulates information and regulates thinking and behaviour. It is one of learning achievements of children showing results. Unfavourable learning environments, low physical activity and long sitting, for example, immobility during breaks, affects learning outcomes of children.

## 3. Research Questions

- What is physical activity and learning outcomes in mathematics in Lithuanian elementary school students?
- Is there any connection between school students' physical activity and learning achievements in mathematics at school?

## 4. Purpose of the Study

The present study aims to identify links between the physical activity of primary schoolchildren and educational factors influencing it and learning outcomes.

https://dx.doi.org/10.15405/epsbs.2018.07.52
Corresponding Author: Irina Kliziene
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

## 5. Research Methods

We selected subjects as a sample that allowed evaluating the physical capacity of all the children in Lithuania. The experimental group included 26 girls and 24 boys aged 6–7 years old, and the control group included adolescent girls (n=25) and boys (n=23).

According to the SVIS database statistics (http://www.svis.smm.lt/), there were 30.126 first-formers (14.609 girls) in Lithuania in academic year 2017/2018. Reliability of spread range in the sample was 95 percent and 5 percent. Overall, 384 first-form students were under test. This study was observational only. And, therefore, a smaller number of respondents were selected.

### 5.1. Participants

A school was randomly selected from primary schools in Lithuania. With the approval of the parents, the time and place of the examination were agreed with the school administration in advance.

In the present research, we used a pre-test/post-test experimental strategy. That was chosen to avoid any interference with educational activities due to the random selection of children into the groups. The experimental group was under test during eight months. We developed the methodology of innovative physical education classes and created the model of educational factors stimulating pupils' physical activity. We identified relationships between the pupils' physical activities at school and learning achievements. We also prepared the methodical material for innovative physical education classes (Form 1). The methodology was based on the DIDSFA model (dynamic exercise, intense motor skills repetition, differentiation, reduction of parking and seating, physical activity distribution in the classroom) (Powell et al., 2016).

The girls and boys in the control group attended the same (non-modified) physical education lessons.

The experimental group included 26 girls 24 boys aged 6-7 years old. Their mean weight and height were 24.3±0.9 kg and 1.25±0.11 m for the girls, and 29.3±0.6 kg and 1.33±0.09 m for the boys. The control group included 25 girls and 23 boys aged 6-7 years old, attending the same school. Their mean weight and height were 22.3±0.7 kg and 1.24±0.1 m for the girls, and 28.4±0.7 kg and 1.36±0.07 m for the boys.

### 5.2. The evaluation of physical activity

The Children's Physical Activity Questionnaire (CPAQ) (Harrell et al., 2005) was for the youngest group and was also based on the Children's Leisure Activities Study Survey (CLASS) questionnaire. It included activities specific to young children, such as "playing in the playhouse." The original intent of the proxy-reported CLASS questionnaire for 6–7-year-olds was to assess the type, frequency, and intensity of physical activities during the usual week. In this study, the CPAQ was done by the parents of the youngest group of volunteers during seven days.

### 5.3. Mathematical diagnostic progress tests

Mathematical Diagnostic Progress Tests (MDPT) were prepared in accordance with requirements of the General Mathematics Education Curriculum (approved by ISAK-2433 on 26th August, 2008). The diagnostic progress tests were an objective way to measure achievement levels of skills and abilities. MDPT were divided into three parts: the division of tasks for achievement levels, the division of tasks according

https://dx.doi.org/10.15405/epsbs.2018.07.52
Corresponding Author: Irina Kliziene
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

to the content and fields of activities and division of tasks according to the cognitive skill groups. The assessment of all the fields of activity was based on the levels of a student’s achievements (unsatisfactory, satisfactory, basic and advanced).

### 5.4. Distribution of mathematical learning achievements by means of curriculum content.

Diagnostic tests for mathematics evaluated the students' knowledge, skills, subject and general skills at mathematics acquired during the first form according to five fields of mathematics education curriculum:

1) numbers and calculations;

2) phenomena, equations, inequalities;

3) geometry, measures and measurements;

4) statistics;

5) communication and general problem-solving strategies.

The learning achievements covered in the General Programs in the field of Geometry, Measure and Measurement were combined in the Diagnostic Assessment Program and described in one field of the curriculum content - Geometry, Measures and Measurements.

