ORIGINAL SCIENTIFIC PAPER

Physical Activity Cannot be Treated as a Predictor of Anthropological Status among Six-year-old Children

Franjo Lovric[1], Petra Mandic Jelaska[2], Zarko Bilic[1]

Affiliations: [1]University of Mostar, Faculty of science and education, Mostar, Bosnia and Herzegovina, [2]University of Split, Faculty of Kinesiology, Split, Croatia

Correspondence: F. Lović, University of Mostar, Faculty of science and education, Department of Physical Culture, Matice Hrvatske b.b. 88000 Mostar, Bosna and Hercegovina. E-mail: franjo.lovric@hotmail.com

ABSTRACT The objective of this study was to examine the relationship between physical activity and anthropological status in six-year-old children. The study was conducted on 30 boys (years 6.34 ± 0.51) and 30 girls (years 6.21 ± 0.59). Six tests for motor ability evaluation, two measures for assessing morphological characteristics, and a questionnaire for assessing physical activity and sedentary activities, the Netherlands Physical Activity Questionnaire (NPAQ), were applied to the participants. The correlation analysis results clearly show that sedentary activity cannot be regarded as a predictor of anthropological status in six-year-old children ($p>0.05$). This research provides an insight into the complex issue of the precise identification of the effects of physical activity, and changes in anthropological status that are influenced by natural growth and development.

KEY WORDS fundamental movement skills, BMI, motor skills, growth, development

@MJSSMontenegro
PHYSICAL ACTIVITY AND ANTHROPOLOGICAL STATUS
http://mjssm.me/?sekcija=article&artid=152

Introduction

For preschool children, movement is exceedingly important for harmonious psychophysical growth and development (Hills, 1995). Furthermore, certain motor skills for children of this age are recognized as fundamental and necessary in the development of more complex movement patterns that an individual will use throughout their life (Barnett, Lai, et al., 2016; Barnett, Salmon, & Hesketh, 2016; Bellows et al., 2017; Čuljak, Miletić, Delaš Kalinski, Kezić, & Žuvela, 2014; Gallahue & Donnely, 2003; Tompsett, Sanders, Taylor, & Cobley, 2017; Yu et al., 2016). Fundamental movement skills are also considered to be the basis for specific sports skills (Donath, Faude, Hagmann, Roth, & Zahner, 2015; Kirk & Rhodes, 2011; Kordi, Nourian, Ghayour, Kordi, & Younesian, 2012; Logan, Robinson, Wilson, & Lucas, 2012; Lubans, Morgan, Cliff, Barnett, & Okely, 2010). Insufficiently stimulated and underdeveloped motor skills and knowledge at a young age can be the cause of decreased or "slumbered" motor creativity (Struza Milić, 2014). Physical exercise and health are closely related, so it is important to create the habit of regular physical activity from the earliest age (Cohen, Morgan, Plotnikoff, Callister, & Lubans, 2015; Liong, Ridgers, & Barnett, 2015; Lovrić, Jelaska, & Bilić, 2015; Rush & Simmons, 2014; Slykerman, Ridgers, Stevenson, & Barnett, 2016). However, the result of modern lifestyles is often minimal physical activity and, subsequently, health problems may occur (Al-Kloub & Froelicher, 2009; Goldfield, Harvey, Grattan, & Adamo, 2012). Therefore, it is of great relevance to monitor and control the level of physical activity of children from an early age (Montoye, Kemper, Saris, & Washburn, 1996).

Previous studies indicate a link between basic motor skills and physical activity (e.g., Lubans et al., 2010). However, no significant correlations between morphological features and physical activity of children have been identified in these studies (Hills & Byrne, 2010). For example, the realization of basic motor skills is not related to body mass index (BMI) in children four to eight years of age (Cantenassi et al., 2007). Accordingly, the objective of this study is to examine the correlation between physical activity, morphological features, and motor skills among six-year-old children.

Accepted after revision: November 07 2017 | First published online: March 01 2018

Conflict of interest: None declared.

Method

Participants

The sample included 30 boys (years 6.34±0.51) and 30 girls (years 6.34±0.51). Children with health problems and motor disorders were not included. Before the research, parents were informed about the details of the study and signed consent forms to allow their children to participate. The research was conducted in accordance with the Declaration of Helsinki, and the institutional ethics committee of the Faculty of Kinesiology, University of Split, approved the proposed research design.

