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Relationship between physical activity, physical fitness, and motor competence in school children

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ORIGINAL ARTICLE

ABSTRACT
The aim of this study was to verify the relationship between habitual physical activity, physical fitness, and motor competence in school children. In total, 100 children aged 8-10 years took part in this study, subdivided into 2 groups: the Physical Education Group (PEG) characterized only by practical classes of Physical Education; and another group that performed Systematized Physical Activity (SPA). Habitual physical activity was investigated using the *webdafa* questionnaire. The physical fitness battery included a 20-meter running test, throwing a medicine ball, a horizontal jump test, and running for six minutes. Motor competence was measured by the TGMD-2 test. For statistical analysis we used the Spearman correlation, Mann-Whitney and Chi-square Fisher tests. The results demonstrated moderate correlations between habitual physical activity and the 20-meter running test (r=0.41) and (r=0.49) motor competence. Furthermore, moderate correlations were found between physical fitness and motor competence in the horizontal jump test (r=0.55), running for six minutes (r=0.50), and 20 meter running test (r=0.65). In conclusion, it was observed that the SPA demonstrated better results and the school physical education classes were not sufficient to ensure adequate levels of habitual physical activity, physical fitness, or motor competence in the children in the present study.
Keywords: motor skills, healthy, children.

INTRODUCTION

The Physical inactivity is the fourth leading cause of death worldwide, being considered a global pandemic with a negative impact on health status, resulting in devastating economic and social consequences (Kohl et al., 2012). It is recognized that adequate incorporation of motor practice habits in childhood and adolescence has an important impact on a physically active lifestyle in adulthood (Telama et al., 2014). On the other hand, obesity patterns established in childhood predispose to an increased risk of cardiovascular morbidity and mortality in adulthood (Cote et al., 2013). Thus, it is acknowledged that, although the clinical outcomes of chronic dysfunctions occur in maturity, it is during childhood and adolescence that eating and physical activity habits are established (Yumuk et al., 2015). In this context, the school environment is highlighted, since it is in the school setting that both academic performance and guidelines for a healthy lifestyle are established (Donnelly et al., 2016; Vanhelst et al., 2016).

On one hand, it is known that regular practice of physical activity relates directly and positively with scores of physical fitness (PA) related to health components (Gallota et al., 2016). On the other hand, the relation between habitual physical activity (HPA), PA, and motor competence (MC) is relatively recent (Robinson et al., 2015; Stodden et al., 2008). In this sense, a systematic review indicated strong evidence that the development of MC was inversely associated with total body mass and positively associated with cardiorespiratory and musculoskeletal fitness throughout childhood and adolescence (Cattuzzo et al., 2016). Participation in sports and organized practices also impacts on MC. Previous studies have shown that children in these environments present better motor coordination, and better levels of PA, MC, and daily task performance when compared to children who are not engaged

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in these practices (Fransen et al., 2012; Lai et al., 2014; Lubans et al., 2012; Nazario & Vieira, 2013; Queiroz et al., 2014; Vandorpe et al., 2012).

In this context, the opportunity for structured and systematized practice within the educational process is the responsibility of the teachers of school physical education classes. However, previous studies have indicated negligence in class regarding the elaboration of the programmed content (Fortes et al., 2012; Gallotta et al., 2016; Guedes & Guedes, 2001; Telford et al., 2016). Thus, children demonstrate lower MC levels than expected for the age group, which, consequently, leads to a lower engagement in organized, sport, recreational, and other activities, thus reducing levels of PA and HPA in childhood and adolescence (Fortes et al., 2012; Guedes & Guedes, 2001; Spessato et al., 2012). For these reasons, the objectives of the present study were to verify the relationship between HPA, PA, and MC of children practicing exclusively school physical education classes and another group included in systemized physical activities organized in the period of the day when they were not at school and, secondarily, to determine if the children belonging to the school physical education classes maintained adequate levels of HPA, PA, and MC.

METHOD

A cross-sectional study, in which all ethical issues were approved prior to execution by the local Ethics Committee (CAEE 44106815.4.0000.5231).

