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Original Article

PHYSICAL ACTIVITY AND MOTOR COMPETENCE IN CHILDHOOD

PRÁTICA DE ATIVIDADE FÍSICA E COMPETÊNCIA MOTORA NA INFÂNCIA

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RESUMO
Os objetivos desta pesquisa foram verificar a quantidade e intensidade de atividade física praticada por crianças de baixo nível socioeconômico durante dias de semana e finais de semana, avaliar indicadores de competência motora e verificar as associações entre essas variáveis. Participaram do estudo 176 crianças entre 3 e 6 anos. As crianças usaram acelerômetro por sete dias consecutivos para mensurar a prática de atividade física e a competência motora foi mensurada com a utilização do *Test of Gross Motor Development (TGMD-2)*. Os meninos despenderam mais tempo em atividade física total do que meninas (222,5 min xs 204 min; p<0,01) nos dias de semana. Em ambos os sexos, o tempo médio diário de atividade física total ficou acima das diretrizes internacionais de prática de atividade física (≥ 3h de atividade física por dia), porém há indicadores de atraso no desenvolvimento da competência motora, principalmente nas habilidades de controle de objetos. Concluímos que meninos apresentam maiores índices de prática de atividade física do que meninas e possuem maior competência motora, porém, valores reduzidos de associação entre prática de atividade física e competência motora sugerem que a quantidade de atividade física não necessariamente implica no desenvolvimento da competência motora.
Palavras-chave: Atividade física. Acelerometria. Desenvolvimento infantil.

ABSTRACT
The objectives of this research were to verify the amount and intensity of physical activity performed by children of low socioeconomic level during weekdays and weekends, to assess motor competence indicators and to verify associations between these variables. A total of 176 children aged 3 to 6 years old participated in the study. They wore an accelerometer for seven consecutive days to measure physical activity engagement, while motor competence was measured by means of the Test of Gross Motor Development (TGMD-2). Boys spent more time on total physical activity than girls did (222.5 min x 204 min; p<0.01) on weekdays. For both sexes, daily average time of total physical activity stood above international guidelines on physical activity (≥ 3h of physical activity per day), but there are indicators of delayed motor competence development, especially in object control skills. In conclusion, boys presented higher physical activity engagement indexes compared to girls and had greater motor competence; however, low values for association between physical activity and motor competence suggest that physical activity amount does not necessarily affect motor competence development.
Keywords: Physical Activity. Accelerometry. Child Development.

Introduction

Regular engagement in physical activity (PA) during childhood and adolescence favors physical, motor, cognitive and social development, with positive consequences to quality of life and prevention of chronic-degenerative diseases[1]. The literature indicates that motor competence (MC), defined as the ability to execute motor skills with a certain degree of proficiency and coordination[2], is an important factor in PA promotion and maintenance throughout life[3]. Thus, in combination with PA, MC development favors health and quality of life during childhood and later years, from both a biological and psychosocial point of view[4].

Children with low MC, condition characterized by an inability to execute motor skills at a level that is adequate to their age[5], tend to avoid or quit PA, which, in its turn, further restricts their motor development and may generate a negative behavioral cycle, raising the probability of sedentariness and associated harms[6]. Data from the World Health Organization bring sedentariness as the fourth main cause of death in the world[7], causing PA promotion to be considered a priority intervention in the public health field[8].

World health guidelines suggest that, for a healthy life style, pre-school children should engage in at least 3 hours of total physical activity (TPA) everyday, regardless of intensity[9]. Exercising during childhood is important for motor competence (MC) development. A group of researchers[10] proposed a model in which, until 6 years of age, PA determines motor competence, and the more experiences, more engagement and more opportunities for engaging in PA, the better the child's motor performance. That is, the higher the PA level, the greater the opportunities of promoting neural and motor development and, consequently, motor skills; in addition, PA and MC levels act positively toward improving physical fitness later in life. Despite evidence of a positive association between PA and MC[11], the association between compliance with PA and MC development world guidelines is not known, especially in children living in regions of social vulnerability, that is, where there is spatial overlapping between very poor and highly deprived population groups, to the point of hindering their social wellbeing[12].

The children who participated in this study reside in the community of *Jardim Keralux*, located in the eastern region of São Paulo. This location is characterized by a high population rate and great concentration of underprivileged communities. Although there is scientific and social relevance, studies on MC in children from this population are necessary; it is important to have a greater understanding of the developmental profile of these children for the planning of intervention programs that favor their motor and psychosocial development and, mid- and long-term, to contribute to reducing sedentariness rates, with consequent prevention of chronic-degenerative diseases, further allowing a greater social integration and evolution in quality of life.