Variables

All participants were measured for height and weight, and BMI scores were calculated. For the evaluation of physical activity and sedentary activity of children, parents were asked to complete the NPAQ (Montoye et al., 1996) of determined psychometric characteristics (Janz, Broffitt, & Levy, 2005). The NPAQ consists of two sections: assessment of physical activity and assessment of sedentary activities. The section that evaluates activity contains seven statements that parents must answer using a Likert scale (1–5) regarding how much they agree with the statement, and the total score is the mean value of all answers (KA). The part that evaluates the child's inactivity contains only two questions related to the average daily time spent doing sedentary activities (watching television and using a computer). The total is calculated by summing the two responses (SA). A six-test set was used to evaluate motor skills: crawl with the ball (PL); bend on the bench (PK); standing broad jump (SUD); side rope jumps (BPK); change of running direction (TPS); and standing on a bench (SK).

Crawl with the ball (PL)

The participant lies on the ground in front of the start line holding a ball of 16 cm in diameter with one hand tight to their body. While they are crawling, the ball should not be dropped or rolled on the floor. If the participant drops the ball during the task, the exercise must be repeated. The time, in seconds, is measured from the oral instruction "Go" to the moment at which the participant moves across the finish line, which is 4 m from the start line.

Bend on the bench (PK)

The participant stands on the bench with their feet together and toes at the edge of the bench where a measuring tape is attached to the bar. The arms should be stretched out and crossed, with the right palm over the left. The participant is required to start lowering into a bend by pulling their hands along the measuring tape. During the exercise, the legs must be straight. The task is completed when the participant reaches the lowest point they can sustain, and this is recorded in centimetres. The zero point is equal with the box. If the participant bends below the zero point, a negative result is recorded.

Standing broad jump (SUD)

Using a two-foot take-off and landing, with the swinging of arms and bending of knees, the participant should attempt to jump as far as possible. The measurement is taken from the take-off line to the nearest point of contact on the landing (back of the heels). No part of the participant's foot may cross over the edge of the scratch board/tape prior to the jump attempt; if this occurs, the jump should be repeated. At the start of the jump, both feet must be parallel to one another; if not, the jump should be repeated. Finally, if the participant lands on a body part other than their feet, the jump should be repeated.

Side rope jumps (BPK)

The participant stands sideways next to the rope that lies on the ground. They are required to start jumping the rope using a two-foot take-off and without double bouncing. The task is performed for 20 seconds. The number of repetitions (one jump over the rope and back again) within 20 seconds is recorded.

Change of running direction (TPS)

Two parallel lines 3 m apart are drawn on the ground. When the tester signals, the participant needs to run four times from line to line, and at each change of direction, at least one foot must completely cross the line marked on the ground. The time, in seconds, is measured from the oral instruction "Go" to the moment at which the participant crosses the marked line the fourth time.

Standing on bench (SK)

With arms next to their body, the participant must step with one foot on a bench (dimensions 10 cm ×6 cm × 6 cm), whilst the other leg is bent at the knee. The participant is asked to maintain this position for as long as possible, and the obtained result is measured in seconds.

All tests were repeated three times and conducted by two testers with many years of experience.

Statistical methods

As a measure of reliability, for all motor variables, Cronbach alpha (Cα), average inter-item correlation (IIR) and coefficient of variation (CV) (Hopkins, 2000) were calculated. Additionally, due to the identification of within-trial bias, repeated ANOVA measures were applied. Gender differences (i.e. homogeneity of subsamples, boys vs girls) were examined using the t-test for independent samples. The normality of distributions was tested using the Kolmogorov–Smirnov test with Lilliefors correction. As a measure of association between

DOI 10.26773/mjssm.180307

variables, the Pearson coefficient of correlation was calculated. Type one error was set at α=5%. All data were calculated using the "Statistica 13.0." data analysis software (Dell Inc., OK, USA).

Results

The distribution normality for both subsamples in all applied variables indicated that only the SK variable in the boys' subsample has a distribution that slightly deviates from normal. Furthermore, using the t-test for independent samples, we determined the homogeneity of the observed sample in motor skill tests, morphological features and physical activity. Considering the statistically significant differences identified in PK (t=2.48, p=0.01), KA (t=2.05, p=0.04) and BMI (t=3.03, p<0.01) variables, the boys were observed separately from the girls. Table 1 presents the reliability analysis results of the observed variables.