Learning achievements in mathematics were according to the groups of cognitive abilities.

The tasks of mathematical diagnostic tests were aimed at assessing the abilities of the students according to the three groups of abilities: mathematical knowledge and understanding, application of mathematics and higher cognitive abilities.

Instructions for evaluating all the mathematical diagnostic progress tests were developed to assess pupils' achievements, helping to ensure a uniform assessment of each student’s work. All the fields of activities were based on students’ achievement levels (unsatisfactory, satisfactory, basic and advanced).

### 5.5. Mathematical statistics

Arithmetic mean (x) and average standard deviation (SN) were determined for comparison. Differences between genders, age and physical fitness were estimated using one-factor dispersion analysis (ANOVA). The relationship between variables was calculated on the basis of the Pearson correlation coefficient and Mann-Whitney U test. There were following reliability levels for statistical outputs: $p > 0.05$ - unreliable; $p < 0.05$ - reliable. All the calculations were performed by means of the MS Excel and SPSS programs.

## 6. Findings

### 6.1. Physical activity. The physical activity questionnaire for a 7-year-old child.

On analyzing the pre-test results of physical activity of the 7-year-old students, it turned out that both the boys (95.87 MET, min/week) and girls (91.30 MET, min/week) in the experimental group were physically active during physical education classes ($p>0.05$).

The analysis of physical activity types, such as cycling to school and walking to school showed that there were no differences in gender according to MET. In the context of average physical activity, a higher indicator (1095.65 MET, min/week) was detected in the boys of the experimental group in comparison with

https://dx.doi.org/10.15405/epsbs.2018.07.52
Corresponding Author: Irina Kliziene
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

the girls (657.39 MET, min/week). Statistically significant differences were found in average MET per boy (1191.52 MET, min/week) in comparison with the girls (785.86 MET, min/week) ($p<0.05$; Table 1).

The post-test of the experimental group boys (1287.59 MET, min/week) was to analyze average physical activity in comparison with the girls of the experimental group (863.05 MET, min/week). Statistically significant difference was found during the analysis of average MET per boy (1417.59 MET, min/week) in comparison with the girls (1000.38 MET, min/week, $p<0.05$; Table 1).

**Table 01.** The physical activity level using the MET method (the pre-test/post-test results of the experimental group)

| Type of physical activity | MET | 1 day/min | Days per week | MET, min/week |
|---|---|---|---|---|
| The experimental group pre-test | | | | |
| Boys | | | | |
| Physical Training lesson | 3.5 | 30 | 1 | 95.7 |
| Cycling to school | 4 | 0 | 3 | 0.00 |
| Walking to school | 3.3 | 0 | 4 | 0.00 |
| Sport groups (mean physical activity) | 6 | 60 | 1 | 1095.65 |
| On average for one boy | | | | 1191.52* |
| Girls | | | | |
| Physical Training lesson | 3.5 | 30 | 1 | 91.30 |
| Cycling to school | 4 | 0.45 | 3 | 15.65 |
| Walking to school | 3.3 | 0,87 | 4 | 21.52 |
| Sport groups (mean physical activity) | 6 | 60 | 1 | 657.39 |
| On average for one girl | | | | 785.86* |
| Experimental group post-test | | | | |
| Boys | | | | |
| Physical Training lesson | 3.5 | 30 | 1 | 130.30 |
| Cycling to school | 4 | 0 | 3 | 0.00 |
| Walking to school | 3.3 | 0 | 4 | 0.00 |
| Sport groups (mean physical activity) | 6 | 60 | 1 | 1287.59 |
| On average for one boy | | | | 1417.89* |
| Girls | | | | |
| Physical Training lesson | 3.5 | 30 | 1 | 96.85 |
| Cycling to school | 4 | 0.45 | 3 | 18.50 |
| Walking to school | 3.3 | 0.87 | 4 | 21.98 |
| Sport groups (mean physical activity) | 6 | 60 | 1 | 657,39 |
| On average for one girl | | | | 1000.38* |

*– $p<0,05$ (according to the Mann-Whitney U test)

https://dx.doi.org/10.15405/epsbs.2018.07.52
Corresponding Author: Irina Kliziene
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

Analyzing the results of the 7-year-old students' physical activity, it turned out that in the control group, both the boys (130.30 MET, min/week) and girls (96.85 MET, min/week) were physically active in physical education classes (p>0.05) during the pre-test.