Participants

The sample was selected for convenience and was composed of 100 eutrophic prepubertal children, between 8 and 10 years old, of both sexes. The eligibility criteria required the absence of any ongoing drug therapy and/or illness or physiological dysfunction in the included children.

Two groups of schoolchildren with distinct physical activity practices were organized. One of the groups was characterized by exclusive participation in school physical education classes (PEG), composed of 56 children (25 boys and 31 girls) without any extracurricular physical activity practice in the 6 months prior to the project. The classes were given twice a week for 50 minutes and followed a similar operating pattern, with stretching activities, global warm-up with running, structured classroom content and, finally, teacher *feedback* to students. The other group consisted of 44 children (19 boys and 25 girls) who performed systemized physical activity (SPA) in athletics, in addition to the school physical education classes, for at least 6 months prior to the beginning of data collection. The athletics practice was performed 3 times a week for 50 minutes.

Instruments and Procedures

The eutrophic nutritional status was obtained by calculating the body mass index (BMI) from the body mass to height ratio according to the WHO criteria (Onis et al., 2007). In addition, relative fat was calculated from the predictive equations specific to sex and maturational status proposed by Slaughter et al. (1988).

The level of HPA was investigated through the Electronic Questionnaire of a Typical Day of Physical Activity and Food *webdafa* (Legnani et al., 2013). The evaluation of PA was obtained using the PROESP-BR battery of motor tests (2015). In the present study the horizontal jump, 20-meter run, *medicine ball* throw, and six-minute run tests were performed (Proesp, 2015), strictly following this order of execution. All tests were conducted individually, except for the six-minute run, which was performed with groups of 4 children. To investigate the MC, the *Test of Motor Development Second Edition* (TGMD-2) was applied, as proposed by Ulrich (2000) and validated for the Brazilian population by Valentini (2012). As a blinding strategy, three previously trained evaluators who did not participate in the data collection analysed the images. The reproducibility between the three evaluators presented an intraclass correlation coefficient equal to 0.85 for the motor quotient scores. This value is classified as excellent reproducibility according to Atkinson et al. (1998).

All research procedures were carried out in the school environment, respecting the academic hours and content. The description and timetable of the procedure steps are shown in figure 1, and the duration was, in total, 165 days.

Statistical analysis

The normality of the data was verified by the *Shapiro-Wilk* test and the *Levene's* test for homogeneity. As the data did not present normal distribution or homogeneity, the *Spearman* correlation was applied to the HPA, PA, and MC variables. Correlations were classified as; weak (r between 0.20 and 0.39); moderate (r = 0.40 to 0.59); moderate to severe (r = 0.60 to 0.79); and strong (r> 0.80) (Cohen, 1992). Subsequently, associations were carried out between the groups with the *Mann-Whitney* and Fisher's exact chi-square tests. All procedures were performed using the statistical package SPSS 20.0 and a significance level of P<0.05was adopted. The principal investigator of the study was blinded to the statistical procedures.

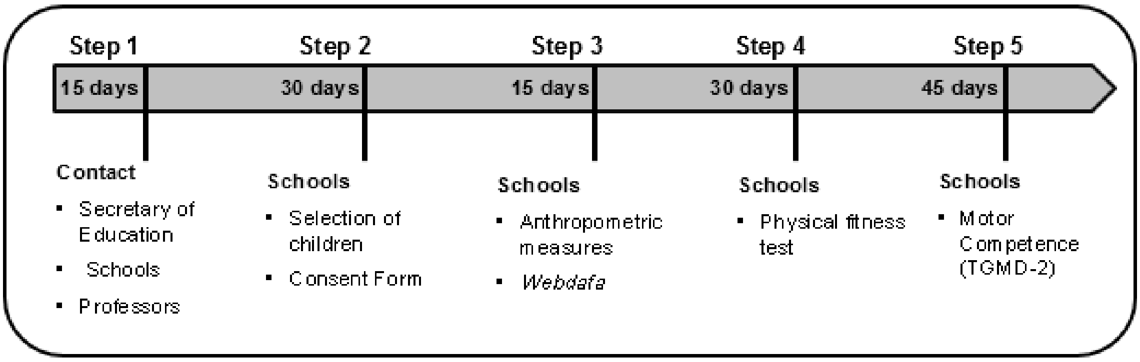

Figure1. Cross-sectional study subdivided into 5 steps with total duration of 165 days