TABLE 1 Results of the reliability test and the t-test for independent samples in motor tests, morphological features and physical activity (Mean±SD: mean ± standard deviation; Cα: Cronbach alpha, IIR: infinite impulse response; CV: coefficient of variation; F: ANOVA test value, p: level of significance)

	Mean±SD	Cα	IIR	CV	F	*p*
	Boys (N=30)					
PL	11.18±3.96	1.00	0.99	3.01	0.08	0.93
PK	-3.00±7.35	0.99	0.98	53.45	0.29	0.75
SUD	103.97±10.99	0.94	0.85	4.21	2.97	0.06
BPK	17.00±2.39	0.96	0.90	4.94	1.57	0.22
TPS	6.70±0.74	0.98	0.95	2.60	1.74	0.19
SK	6.59±5.93	0.99	0.98	13.56	0.98	0.38
PA	3.62±0.57					
SA	108.17±68.84					
BMI	15.44±1.34					
	Girls (N=30)					
PL	12.43±2.28	0.99	0.98	2.81	0.55	0.59
PK	-6.83±4.19	0.98	0.96	14.50	0.32	0.73
SUD	100.30±9.56	0.96	0.93	3.64	0.14	0.87
BPK	16.80±2.76	0.95	0.87	6.28	4.25	0.02
TPS	7.02±0.70	0.96	0.90	3.35	1.19	0.31
SK	8.41±4.58	0.99	0.97	9.15	3.76	0.03
PA	3.34±0.50					
SA	107.50±43.25					
BMI	14.53±0.97					

Note: PL: crawl with the ball; PK: bend on the bench; SUD: standing broad jump; BPK: side rope jumps; TPS: change of running direction; SK: standing on bench; PA: physical activity; SA: sedentary activities; BMI: body mass index.

The results clearly indicate that almost all the applied variables are satisfyingly reliable. The exception is the variable SK whose reliability is slightly reduced. In accordance with other objectives of this study, we have determined the correlation between physical activity and sedentary activities and BMI divided by gender. The results clearly indicated that kinesiological activity (boys: r=0.28, p=0.67; girls: r=-0.13, p=0.42) and sedentary activities (boys: r=0.01, p=0.89; girls: r=0.26, p=0.77) have no significant impact on BMI.

Furthermore, we have determined the correlation between physical activity and sedentary activities and motor skill tests divided by gender.

TABLE 2 Correlation coefficient with significance motor skill assessment tests for the variables of physical activity and sedentary activities in boys and girls

	PL	PK	SUD	BPK	TPS	SK
			Boys			
PA	-0.06	0.03	-0.05	-0.00	-0.20	-0.21
SA	0.32	0.11	-0.18	0.31	0.19	0.13
			Girls			
PA	-0.25	0.07	0.37*	-0.01	-0.05	-0.14
SA	-0.26	0.16	-0.03	0.25	-0.13	0.15

Note: Motor skill tests (PL: crawl with the ball; PK: bend on the bench; SUD: standing broad jump; BPK: side rope jumps; TPS: change of running direction; SK: standing on bench). Variables of the questionnaire (PA: physical activity; SA: sedentary activities, * p<0.05)

The results clearly indicate that there is no significant correlation between physical and sedentary activities and motor variables. A significant correlation of the variable SUD with physical activity was identified, but only for girls. A previous study in which the authors recorded an average physical activity of boys of 3.30 using NPAQ also indicates that there is no correlation between physical activity and sedentary activities and motor skills tests; however, they suggest that this could be the result of the small number of participants in the research (Janz et al., 2005).

Discussion

Differences between boys and girls in applied motor skill tests were identified only in the flexibility test, which confirms previous research in which girls were found to perform better than boys did (Kraljević, Gađić, & Vučković, 2013). As expected, boys have a significantly higher average BMI and higher physical activity than girls do (Olsson, Fahlen, & Janson, 2008). Boys may have a higher physical activity score because of the selection of the games that they play in their free time (Hamar, Biddle, Soos, Takacs, & Huszar, 2010).

No correlation was found between BMI and physical activity and sedentary activities, which means that boys and girls who spend more or less of their free time actively do not necessarily have a higher or lower BMI. These results are analogous to previous studies (e.g. Green & Cable, 2006), which indicated that the activity level of preschool children does not significantly affect their body weight. The results also indicate that the recorded level of physical activity and sedentary activities does not significantly affect their performance in motor skills tests. These results point to the persistence of the assumption that children, through their innate need for movement, experience harmonious growth and development, which is independent of external influences, such as levels of physical and sedentary activities (Franjko, Žuvela, Kuna, & Kezić, 2013).