A study conducted with children in situation of socioeconomic vulnerability showed that they were disproportionately limited as to opportunity of motor development experiences[13]. In another study, a high prevalence of motor delay was detected in a sample of Brazilian children of low socioeconomic status, considering both isolated and combined results for the TGMD-2 and KTK[14]. For this reason, researches with youths living in these locations have been especially recommended due to their social relevance and the need for a greater understanding of associations between PA engagement and MC development, enabling the identification of young individuals in risk situation and the generation of intervention programs that favor motor development and contribute to reducing sedentariness rates, further promoting greater social integration and quality of life[15]. Thus, this research aimed to verify the amount and intensity of physical activity performed by children of low socioeconomic level during weekdays and weekends, to assess motor competence indicators and to verify associations between these variables. As hypothesis, due to environmental limitations associated with social vulnerability, low PA and MC indexes are expected to be found among these children.

Methods

Participants

This research had the participation of 176 children aged between 3 and 6 years old (72 girls: BMI = 16.09 ± 1.78 $kg.m^{-2}$; age = 5.41 ± 0.75 years old, and 104 boys: BMI = 16.81 ± 2.74 $kg.m^{-2}$; age = 5.28 ± 0.75 years old), who wore accelerometers during seven consecutive days and performed motor tests. The project legal opinion number is 476.123, of 02.12.2013. Parents or legal guardians signed a free and informed consent form, and the children agreed to join the research. All participants study and reside in locations within Ermelino Matarazzo/SP considered to be of low socioeconomic level. The following inclusion criteria were used: attending class on test days, agreeing to participate in the research, and having no medical contraindications for exercising.

Procedures

Engagement in physical activity as well as PA time and intensity were measured directly using accelerometers (ActiGraph wGT3X+, Pensacola, FL, USA). The parents/guardians received a spreadsheet with detailed information on how the device worked and were instructed as to the need to maintain the children's normal habits. The monitor was placed at hip height, attached and protected by a belt, and was taken off for shower and sleep only. Telephone calls and text messages via cell phone were used for answering the parents' questions about the use of the accelerometers. Activities were recorded on the device at intervals (epoch) of 1 second, and each child was monitored during seven consecutive days (Tuesday and Monday). Non-wear time was set at 60 consecutive minutes of count equal to zero, allowing 2 minutes of interruption with values above zero. The study included those children who wore the accelerometer at least 500 minutes per day, for 3 days (including at least 1 day on the weekend), according to criteria suggested in recent researches[16,17]. To calculate the amount of time spent on each effort intensity (sedentary, light, moderate and vigorous activity, the following cutoff points, proposed by Evenson et al.[18] were used, which have been recommended[19,20] for the age group of the present research: 0-100 counts per minutes (cpm) of time for sedentary activities; 101-2295 for light PA; 2296-4011 for moderate PA, and above 4012 for vigorous PA. From these cutoff points, it was possible to calculate the average PA time at different intensities on the valid days of accelerometer use, and to calculate the proportion of children who had daily TPA average ≥ 180 minutes.

Motor Competence Indicators

To assess MC, the Test of Gross Motor Development – Second Edition (TGMD-2)[21] was adopted. The TGMD-2 consists of a qualitative assessment of six locomotion skills (running, jumping obstacles, hopping, galloping, leaping and sliding) and six object control skills (ball) (striking, rolling, catching, kicking, bouncing and throwing). For each skill, the children were given verbal instruction and demonstration, then executed a familiarization attempt. Afterwards, two attempts were filmed (Sony Cyber-Shot DSC-H20 digital camera, 10.1 Megapixel) for later analysis. To prevent fatigue or attention loss that could influence performance, each child performed locomotion and object control tasks on two different days in the same week. Accelerometry measures were taken and motor tests (TGMD-2) were carried out in a maximum interval of two weeks.

On the TGMD-2 checklist, each skill has performance criteria referring to movement quality; if the child's performance meets the criterion, it scores one point (1) or, otherwise, performance as to said criterion scores zero (0). Each skill was executed twice, and performance criteria were summed to provide gross scores for locomotion skills (0-48 points), object control skills (0-48 points) and TGMD-2 total sum (0-96 points). In addition to gross scores, standardized data (percentiles) were calculated as well, according to normative tables specifically designed for each sex and age group, proposed in the TGMD-2 original guide, composed of data on 1,208 healthy North-American children[21]. Individual percentile values were used for calculating the percentage of individuals classified in the TGMD-2 into: low MC (percentile ≤ 15), normal MC (percentile > 15 and ≤ 50) and high MC (percentile > 50).