RESULTS

The anthropometric characteristics of the groups (PEG and SPA) demonstrated homogeneity for the variables age, total body mass, BMI, and lean body mass. In the relative fat variable, significant differences were observed, with the PEG presenting a higher percentage of fat when compared to the SPA (P<0.030) (Table 1).

Table 1

Characterization of the sample with median (M), interquartile range (Q1-Q3), age (years), total body mass (MC (kg)), height (m), body mass index (BMI (kg/m²)), lean body mass (LBM (kg)) and relative fat (% g (%)) of the groups (PEG and SPA).

	PEG M (Q1;Q3)	SPA M (Q1;Q3)	P value
Age (years)	9.0 (8.0-10.0)	9.0 (9.0-10.0)	0.422
BM (kg)	32.5 (28.2-38.1)	31.1 (29.3-34.3)	0.779
Height (m)	1.35 (1.32-1.42)	1.38 (1.32-1.42)	0.329
BMI (kg/m²)	17.4 (15.9-19.4)	16.6 (15.7-17.8)	0.165
LBM (kg)	25.6 (23.2-29.0)	26.4 (24.6-28.3)	0.457
Relative fat (%)	17.4 (15.3-22.8)	15.9 (12.9-19.8)	0.026*

Note. Mann-Whitney test to verify the differences P<0.05.

Table 2 presents the degree of correlation between the HPA variables evaluated by the *webdafa* questionnaire, horizontal jump, medicine ball throw, six-minute run, 20-meter run, and MC (TGMD-2). The results demonstrated that HPA indicated a moderate positive correlation (r = 0.49) with CM, a moderate negative correlation (r = 0.41) with the 20-meter run, and a positive but weak correlation (r = 0.28) with the 6-minute run. However, the 6-minute run test presented a moderately positive correlation (r = 0.50) with the motor quotient, indicating that increasing aerobic fitness enhances the motor competence score. The values of the correlations demonstrated an inversely proportional pattern, that is, negative correlations between the 20-meter run and the other research variables. The moderate to severe negative correlation of r = -0.65 with the motor quotient is highlighted, indicating that the higher the speed in the 20-meter run, characterized by anaerobic metabolic predominance, the higher the motor competence scores. In addition, it is important to mention that MC indicated a moderate positive correlation (r = 0.55) with the horizontal jump, that is, the higher the horizontal jumping ability, the higher the motor quotient value.

The comparisons between groups (PEG and SPA) for all variables are presented in Table 3. The results demonstrated, for all variables except for *medicine ball* throw, statistically significant differences between groups, with the SPA presenting significantly higher values when compared to the PEG (*P*<0.001).

Table 2

Correlations between the webdafa variables, horizontal jump (HJ (cm)), throw (throw), 6-minute run (m), 20 meter run (s), and motor quotient (MQ).

	HJ (cm)	Throw (cm)	Run 6m (m)	Run 20m (s)	MQ
Webdafa	0.219*	0.191	0.280**	-0.413**	0.490**
HJ (cm)		0.187	0.419**	-0.680**	0.559**
Throw (cm)			0.028	-0.417**	0.171
Run 6m (m)				-0.415**	0.503**
Run 20m (s)					-0.653**

Note. Spearman Correlation Coefficient. P<0.05 ** P<0.01

Table 3

Median (M) and Interquartile Range (Q1-Q3) of the webdafa variables, horizontal jump (HJ (cm), throw (throw), 6-minute run (m), 20-meter run (s), and motor quotient (MQ) between the PEG and SLA groups

	PEG M (Q1;Q3)	SLA M (Q1;Q3)	P value
Webdafa	62 (50-74)	89 (79-103)	0.001*
HJ (cm)	132 (122-146)	156 (144-171)	0.001*
Throw (cm)	236 (200-260)	248 (222-271)	0.068
Run 6m (m)	699 (621-800)	849 (770-900)	0.001*
Run 20m (s)	4.67 (4.29-4.97)	3.82 (3.57-4.00)	0.001*
MQ	73 (67-77)	91 (89-94)	0.001*

Note. Mann-Whitney test to verify the differences P <0.05.