The analysis of physical activity types such as cycling to school and walking to school found no differences in gender according to MET. A higher number of the boys in the control group (998.56 MET, min/week) was determined during the analysis of average physical activity compared to the girls of the same group (583.52 MET, min/week). Statistically significant differences were found during the analysis of average MET per boy in the control group (1116.70 MET, min/week) compared to the girls (704.62 MET, min/week, p<0.05; 2 table).

The post-test results of the boys of the control group (1020.10 MET, min/week) were determined by the analysis of average physical activity in comparison with the girls of the same group (603.03 MET, min/week). Statistically significant differences were found in average MET per boy (1141.26 MET, min/week) in comparison with the girls (729.23 MET, min/week, p<0.05; Table 1).

**Table 02**. Physical activity level using the MET method (the control group pre-test/post test)

| Type of physical activity | MET | 1 day/min | Days per week | MET, min/week |
|---|---|---|---|---|
| Control group pre-test | | | | |
| Boys | | | | |
| Physical Training lesson | 3.5 | 30 | 1 | 94.56 |
| Cycling to school | 4 | 0.68 | 3 | 23.58 |
| Walking to school | 3.3 | 0 | 4 | 0.00 |
| Sport groups (mean physical activity) | 6 | 60 | 1 | 998.56 |
| On average for one boy | | | | 1116.70* |
| Girls | | | | |
| Physical Training lesson | 3.5 | 30 | 1 | 91.98 |
| Cycling to school | 4 | 0,55 | 3 | 10.80 |
| Walking to school | 3.3 | 0,67 | 4 | 18.32 |
| Sport groups (mean physical activity) | 6 | 60 | 1 | 583.52 |
| On average for one girl | | | | 704.62* |
| Control group post-test | | | | |
| Boys | | | | |
| Physical Training lesson | 3.5 | 30 | 1 | 97.03 |
| Cycling to school | 4 | 0.68 | 3 | 24.13 |
| Walking to school | 3.3 | 0 | 4 | 0.00 |
| Sport groups (mean physical activity) | 6 | 60 | 1 | 1020.10 |
| On average for one boy | | | | 1141.26* |
| Girls | | | | |
| Physical Training lesson | 3.5 | 30 | 1 | 92,30 |

https://dx.doi.org/10.15405/epsbs.2018.07.52
Corresponding Author: Irina Kliziene
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

| | | | | |
|---|---|---|---|---|
| Cycling to school | 4 | 0,55 | 3 | 13,65 |
| Walking to school | 3.3 | 0,67 | 4 | 20.25 |
| Sport groups (man physical activity) | 6 | 60 | 1 | 603.03 |
| On average for one girl | | | | 729.23* |

*– p<0,05 (according to the Mann-Whitney U test)

### 6.2. Distribution of mathematical learning achievements using curriculum content

Assessing the students’ learning achievements by means of curriculum content, we received the following results based on nine tasks presented within the experimental group pre-test: the girls had 7.86±1.07, and the boys had 7.75±1.37; there were no differences found between genders (p>0.05). Within the experimental group post-test, the girls had 8.65±1.18, and the boys – 8.53±1.51; there were no differences found between genders were (p>0.05). Within the control group pre-test, the girls had 7.78±1.06, and the boys - 7.67±1.36; there were no differences found between genders were (p>0.05). Within the control group post-test, the girls had 7.98±1.09, and the boys - 7.87±1.39; there were no differences found between genders were (p>0.05).