All videos were analyzed independently by two researchers. The percentage of agreement in the evaluations was calculated according to recommendations by Baumgartner et al.[22] [Number of agreements / (number of agreements + discrepancies) x 100], based on the analysis of videos of 20 children with complete TGMD-2 data. Inter-rater agreement stood at 85.7% (82.2% to 97.3%), and intra-rater agreement, at 88.0% (84.1% to 98.1%).

Data Analysis

For data analysis, descriptive tables were designed, and Pearson's correlation

coefficients were calculated between motor competence and physical activity indicators; to verify associations between sex and compliance with PA international guidelines, chi-squared tests were applied. To detect possible inter-group differences, the two-factor Analysis of Variance (ANOVA) was used: age group (yearly interval) x sex (male and female). Further comparisons (post-hoc), if necessary, were made through Bonferroni correction. For comparisons between PA performed during the week and weekend, the t-test for dependent measures was employed. Existence of data normal distribution and equality of variances was confirmed by means of the Kolmogorov-Smirnov and Levene's tests, respectively, according to recommendations in the literature[23,24]. Statistical analyses were run with the aid of software SPSS, version 22, and the significance level was set at 5%.

Results

Physical Activity Level

Table 1 displays mean values for accelerometer use and PA on weekdays and weekends.

Table 1. Mean values for accelerometer use and PA on weekdays and weekends

	Girls (n=72)	Boys (n=104)	ANOVA*
	Mean (SD)	Mean (SD)	
Total accelerometer wear time (min.)			
Weekdays	711.6 (69.3)	720.6 (70.8)	F(1.174)= 0.704, p=0.403
Weekend	680.1 (92.2)	701.7 (93.5)	F(1.174)= 2.279, p=0.133
t-test**	t(71) = 2.534, p=0.013	t(103)= 2.054, p=0.043	
Total physical activity (TPA, minutes)			
Weekdays	204.0 (44.0)	222.5 (41.8)	F(1.174)= 8.060, p=0.005
Weekend	209.3 (49.3)	227.9 (65.0)	F(1.174)= 4.203, p=0.042*
t- test**	t(71) = 1.034, p=0.304	t(103)= -0.871, p=0.385	

Legend: *difference between sexes (ANOVA), **difference between weekdays and weekends (t-test for dependent measures)
Source: The authors

Boys spent more time on TPA than girls did on weekdays (222.5 min x 204 min; $p<0.01$) and on weekend days (228 min x 209 min; $p < 0.01$). For both sexes, there was no statistically significant difference between indicators of PA engagement on weekdays and weekends.

Table 2. Proportion of children who meet international guidelines on total physical activity during weekdays and weekends (≥ 180 min/day)

	Girls	Boys	General
Weekdays	54(71.1%)	86(86.0%)	140(79.5%)
Weekends	54(71.1%)	79(79.0%)	133(75.6%)

Source: The authors

Motor Competence Indicators

Table 3 displays descriptive results for absolute scores and classification percentiles for TGMD-2 overall performance and for locomotion and object control tasks. Broadly speaking, boys were better at object control tasks, and classification percentiles decreased with older age groups.