The next question is to what extent children are able to meet their needs for movement during further growth and development, and how their level of physical activity will affect the development of motor skills and morphological features, keeping in mind the school's obligations and a social environment that is mostly sedentary (Biddle, Marshall, Gorely, & Cameron, 2009; Veitch et al., 2011). In this study, comparisons between physical activity and sedentary activities and motor skills tests did not show any correlation in boys; in girls, the correlation between physical activity was indicated in only one motor skill test. The most probable reason for the absence of significant correlation between physical activity and motor skills can most likely be sought in the non-measurement of the quality of physical activity. Specifically, in addition to the amount of physical activity, it is also necessary to determine its quality, i.e. the type of organization and methods of implementation.

Therefore, despite this deficiency, this article provides a good understanding of the complex interaction dynamics of the natural process of growth and development with various modes of free time activity for preschool children. Furthermore, the information obtained can be a theoretical basis for the precise structuring and practical implementation of organized leisure activities. The objective would also be to establish and hierarchically structure the predictors of harmonious growth and development. Additionally, based on the obtained predictors, it may significantly influence the optimal anthropological status in preschool children.

Further monitoring and control of the correlation between anthropological characteristics and external factors are necessary. Longitudinal studies of this type with a larger sample size would provide a deeper insight into the structure of children's growth and development mechanisms.

REFERENCES

Al-Kloub, M. I., & Froelicher, E. S. (2009). Factors contributing to adolescent obesity. *Saudi Med J, 30*(6), 737-749.

Barnett, L. M., Lai, S. K., Veldman, S. L., Hardy, L. L., Cliff, D. P., Morgan, P. J., . . . Okely, A. D. (2016). Correlates of Gross Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Med, 46*(11), 1663-1688. doi: 10.1007/s40279-016-0495-z

Barnett, L. M., Salmon, J., & Hesketh, K. D. (2016). More active pre-school children have better motor competence at school starting age: an observational cohort study. *BMC Public Health, 16*(1), 1068. doi: 10.1186/s12889-016-3742-1

Bellows, L. L., Davies, P. L., Courtney, J. B., Gavin, W. J., Johnson, S. L., & Boles, R. E. (2017). Motor skill development in low-income, at-risk preschoolers: A community-based longitudinal intervention study. *J Sci Med Sport*. doi: 10.1016/j.jsams.2017.04.003

Biddle, S. J., Marshall, S. J., Gorely, T., & Cameron, N. (2009). Temporal and environmental patterns of sedentary and active behaviors during adolescents' leisure time. *Int J Behav Med, 16*(3), 278-286. doi: 10.1007/s12529-008-9028-y

Cantenassi, F.Z., Marques, I., Bastos, C.B., Basso, L., Vaz Ronque, E.R. i Gerage, A.M. (2007). Relationship between body mass index and gross motor skill in four to six year-old children. *Revista Brasileira de Medicina do Esporte*, *13*(4), 203-206.

Cohen, K. E., Morgan, P. J., Plotnikoff, R. C., Callister, R., & Lubans, D. R. (2015). Physical activity and skills intervention: SCORES cluster randomized controlled trial. *Med Sci Sports Exerc, 47*(4), 765-774. doi: 10.1249/MSS.0000000000000452

 DOI 10.26773/mjssm.180307

Čuljak, Z., Miletić, Đ., Delaš Kalinski, S., Kezić, A. & Žuvela, F. (2014). Fundamental Movement Skills Development Under the Influence of a Gymnastics Program and Everyday Physical Activity in Seven-Year-Old Children. *Iran J Pediatr, 24*(2), 124-130.

Donath, L., Faude, O., Hagmann, S., Roth, R., & Zahner, L. (2015). Fundamental movement skills in preschoolers: a randomized controlled trial targeting object control proficiency. *Child Care Health Dev, 41*(6), 1179-1187. doi: 10.1111/cch.12232

Franjko, I., Žuvela, F., Kuna, D., & Kezić, A. (2013). Relations between some anthropometric characteristics and fundamental movement skills in eight-year-old children. *Croatian Journal of Education, 15*(4), 195-209.

Gallahue, D. & Donnely, F. (2003). Developmental physical education for all children. Champaign, IL: Human Kinetics.

