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# THE EFFECTS OF PHYSICAL EDUCATION ON GROSS MOTOR SKILLS IN 6-7 YEARS OLD

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## Abstract

Introduction: Physical education classes are essential for the development of fundamental gross motor behaviors during the first years of primary education. The aim of this study was to examine the effects of physical education classes, held twice per week, on the gross motor skills of 6-7 years old children. Methodology: Participants were 102 children (age 6-7 years old; 57 boys, 45 girls) enrolled at two public schools from Cluj-Napoca, Romania. Anthropometric measurements were performed for all subjects and gross motor skills were assessed during physical education classes at the beginning of the 2018-2019 school year, in the second semester of the 2018-2019 school year, and at the beginning of the 2019-2020 school year using the Test of Gross Motor Development – 2nd Edition (TGMD-2). An analysis of variance test with repeated measures (repeated measures ANOVA) was carried out to evaluate the effects of physical education classes on body mass index, body fat and TGMD-2 scores. Results: There were no statistically significant differences for body mass index, $F(2, 202) = 0.37$, $p = 0.688$. On the other hand, body fat values increased significantly over the course of twelve months, $F(2, 198) = 8.33$, $p = 0.000$. Statistically significant increases were also observed for the locomotor subtest scores, $F(2, 202) = 29.53$, $p = 0.000$, for the object control subtest scores, $F(2, 202) = 37.51$, $p = 0.000$, as well as for the cumulate outcomes of TGMD-2, $F(2, 202) = 47.79$, $p = 0.000$. Conclusions: A physical education curriculum with a frequency of two classes per week seems to be effective in improving gross motor skills in children (age 6-7 years).

Keywords: gross motor development, primary school children, physical education, assessment

## 1 INTRODUCTION

Preschool and early elementary years constitute the time interval during which children develop their fundamental gross motor behaviors [1]. In order to be able to perform complex movements during middle school and further in life, children have to acquire the basic patterns of coordination [1-4]. The foundation for sport- and context-specific movement skills, fundamental motor skills include several aspects of human movement, such as: locomotor skills (walking, running, galloping, hopping, leaping, jumping, sliding, and skipping), object control skills (striking, dribbling, catching, kicking, bouncing, throwing, underhand roll), and, according to some authors [5,6], balance/stability skills, referred to as non locomotor skills (body rolling, bending, dodging, stick balancing, unipedal balance, stretching, swinging, twisting, and turning) [6,7].

Over the last decades, regular physical activity has been positively associated with multiple health-related and developmental factors. Thus, physical activity has been shown to have beneficial effects on motor development [8-11], on physical [12], cognitive [13,14], and social [15] abilities. One study has found no associations between physical activity and gross motor coordination development in primary school children [16]. Positive changes in fundamental movement skill proficiency were reported in youth following school- and community-based interventions delivered by physical education specialists [17]. After a 12-week intervention during physical education classes, greater

improvements in gross motor skills were observed among primary school children than among middle school children [4]. A recent review concludes that overall motor competence in children and adolescents can be enhanced by various physical education curricula [18].

Primary education, in Romania, includes the preparatory class and grades I-IV [19]. Throughout the five years of primary education, physical education is compulsory. The frequency of physical education classes in the Romanian primary education system is twice per week [20], similar to the Slovak system, but different from the Hungarian system, where children have physical education classes every single day of the week (five times per week) [21]. The present study is part of a project aimed at comparing the interactions between physical activity, quality of life, motor abilities and body composition among primary school children from three European countries (i.e., Hungary, Romania, Slovakia) [22]. From the studies published so far, the main conclusion would be the fact that children with a high body mass index (BMI) (i.e., obese/overweight children) have weaker motor skills than children with a low BMI (i.e., lean children) [23,24]. In these circumstances, the purpose of this study was to examine the effects of physical education classes, with a frequency of twice per week, on the gross motor skills of preparatory and first grade students.

# 2 METHODOLOGY

## 2.1 Procedure

Longitudinal data was collected from preparatory class and first grade children. Assessments were completed over a time interval of two months in autumn 2018, spring 2019, and autumn 2019. The data consisted of information obtained from body composition and gross motor skills measurements performed at baseline (T1), intermediate (T2), and follow-up (T3). Body composition was assessed prior to motor competency, in the morning, at the children's schools. Gross motor skills were evaluated during physical education classes by trained personnel.

The study had been approved by the Faculty of Physical Education and Sport's Ethics Committee, Babeș-Bolyai University, Cluj-Napoca, Romania, by the School Inspectorate of Cluj, and by the school boards. Parents signed a written informed consent for their children to participate in the study. Oral consent was obtained from the children.