Table 3. Mean (SD) of MC indicators (TGMD-2) by sex and age group

	Age group	Girls	N	Boys	N	Anova*
Total score (TGMD-2 (0-96)	3 years old	34.7 (9.4)	11	41.7 (11.3)	14	F(1.23)=2.703, p=0.114
	4 years old	43.5 (11.9)	60	49.6 (11.9)	83	F(1.141)= 9.102, p=0.03
	5 years old	51.6 (9.7)a	61	55.7 (10.6)a	84	F(1.143)=5.732, p=0.018
	6 years old	56.4 (8.6)	36	62.2 (10.3)a	38	F(1.72)=6.905, p=0.010
	Total	48.6 (11.9)	168	53.6 (12.3)	219	F(1.385)=16.028, p=0.000
Locomotion scores (0-48)	3 years old	21.8 (6.7)	11	22.4 (6.8)	14	F(1.23)=0.040, p=0.844
	4 years old	26.2 (7.3)	60	27.9 (7.1)a	83	F(1.141)= 2.039, p=0.156
	5 years old	31.3 (5.6)a	61	30.7 (5.6)a	84	F(1.143)=0.444, p=0.506
	6 years old	33.1 (5.1)	36	34.1 (5.7)a	38	F(1.72)=0.587, p=0.446
	Total	29.2 (7.1)	168	29.7 (6.9)	219	F(1.385)=404, p=0.525
Object control scores (0-48)	3 years old	12.9 (4.2)	11	19.4 (6.2)	14	F(1.23)=8.687, p=0.007
	4 years old	17.3 (6.7)	60	21.7 (6.7)	83	F(1.141)=14.817, p=0.000
	5 years old	20.3 (5.9)a	61	25.0 (6.8)a	84	F(1.143)=19.401, p=0.000
	6 years old	23.3 (5.5)	36	28.2 (6.6)	38	F(1.72)=11.453, p=0.001
	Total	19.4 (6.6)	168	23.9 (7.1)	219	F(1.385)=41.114, p=0.000
TGMD-2 Overall Percentile	3 years old	34.1 (21.4)	11	45.7 (25.5)	14	F(1.23)=1.474, p=0.237
	4 years old	32.5 (24.4)	60	41.1 (24.8)	83	F(1.141)= 4.562, p=0.034
	5 years old	27.7 (23.0)	61	28.8 (20.7)a	84	F(1.143)=0.079, p=0.779
	6 years old	19.8 (17.7)	36	26.3 (21.9)	38	F(1.72)=1.971, p=0.165
	Total	28.1 (22.8)	168	34.2 (23.8)	219	F(1.385)=6.420, p=0.012
Locomotion percentile	3 years old	45.4 (24.3)	11	48.6 (24.8)	14	F(1.23)=0.105, p=0.749
	4 years old	43.4 (24.9)	60	50.5 (24.9)	83	F(1.141)=2.836, p=0.094
	5 years old	41.1 (21.4)	61	38.2 (20.2)a	84	F(1.143)=0.703, p=0.403
	6 years old	29.3 (17.9)	36	36.4 (23.4)	38	F(1.72)=2,183, p=0.144
	Total	39.7 (22.7)	168	43.2 (23.6)	219	F(1.385)=2.218, p=0.137
Object control percentiles	3 years old	28.2 (16.8)	11	43.8 (23.7)	14	F(1.23)=3.403, p=0.078
	4 years old	28.3 (22.7)	60	35.1 (21.9)	83	F(1.141)= 3.235, p=0.074
	5 years old	23.00 (22.6)	61	26.5 (21.4)	84	F(1.143)=0.892, p=0.347
	6 years old	20.2 (18.9)	36	23.7 (19.5)	38	F(1.72)=0.620, p=0.433
	Total	24.6 (21.6)	168	30.4 (22.0)	219	F(1.385)=6.531, p=0.011

Legend: *difference between sexes (ANOVA). a: Bonferroni's post-hoc (p<0.005), considering the same sex and previous age group
Source: The authors

Association between Physical Activity Engagement and Motor Competence Indicators

Table 4 displays correlations between MC and PA engagement indicators for girls and boys. Among girls, no statistically significant correlation was found and, among boys, there were low correlation values (between 0.2 and 0.3) between locomotion skills and PA performed during the week.

Table 4. Pearson's correlation coefficient between motor competence and physical activity engagement indicators by sex

	MVPA-(W)	MVPA-(WE)	TPA-(W)	TPA-(WE)
Girls				
Total score (TGMD-2)	0.08	-0.07	-0.05	-0.16
Locomotion scores (TGMD-2)	0.06	-0.02	0.01	-0.11
Object control scores (TGMD-2)	0.07	-0.1	-0.1	-0.17
TGMD-2 Overall Percentile	0.04	0.02	-0.04	-0.10
Locomotion Percentile	0.04	0.11	0.05	0.10
Object Control Percentile	0.03	-0.06	-0.08	-0.247
Boys				
Total score (TGMD-2)	0.18	0.03	0.09	-0.04
Locomotion scores (TGMD-2)	0.261*	0.11	0.203*	0.05
Object control scores (TGMD-2)	0.06	-0.05	-0.04	-0.12
TGMD Overall Percentile	0.12	-0.01	0.12	-0.02
Locomotion Percentile	0.202*	0.05	0.229	0.06
Object Control Percentile	0.06	-0.06	0.03	-0.08

Legend: * $p<0.05$; W - weekdays; WE = weekend days
Source: The authors

Table 5 displays the distribution of children who meet international guidelines on TPA during weekdays and weekends, within each MC classification (low, normal and high). Among girls, 58% and 63% of children with low MC meet world guidelines on TPA during weekdays and weekend days, respectively. Among boys, 79% and 71% of those who meet the guidelines, respectively on weekdays and weekends, present low MC. For both sexes, no association was found between MC and compliance with TPA recommendations ($\chi 2 > 0.05$).