Goldfield, G. S., Harvey, A., Grattan, K., & Adamo, K. B. (2012). Physical activity promotion in the preschool years: a critical period to intervene. *Int J Environ Res Public Health, 9*(4), 1326-1342. doi: 10.3390/ijerph9041326

Green, D. J., & Cable, T. (2006). Physical activity to prevent obesity in young children: BMI in the BMJ. *BMJ, 333*(7579), 1171; author reply 1171-1172. doi: 10.1136/bmj.39045.484167.FA

Hamar, P., Biddle, S., Soos, I., Takacs, B., & Huszar, A. (2010). The prevalence of sedentary behaviours and physical activity in Hungarian youth. *Eur J Public Health, 20*(1), 85-90. doi: 10.1093/eurpub/ckp100

Hills, A. (1995). Physical activity and movement in children: its consequences for growth and development. *Asia Pac J Clin Nutr, 4*(1), 43-45.

Hills, A. P., & Byrne, N. M. (2010). An overview of physical growth and maturation. *Med Sport Sci, 55*, 1-13. doi: 10.1159/000321968

Hopkins, W. G. (2000). Measures of reliability in sports medicine and science. *Sports Med, 30*(1), 1-15.

Janz, K.F., Broffitt, B. & Levy, S. M. (2005). Validation evidence for the Netherlands physical activity questionnaire for young children: the Iowa Bone Development Study. *Research Quarterly for Exercise and Sport*, *76*(3), 363-369.

Kordi, R., Nourian, R., Ghayour, M., Kordi, M., & Younesian, A. (2012). Development and evaluation of a basic physical and sports activity program for preschool children in nursery schools in iran: an interventional study. *Iran J Pediatr, 22*(3), 357-363.

Kraljević, R., Gađić, A., & Vučković, I. (2013). Differences in motor skills of seventhgrade boys and girls. *Acta Kinesiologica*, *7*(2), 62-66.

Liong, G. H., Ridgers, N. D., & Barnett, L. M. (2015). Associations between skill perceptions and young children's actual fundamental movement skills. *Percept Mot Skills, 120*(2), 591-603. doi: 10.2466/10.25.PMS.120v18x2

Logan, S. W., Robinson, L. E., Wilson, A. E., & Lucas, W. A. (2012). Getting the fundamentals of movement: a meta-analysis of the effectiveness of motor skill interventions in children. *Child Care Health Dev, 38*(3), 305-315. doi: 10.1111/j.1365-2214.2011.01307.x

Lovrić, F., Jelaska, I., & Bilić, Ž. (2015). Polygon With Obstacles As An Assesment Of Fundamental Movement Skills In 6 Year Old Children. *Croatian Journal of Educaton*, (*Sp. Ed. 3*)13, 213-225.

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 Med, 40*(12), 1019-1035. doi: 10.2165/11536850-000000000-00000

Montoye, H. J., Kemper, H. C. G., Saris, W. H. M., & Washburn, R. A. (1996). Measuring Physical Activity and Energy Expenditure. Champaign, IL: Human Kinetics.

Olsson, A., Fahlen, I., & Janson, S. (2008). Health behaviours, risk-taking and conceptual changes among schoolchildren aged 7 to 19 years in semi-rural Sweden. *Child Care Health Dev, 34*(3), 302-309. doi: 10.1111/j.1365-2214.2008.00836.x

Rush, E., & Simmons, D. (2014). Physical activity in children: prevention of obesity and type 2 diabetes. *Med Sport Sci, 60*, 113-121. doi: 10.1159/000357341

Slykerman, S., Ridgers, N. D., Stevenson, C., & Barnett, L. M. (2016). How important is young children's actual and perceived movement skill competence to their physical activity? *J Sci Med Sport, 19*(6), 488-492. doi: 10.1016/j.jsams.2015.07.002

Sturza Milić, N. (2014). The influence of motor experience on motor creativity (fluency) of preschool children. *Kinesiology*, *(Suppl. 1)*46, 81-86.

Tompsett, C., Sanders, R., Taylor, C., & Cobley, S. (2017). Pedagogical Approaches to and Effects of Fundamental Movement Skill Interventions on Health Outcomes: A Systematic Review. *Sports Med*. doi: 10.1007/s40279-017-0697-z

Veitch, J., Timperio, A., Crawford, D., Abbott, G., Giles-Corti, B., & Salmon, J. (2011). Is the neighbourhood environment associated with sedentary behaviour outside of school hours among children? *Ann Behav Med, 41*(3), 333-341. doi: 10.1007/s12160-011-9260-6

Yu, J., Sit, C. H., Burnett, A., Capio, C. M., Ha, A. S., & Huang, W. Y. (2016). Effects of Fundamental Movement Skills Training on Children With Developmental Coordination Disorder. *Adapt Phys Activ Q, 33*(2), 134-155. doi: 10.1123/APAQ.2015-0008