## 2.2 Participants

One hundred and two children (age 6-7 years old; 57 boys, 45 girls) participated in the study. At baseline, the children were enrolled at two public schools from Cluj-Napoca, Romania, in the preparatory class. At the end of the study, the children were first grade students.

## 2.3 Measures

BMI was assessed with the Omron BF511 body composition monitor (Healthcare Co., Kyoto, Japan). Omron BF511 also measures weight, body fat (in %), skeletal muscle (in %), visceral fat, and resting metabolism rate. Body fat data provided by the body composition monitor was also used in the present study.

The Test for Gross Motor Development – 2$^{nd}$ Edition (TGMD-2) was applied to evaluate gross motor skills [1]. TGMD-2 contains 12 motor skills divided into two subtests: locomotor (run, gallop, hop, leap, horizontal jump, slide) and object control (striking a stationary ball, stationary dribble, catch, kick, overhand throw, underhand roll) tasks. The assessment protocol involved providing children with a demonstration of the correct technique immediately before asking them to perform the task. Each task was performed twice by every child. Each attempt was scored based on specific performance criteria (0 = did not perform correctly; 1 = performed correctly) [1]. The sum of the observed criteria for each subscale comprises the overall score of the subtest. The sum of the overall scores from both subtests (i.e., locomotor, object control) was referred to as the cumulate outcome.

Means, standard deviations, and standard errors were calculated for all measured parameters. An analysis of variance test with repeated measures (repeated measures ANOVA) was carried out to evaluate the effects of physical education classes on body mass index, body fat and TGMD-2 scores. The statistical significance level was set at $p < 0.05$. All statistical analyses were carried out using SPSS, version 17.0 (SPSS Institute, Chicago, IL).

## 3 RESULTS

Descriptive statistics for BMI (mean ± SD) among participants were 16.38 ± 2.19 at baseline (T1), 16.56 ± 2.80 at intermediate (T2), and 16.62 ± 3.74 at follow-up (T3) (Table 1). There were no statistically significant differences for body mass index after two semesters, $F(2, 202) = 0.37$, $p = 0.688$. Descriptive statistics for body fat (mean ± SD) among children were 18.65 ± 6.62 at baseline (T1), 19.28 ± 6.57 at intermediate (T2), and 20.12 ± 6.77 at follow-up (T3). The results show that body fat values increased significantly over the course of twelve months, $F(2, 198) = 8.33$, $p = 0.000$ Table 2).

*Table 1. Descriptive statistics for BMI.*

| | T1 | T2 | T3 |
|---|---|---|---|
| BMI | 16.38 ± 2.19 | 16.56 ± 2.80 | 16.62 ± 3.74 |

*Table 2. Descriptive statistics for body fat.*

| | T1 | T2 | T3 |
|---|---|---|---|
| Body fat (%) | 18.65 ± 6.62 | 19.28 ± 6.57 | 20.12 ± 6.77 |

Descriptive statistics (mean ± SD) for the locomotor and object control subtests are presented in Table 3, and Table 4, respectively. Table 5 shows the descriptive statistics (mean ± SD) for the cumulate outcomes of TGMD-2. Statistically significant increases were observed for the locomotor subtest scores, $F(2, 202) = 29.53$, $p = 0.000$, for the object control subtest scores, $F(2, 202) = 37.51$, $p = 0.000$, as well as for the cumulate outcomes of TGMD-2, $F(2, 202) = 47.79$, $p = 0.000$.

*Table 3. Descriptive statistics for locomotor tasks.*

| | T1 | T2 | T3 |
|---|---|---|---|
| Run | 5.89 ± 2.00 | 6.78 ± 2.03 | 7.62 ± 1.03 |
| Gallop | 5.71 ± 2.04 | 5.94 ± 2.31 | 6.50 ± 1.75 |
| Hop | 7.50 ± 2.20 | 8.26 ± 2.48 | 8.54 ± 1.76 |
| Leap | 4.19 ± 1.77 | 4.72 ± 1.77 | 5.15 ± 1.36 |
| Horizontal jump | 5.21 ± 2.22 | 6.25 ± 2.03 | 6.63 ± 1.74 |
| Slide | 6.25 ± 2.26 | 7.18 ± 1.82 | 7.77 ± 0.62 |
| Overall score | 34.74 ± 7.99 | 39.14 ± 9.91 | 42.22 ± 4.61 |