Table 4 presents the values of the associations between the groups (PEG and SPA). The results demonstrated significant differences (*P*<0.001) for all associations except the *medicine ball* throw. In the HPA variable, the highest percentage of children (80.4%) in the PEG remained in the non-active classification, while the SPA showed higher percentages in the active classification (84.1%), with significant differences between groups (*P*<0.001). The associations for the six-minute run and 20 meter run variables are emphasized, in which the highest percentage of the PEG were allocated in the weak classification (69.6% and 62.5%, respectively). In the MC analysis, the results indicated a significant superiority for the SPA, with percentages for the motor quotient of 65.9%, classified as average or above average, while in the PEG only 1.8% were indicated as average, while 98.2% of the PEG sample were allocated in the very poor, poor, and below average classifications.

DISCUSSION

The main findings of the present study indicated a moderate relation (r = 0.49) between HPA and MC. Among the PA tests, the 20-meter run with a moderate negative correlation (r = -0.41) with HPA and a moderate to strong positive correlation (r = 0.65) with MC was the most prominent. In this context, the literature also shows positive correlations between HPA and MC variables.

Table 4

Absolute and relative frequency of the groups (PEG and SLA) in the WEBDAFA questionnaire, horizontal jump, throw, 6-minute run, 20-meter run, and motor quotient

	Classification	PEG n	PEG %	SLA n	SLA %	P value ≠ between groups
Webdafa	Not active	45	80.4	7	15.9	<0.001
	Active	11	19.6	37	84.1	
Horizontal Jump	Weak	09	16.1	2	4.5	<0.001
	Reasonable	11	19.6	2	4.5	
	Good	14	25	2	4.5	
	Very Good	19	33.9	30	68.2	
	Excellent	3	5.4	8	18.2	
Throw	Weak	10	17.6	4	9.1	0.71
	Reasonable	6	10.7	3	6.8	
	Good	13	23.2	8	18.2	
	Very Good	23	41.1	24	54.5	
	Excellent	4	7.1	5	11.4	
6 minute Run	Weak	39	69.6	10	22.7	<0.001
	Reasonable	4	7.1	7	15.9	
	Good	3	5.4	9	20.5	
	Very Good	5	8.9	15	34.1	
	Excellent	5	8.9	3	6.8	
20 meter Run	Weak	35	62.5	4	9.1	<0.001
	Reasonable	10	17.9	1	2.3	
	Good	7	12.5	5	11.4	
	Very Good	4	7.1	30	68.2	
	Excellent	0	0	4	9.1	
Motor Quotient	Very Poor	19	33.9	0	0.0	<0.001
	Poor	28	50.0	0	0.0	
	Below average	8	14.3	15	34.1	
	Average	1	1.8	28	63.6	
	Above average	0	0	1	2.3	

Note. Chi-square; Fisher exact; (P <0.05).

Stodden et al. (2008) proposed a conceptual framework in which MC levels promote participation in physical activity practice. Based on this assumption, literature review studies have found positive correlations between MC and HPA (Barnett et al., 2016; Holfelder & Schott, 2014; Logan et al., 2015; Lubans et al., 2010). However, although the authors reinforce that there is evidence of a cause and effect relationship, the strength of the correlations do not demonstrate high values, indicating limitations for an effective conclusion on the relation between the variables (Barnnett et al., 2016; Khodaverdi et al., 2015; Logan et al., 2015; Robinson et al., 2015).