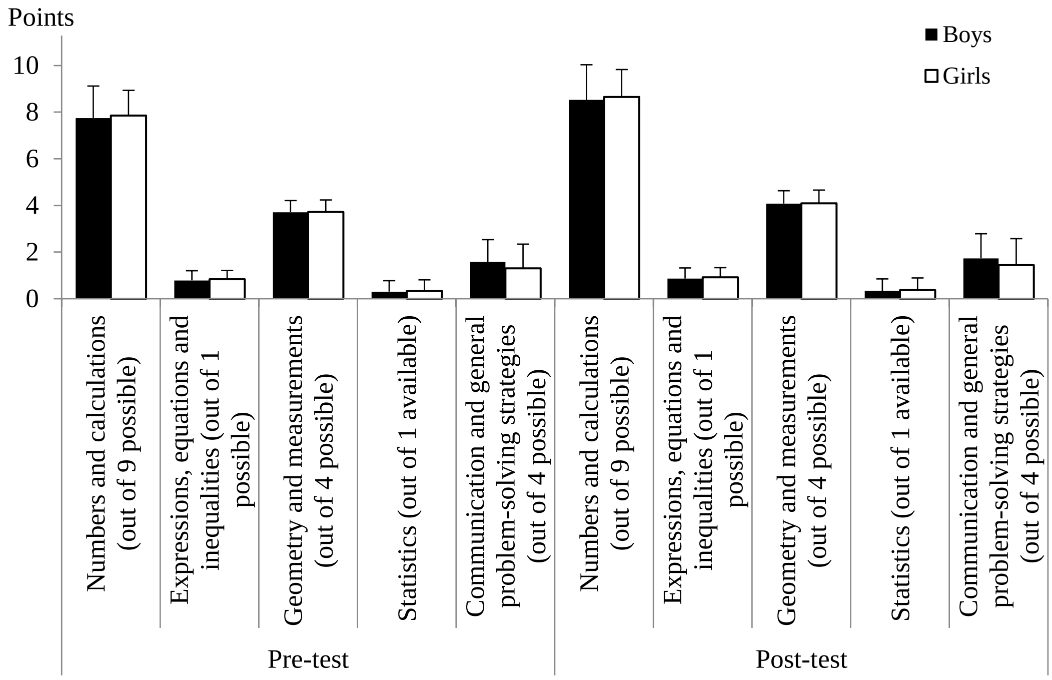


**Figure 01.** EG Distribution of mathematical learning achievements using curriculum content

The tasks containing phenomena, equations, inequalities were solved by the girls (0.83±0.38) and boys (0.79±0.41); there were no differences found between genders (p>0.05). Within the experimental group post-test, the girls had 0.92±0.42, and boys – 0.87±0.45; there were no differences found between genders (p>0.05). Within the control group pre-test, the girls had 0.83±0.37, and the boys – 0.78±0.41;

https://dx.doi.org/10.15405/epsbs.2018.07.52
Corresponding Author: Irina Kliziene
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

there were no differences found between genders (p>0.05). Within the control group post-test, the girls had 0.85±0.38, and the boys – 0.80±0.42; there were no differences found between genders (p>0.05).

Tasks on geometry, measures and measurements presented within the experimental group pre-test, detected 3.72±0.51 for the girls and 3.71±0.50 for the boys; there were no differences found between genders (p> 0.05). Within the experimental group post-test, the girls had 4.09±0.56, and the boys – 4.08±0.55; there were no differences found between genders (p> 0.05). Within the control group pre-test, the girls had 3.69±0.51, and the boys – 3.67±0.49; there were no differences found between genders (p>0.05); Within the control group post-test, the girls had 3.78±0.52, and the boys – 3.77±0.51; there were no differences found between genders (p>0.05).

Mathematical statistics within the experimental group post-test found 0.33±0.48 for the girls and 0.31±0.47 for the boys; there were no differences found between genders (p>0.05). This corresponded to the learning outcomes described in the general curriculum for boys and girls. Within the experimental group post-test, the girls had 0.37±0.53, and the boys – 0.34±0.51; there were no differences found between genders (p>0.05). Within the control group pre-test, the girls had 0.33±0.47, and the boys – 0.30±0.46; there were no differences found between genders (p>0.05). Within the control group post-test, the girls had 0.34±0.49, and the boys – 0.31±0.47; there were no differences found between genders (p>0.05)