*Table 4. Descriptive statistics for object control tasks.*

| | T1 | T2 | T3 |
|---|---|---|---|
| Striking a ball | 4.76 ± 2.25 | 6.91 ± 2.50 | 7.05 ± 2.07 |
| Stationary dribble | 4.84 ± 2.44 | 5.96 ± 2.24 | 7.13 ± 1.34 |
| Catch | 4.24 ± 1.51 | 4.82 ± 1.45 | 5.26 ± 0.91 |
| Kick | 5.87 ± 2.18 | 6.57 ± 2.09 | 7.29 ± 1.28 |
| Overhand throw | 4.89 ± 2.10 | 6.00 ± 2.32 | 6.03 ± 1.64 |
| Underhand roll | 5.05 ± 2.44 | 5.36 ± 2.22 | 6.31 ± 1.92 |
| Overall score | 29.66 ± 8.52 | 35.57 ± 9.60 | 39.08 ± 5.42 |

*Table 5. Descriptive statistics for cumulate outcomes of TGMD-2.*

| | T1 | T2 | T3 |
|---|---|---|---|
| Cumulate outcomes of TGMD-2 | 64.39 ± 12.43 | 74.71 ± 18.33 | 81.29 ± 8.34 |

## 4 CONCLUSIONS

The effects of physical education on motor competence have been investigated for at least six decades, but the last two decades have witnessed an unprecedented increase in published studies on topics like physical activity, physical education and motor development, probably as a result of the worldwide rise in childhood obesity [18]. The weekly frequency of physical education classes in primary education systems varies from country to country. As some countries have a greater number of physical education classes per week compared to Romania (e.g., Hungary, with five physical education classes per week), the present study had the purpose of examining the outcomes of two physical education classes per week on the gross motor development of primary education children. The results suggest that a curriculum with two physical education classes per week has been effective in improving fundamental gross motor skills in preparatory class children over the course of twelve months. This work is part of a larger project aimed at studying the correlations between physical activity, quality of life, motor abilities and body composition among primary school children. The final results of the project are yet to be published.

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## REFERENCES

[1] D.A. Ulrich, Test of Gross Motor Development (2nd ed.): Examiner's Manual. Austin/Texas: PRO-ED, 2000.

[2] J.E. Clark, "Motor development," in *Encyclopedia of Human Behavior (3rd ed.)*, (V.S. Ramachandran, ed.), pp. 245-255, New York: Academic Press, 1994.

[3] A.W. Burton and D.E. Miller, *Movement Skill Assessment*. Champaign/Illinois: Human Kinetics, 1998.

[4] R.D. Burns, Y. Fu, Y. Fang, J.C. Hannon, and T.A. Brusseau, "Effect of a 12-week physical activity program on gross motor skills in children," *Perceptual and Motor Skills*, vol. 124, no. 6, pp. 1121-1133, 2017. doi:10.1177/0031512517720566

[5] D.L Gallahue, J.C. Ozmun, and J. Goodway, Understanding Motor Development: Infants, Children, Adolescents, Adults (7th ed.). New York: McGraw-Hill, 2012.

[6] S.W. Logan, S.M. Ross, K. Chee, D.F. Stodden, and L.E. Robinson, "Fundamental motor skills: A systematic review of terminology," *Journal of Sports Sciences*, vol. 36, no. 7, pp. 781-796, 2018. doi:10.1080/02640414.2017.1340660

[7] G. Battaglia, V. Giustino, G. Tabacchi, M. Alesi, C. Galassi, C. Modica, A. Palma, and M. Bellafiore, "Effectiveness of a physical education program on the motor and pre-literacy skills of preschoolers from the training-to-health project: A focus on weight status," *Frontiers in Sports and Active Living*, vol. 2, Article 579421, 2020. doi:10.3389/fspor.2020.579421

[8] A. Fischer, J.J. Reilly, L.A. Kelly, C. Montgomery, A. Williamson, J.Y. Patton, and S. Grant, "Fundamental movement skills and habitual physical activity in young children," *Medicine and Science in Sports and Exercise*, vol. 37, no. 4, pp. 684-688, 2005. doi:10.1249/01.mss.0000159138.48107.7d

[9] C. Graf, B. Koch, E. Kretschmann-Kandel, G. Falkowski, H. Christ, S. Coburger, W. Lehmacher, B. Bjarnason-Wehrens, P. Platen, W. Tokarski, H.G. Predel, and S. Dordel, "Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-project)," *International*

*Journal of Obesity and Related Metabolic Disorders*, vol. 28, no. 1, pp. 22-16. doi:10.1038/sj.ijo.0802428