The results of a moderate correlation between PA and MC in the present study corroborate a recent systematic review of Cattuzzo et al. (2016). These associations may be explained by the causal mechanisms of improvement in coordination patterns and in the performance of locomotion and control of objects which are closely related to changes in the muscular system, such as the recruitment of motor units, coactivation of antagonists, altered proprioceptor sensitivity, and concentric and eccentric muscle activity. Thus, there is a reciprocal combination between elements, in which the increase in one variable possibly results in improvement in the other (Cattuzzo et al., 2016; Stodden et al., 2014).

In the comparisons between the groups, the SPA demonstrated superior and significant values to the PEG group in the HPA, MC, horizontal jump, 20-meter run, and six-minute run (P <0.001). With regard to meeting the criteria for health, the results showed that a significant percentage of the SPA sample was classified in the top score in all parameters analyzed. On the other hand, the PEG presented worrying results, with 83.9% of children in this group classified as poor and very poor for MC, underlining that, in HPA, about 80.4% of the group were classified as non-active by the *webdafa*. In addition, there were poor PA classifications in both the aerobic 6-minute run

(69.6%), and the anaerobic 20-meter test (62.5%). The results of the present study are in agreement with others previously reported in the literature which indicated that the practice of organized physical activity potentiates MC levels, motor coordination, PA, and body weight *status* in children, when compared to their peers who are not engaged in the same stimulatory environment (Fransen et al., 2012; Lai et al., 2014; Lubans et al., 2012; Queiroz et al., 2014; Vandorpe et al., 2012). Fransen et al. (2012) analyzed the levels of PA and participation in sports in children with low, medium, and high MC. In the analyses, children with higher MC, measured by the *Bruininks-Oseretsky* test, demonstrated higher levels of PA through the *Eurofit physical fitness test* (EUROFIT). In addition, greater engagement in organized physical activities was indicated. Thus, the authors reinforce that children with high MC have greater possibilities to develop adequate levels of PA and a greater probability of inclusion in programmed practices, in contrast to children with low and average MC.

Additional results from the present study indicate that school physical education classes were not sufficient to improve HPA, PA (six minute run and 20 meter run), or MC. Similar to these findings, intervention studies with physical activity programs in the school environment have identified that general content, short effective classroom time, motivation, and teaching strategies do not guarantee the achievement of desirable health criteria (Gallotta et al., 2016; Lai et al., 2014; Lonsdale et al., 2013; Telford et al., 2016).

Analysing the school physical education classes, Spessato et al. (2012) evaluated 1248 children between 3 and 10 years of age with the TGMD-2 test. Overall, 69% of boys and 82% of girls scored below the test average. The authors questioned the fact that Physical Education classes are developed in 45 minutes, twice a week, and although many of them include free or sports content, they do not involve instruction and correction of motor skills. From these observations, some elements seem fundamental for the classes to potentiate motor competence, among them the following stand out: 1) to evaluate level of motor competence and draw up an activity plan for improvement; 2) offer varied types of practice in motor skills in situations of different contexts with instruction and feedback; 3) develop tasks appropriate to the needs of students (Spessato et al., 2012).

Corroborating with these indicatives, the results of the present study are worrisome, due to the high percentage of schoolchildren in ratings below the expected for the age group in the HPA, PA, and MC variables. As limitations, we can highlight the non-use of direct instruments for the measurement of HPA, the absence of a sample calculation as the sample was selected for convenience, and the absence of qualitative analysis of the school physical education classes. However, it is possible to indicate practical implications from the results of the present study, in which it is suggested that teachers of physical education at school regularly evaluate the PA and MC of the children to better adapt the structured activities in class. In future studies mapping of the activities performed is proposed in addition to which the use of direct HPA instruments could minimize these biases and reinforce the findings of the present study.

CONCLUSION

Positive correlations were observed between HPA, PA, and MC in children aged 8 to 10 years. Additionally, it is clear that the children participating in the SPA presented better results in all variables when compared to their peers who exclusively participated in the school physical education classes. Thus, physical education classes seem not to be sufficient to guarantee adequate levels of HPA, PA, and MC in the children in this study.

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