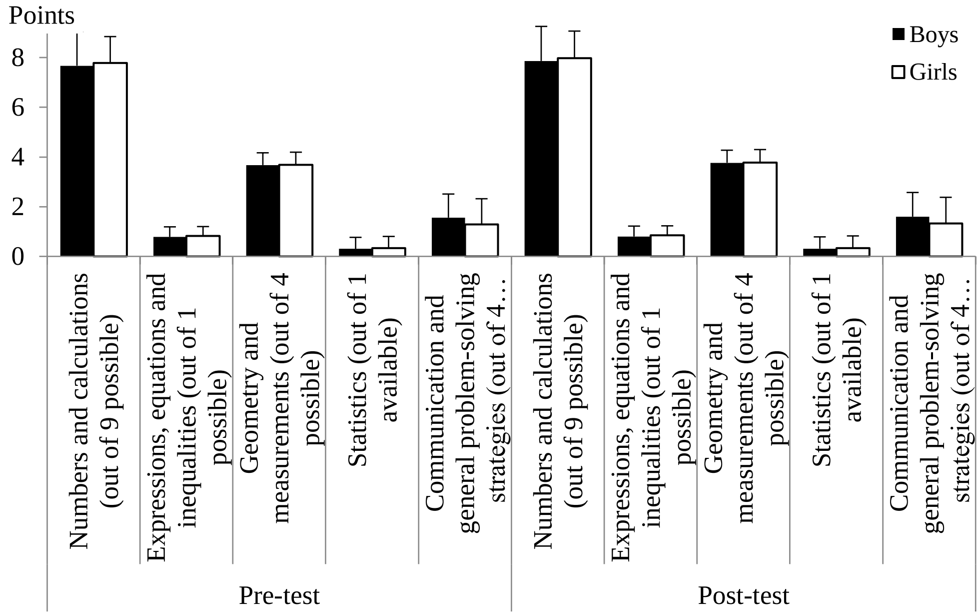


**Figure 02.** Distribution of mathematical learning achievements in the control group using curriculum content

However, communication and general problem-solving strategies based on four tasks found within the experimental group pre-test found 1.31±0.69 for the girls and 1.58±0.96 for the boys. There were statistically significant difference between genders (p <0.05). This meant that this field was the weakest, and there was a need for improvement. Within the experimental group post-test, the girls had 1.44±1.14, and the boys – 1.73±1.05; there were no differences found between genders (p> 0.05). Within the control group pre-test, the girls had 1.29±1.03, and the boys – 1.56±0.95; there were no differences found between

https://dx.doi.org/10.15405/epsbs.2018.07.52
Corresponding Author: Irina Kliziene
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

genders (p> 0.05). Within the control group post-test, the girls had 1.32±1.05, and the boys – 1.60±0.97; there were no differences found between genders (p> 0.05). This evidenced to that physical activity affected Mathematical Diagnostic Progress Tests.

## 7. Conclusion

The findings of the present study provide evidence and details to the assumption that there are associations between physical activity and academic achievement of primary schoolchildren. There is a linear association between physical fitness test and mathematic test scores. No variable have any significant association with gender or academic test outcome.

## Acknowledgments

The research is supported by the research grant from the Lithuanian Research Council, Promotion of Students' Scientific Activities, sponsored by the European Structural Funds 2017/2018. (09.3.3-LMT-K-712-03-0101

## References

Booth, M.Z., Curran, E.M., Frey, C.J., Gerard, J.M., Collet, B., Bartimole, J. (2014). Ethnic Identity, Gender, and Adolescent Attitude toward School: Adaptive Perspectives in Diverse Settings. Mid-western educational researcher: official publication of the Mid-Western Educational Research Association, 26(2):3-27.

Diamond, A. (2013). Executive functions. Annual Review of Psychology, 64, 135–168.

Haapala E.A., Väistö, J., Lintu, N., Westgate, K., Ekelund, U., Poikkeus, A.M., Brage, S., Lakka, T.A. (2017). Physical activity and sedentary time in relation to academic achievement in children. Journal of science and medicine in sport, 20(6):583-589.

Harrell, J., McMurray, R., Baggett, C., Pennell, M., Pearce, P., Bangdiwala, S. (2005). Energy Costs of Physical Activities in Children and Adolescents. Med Sci Sports Exerc, 37:329-336

McKenzie, T.L[1], Lounsbery, M.A. (2014). The pill not taken: revisiting Physical Education Teacher Effectiveness in a Public Health Context. Research quarterly for exercise and sport, 85(3), 287-92.

Powell, E. Woodfield, L.A., Nevill, A.M. (2016). Increasing physical activity levels in primary school physical education: The SHARP Principles Model. Preventive Medicine Reports, 3:7–13

Syväoja, H., Kantomaa, M.T., Ahonen, T. Hakonen, H., Kankaanpää, A., Tammelin, T.H. (2013). Physical activity, sedentary behaviour, and academic performance in Finnish children. *Medicine and Science in Sports and Exercise,* 45(11), 2098-2104

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):111–131.