[10] S. Houwen, E. Hartman, and C. Visscher, “Physical activity and motor skills in children with and without visual impairments,” *Medicine and Science in Sports and Exercise*, vol. 41, no. 1, pp. 103-109, 2009. doi:10.1249/MSS.0b013e318183389d

[11] L.C. Dapp, V. Gashaj, and C.M. Roebers, “Physical activity and motor skills in children: A differentiated approach,” *Psychology of Sport & Exercise*, vol. 54, Article 101916, 2021. https://doi.org/10.1016/j.psychsport.2021.101916

[12] R. Bailey, “Physical education and sport in schools: a review of benefits and outcomes,” *Journal of School Health*, vol. 76, no. 8, pp. 397-401, 2006. doi:10.1111/j.1746-1561.2006.00132.x

[13] B.A. Sibley and J. Etnier, “The relationship between physical activity and cognition in children: A meta-analysis,” *Pediatric Exercise Science*, vol. 15, no. 3, pp. 243-256, 2003. doi:10.1515/ijsl.2000.143.183

[14] A.G. van der Niet, J. Smith, E.J.A. Scherder, J. Oosterlaan, E. Hartman, and C. Visscher, “Associations between daily physical activity and executive functioning in primary school-aged children,” *Journal of Science and Medicine in Sport*, vol. 18, no. 6, pp. 673-677, 2015. doi:10.1016/j.jsams.2014.09.006

[15] H. Taras, “Physical activity and student performance at school,” *Journal of School Health*, vol. 75, no. 6, pp. 214-218, 2005. doi:10.1111/j.1746-1561.2005.00026.x

[16] R. Chaves, A. Baxter-Jones, T. Gomes, M. Souza, S. Pereira, and J. Maia, “Effects of individual and school-level characteristics on a child’s gross motor coordination motor development,” *International Journal of Environmental Research and Public Health*, vol. 12, no. 8, pp. 8883-8896, 2015. doi:10.3390/ijerph120808883

[17] P.J. Morgan, L.M. Barnett, D.P. Cliff, A.D. Okely, H.A. Scott, K.E. Cohen, and D.R. Lubans, “Fundamental movement skill interventions in youth: a systematic review and meta-analysis,” *Pediatrics*, vol. 132, no. 5, pp. 1361-1383, 2013. doi:10.1542/peds.2013-1167

[18] H. Lorås, “The effects of physical education on motor competence in children and adolescents: A systematic review and meta-analysis,” *Sports*, vol. 8, no. 6, pp. 88, 2020. doi:10.3390/sports8060088

[19] Primary education, Ministerul Educației, Accessed 12 January, 2022. Retrieved from https://www.edu.ro/invatamant-primar

[20] Inspectoratul Școlar Județean Vaslui, Ministerul Educației, Accessed 12 January, 2022. Retrieved from https://isj.vs.edu.ro/download/SCRISOARE-METODICA-Educatie-Fizica-Sport-si-Sanatate.pdf

[21] Magyar Közlöny, Regulation by the Hungarian Government, 4 June, 2012. Retrieved from http://www.kozlonyok.hu/nkonline/MKPDF/hiteles/mk12066.pdf

[22] EFOP-5.2.2-17-2017-00035, Accessed 12 January, 2022. Retrieved from https://efop522.diaktanacsado.hu/en

[23] A.H. Molnár, J. Šimonek, N. Halmová, I. Boros-Bálint, G.F. Deak, V.P. Ardelean, V.L. Andrei, A.V. Nagy, B. Vári, K. Orbán, C. Fintor, T. Ocskó, R. Szász, G. Olajos, F. Győri, I. Alattyányi, R. Csetreki, and B. Dobay, “Motor development of Slovak and Hungarian 6-7-year-old pupils in the aspect of degree of obesity (First phase of a longitudinal study),” in *Sport Science in Motion, Komárno*, *September 5$^{th}$-7$^{th}$, 2019*. vol. 1, pp. 69-77, 2019.

[24] A.H. Molnár, G.F. Deak, V.L. Andrei, V.P. Ardelean, J. Šimonek, N. Halmová, B. Dobay, A.V. Nagy, B. Vári, K. Orbán, C. Fintor, T. Ocskó, R. Szász, F. Győri, I. Alattyányi, R. Csetreki, and I. Boros-Bálint, “Does the gross motor development of Romanian and Hungarian 6-7-year-old children depend on the degree of the obesity? (First phase of a longitudinal study), “ in *ICU 2019*, *The 5$^{th}$ International Conference of the Universitaria Consortium – Education for Health and Performance, October 11-12, Cluj-Napoca, Romania*. vol. 1, pp. 211-216, 2019.