Table 5. TGMD-2 classification and number (percentage) of children who meet international guidelines on total physical activity.

Sex	TPA guidelines (≥ 180 min/day)	Low MC Percentile ≤15	Normal MC Percentile >15 and ≤50	High MC Percentile >50	χ^2 (p- value)
Girls	Weekdays	14 (58.3%)	35 (77.8%)	5 (71.4%)	0.237
	Weekend	15 (62.5%)	34 (75.6%)	5 (71.4%)	0.523
Boys	Weekdays	19 (79.2%)	44 (86.3%)	23 (92%)	0.431
	Weekend	17 (70.8%)	42 (82.4%)	20 (80%)	0.515

Source: The authors

Discussion

This research aimed to verify the amount and intensity of PA performed during weekdays and weekends and to verify associations with MC. The hypothesis that these children would tend to present low PA indexes was not confirmed, although girls presented lower PA indexes compared to boys. Girls also obtained lower MC indexes, particularly in object control skills. Overall, statistically significant values were observed, but with low correlation (r = 0.2 to 0.3) between PA engagement and MC. Boys spent more time on TPA and MVPA than girls did, which corroborates the trend observed in other studies that measured physical activity directly and reported boys' superiority over girls[25] in this sense. Moreover, results showed that, for both sexes, there was no statistically significant difference between weekdays and weekends comparing TPA time. These results diverge from those of other researches that report higher PA engagement indexes on weekdays for both sexes[26,27]; these studies, however, included European, USA, Canadian and Australian children, reinforcing the perspective that socio-cultural factors can determine opportunities for PA

engagement. Possibly, among the children of the present study, the available offer of PA is not very different on weekdays and weekends. The main hypothesis that may explain this phenomenon is the socioeconomic factor, which puts children and adolescents in disadvantage when it comes to participation in some forms of PA, especially at clubs, sports centers and in the school environment itself[28]. Another relevant factor that may have contributed to the present results is issues concerning lack of public security, which limits PA in public spaces[29].

As for the proportion of children who meet international guidelines on TPA, boys had a significantly higher proportion in relation to girls during weekdays. On the weekend, though, the proportion was similar. Concerning MC, there was a statistically significant superiority of boys, especially as to object control skills, indicating a cultural influence on engagement in playful activities involving ball control. Altogether, and based on the social vulnerability maps of the city of São Paulo, the results of the present research suggest that children who live in situation of social vulnerability, especially girls, have limited opportunities to exercise and develop a good MC.

Several studies report the existence of positive correlations between PA engagement and MC[30-33], but with weak and/or moderate correlation coefficient values. In this research, the low and/or non-significant values for association between PA engagement and MC suggest that the quality of the PA performed is not being sufficient to promote MC development. Reinforcing this statement, no association was found, for both sexes, between MC level and compliance with international guidelines on TPA for preschoolers. We believe that this low correlation is due to the fact that the children participating in the research have no access to physical activities aimed at developing their motor skills. The results found in this study allow stating that PA quantitative aspects do not necessarily promote MC development. For these children's MC development and for them to reach satisfactory levels, they need to engage in a quality physical activity that has specific objectives, with the purpose of developing their MC.

Furthermore, it is important that future public policies in the PA and health field foster MC development during childhood, considering that this development has been associated with continuation of PA engagement and better physical fitness later in life[34].

The present investigation has some limitations worth mentioning. In view of the relative homogeneity of this sample concerning its socioeconomic stratum and region of residence, the generalization of results to other populations is not adequate (e.g., children of low socioeconomic level residing in small cities). Other important limitations were the use of cross-sectional data and lack of control over opportunities and type/quality of PA, requiring further researches that check these factors, as well as the longitudinal effects of observed results.

Conclusions

The data of this research show that most of the children living in an area of social vulnerability in São Paulo's eastern region meet international guidelines on PA but present low MC level. The absence of information on PA qualitative aspects limits the understanding of associations with MC. Still, the number of children that stood below the minimal criteria recommended for TPA is worrisome. Just as in other countries, these pieces of data reinforce the need to develop actions that stimulate and provide support to PA engagement. Girls presented lower PA and MC indexes, and the associations between these variables were weak or insignificant for both sexes. These data suggest a need to revise PA guidelines, currently focused on quantitative aspects that do not necessarily favor MC development. Besides, the

results found reinforce the importance of designing public policies aimed at the population's reality, with special attention to girls and PA quality, mainly during childhood.

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