

Physical Activity Patterns in Mexican School-Aged Children

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Abstract

Aims: To describe physical activity patterns, and explore the associations of physical activity with demographic and anthropometric characteristics in Mexican children.

Relevance: Knowledge of physical activity patterns in school-age children may offer ways in ameliorating early childhood obesity in Mexico.

Methods: Physical activity by accelerometry was measured in 358 children aged 7 to 11 years attending 24 Mexico City schools. Anthropometric measurements (height, weight, hip and waist circumferences, and triceps skinfold) were also done.

Results: Only 31% of the girls and 51% of the boys achieved the minimum of one hour per day recommended by WHO of moderate to vigorous physical activity (MVPA). This deficit was less critical for Friday and Weekends, a finding that we believe obeyed to the lack of school homework that leaves them with more playtime. We also observed that activity decreased with age and school grade, starting in the third grade, and that physical activity was higher in girls with a high hip-waist ratio.

Limitations: We were able to recruit a very low proportion of schools (24 of more than 400 invited).

Conclusions: The children in our study were mostly sedentary, this deficit of physical activity was less critical for Fridays and Weekends.

Keywords: Physical activity patterns; School homework; School grade; Mexico

Introduction

The prevalence of excessive weight among children is increasing in both developed and developing countries and has reached epidemic proportions in our country. In Mexico, according to the National Health and Nutrition Survey 2012 [1], obesity affects 17.4% and 11.8% of school-aged boys and girls, respectively. Systematic reviews have identified a wide range of comorbidities of childhood obesity, both in the short term, for the obese child, and the long term, for the adult obese as a child [2-4].

Physical activity is an essential component for preventing early childhood obesity, as it promotes total weight and fat mass loss [5]. Sedentarism has been acknowledged as a risk factor for obesity [5] and research studies have shown that preschool age children do not regularly engage in the recommended 60 minutes of moderate to vigorous physical activity (MVPA) each day [6] and furthermore, there are reports that as children approach adolescence, their physical activity decreases [7-9] with a substantial amount of weight gain and more access to electronic devices that replace outdoor activities.

According to Héroux et al. [7] aerobic fitness relates to the ability to perform physical activity and is negatively associated with body composition data, i.e., Mexican schoolers had a significantly higher BMI than those from Kenya (19.8 vs. 16.2 kg/m²) whereas Kenyans had a significantly higher aerobic fitness (VO_{2max} = 50.2 vs. 47.1 mL/kg/min) [7]. These authors state that the decline of aerobic fitness over the past decades is due to the rise in childhood obesity and an increase in inactive lifestyles as well as a decrease in time, frequency, intensity or type of physical activity performed. The sedentary behavior has benefited by the emergence of electronic media in the lives of children, that influence energy balance in a negative way [10]. In this regard, most children over 6 years old, report more than 4 hours just for TV

watching, that increases as they grow older [9]. A sedentary behavior lasting more than two hours per day is associated with unfavorable body composition, lower self-esteem scores, and less social behavior.

Besides age, children's gender has been consistently shown to be associated with their physical activity, i.e., boys score higher than girls in sedentary-snacking and sedentary-food intake, and in screen time activities such as TV and videogames [9], but they are more likely to have sport-healthy eating patterns, and higher values of the ratio high activity/sedentary activity. On the other hand, girls show higher scores in healthy intake patterns, but are less likely to be involved in sports groups, and more prone to computer use than boys. In some studies, the association of sedentary behavior and body mass index (BMI) has been stronger in girls [8,9]. Socio-economic status is also an important determinant in these behaviors, i.e., children of low socio-economic status have a higher risk for less healthy lifestyle, probably because they are less involved in club sports and have less access to sporting facilities [10,11].

The aims of the present study were: 1) to describe physical activity patterns in 358 school-aged Mexican children and 2) to explore the

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associations of physical activity to anthropometric and demographic characteristics in this population.

Material and Methods

Subjects

In this cross-sectional study, anthropometric (height, body weight, hip and waist circumferences, and triceps skinfold) and physical activity were collected from 358 children aged 7-11 years from tuition and non-tuition primary schools in Mexico City. Schools were invited to participate by telephone: More than 400 schools were invited but only 24 accepted; 10 tuition and 14 non-tuition schools. A meeting with the children in the 2nd to 5th grades and their parents was held in each school to present the objectives of the study. The parents of those agreeing to participate signed a letter of consent, and the children signed a letter of acceptance. They were given a phone number to contact us in case of any doubt on the accelerometry. The anthropometric measurements were made at the schools and the children were under no restrictions for physical activity when studied.

The study was approved by the Research, Ethics and Biosecurity Committees of the Instituto Nacional de Medicina Genómica (INMEGEN) located in Mexico City.

Measurements

Physical activity

The children were asked to wear an accelerometer (Actigraph GT3X) over their right hip tied with an elastic belt. The Actigraph has been validated to measure physical activity in children [12,13]. Trained staff members instructed the children on the use of the accelerometers and provided detailed verbal and written instructions on when and how to wear the accelerometers over a period of one week. They were asked to remove the monitor only for sleeping, bathing, or swimming. The accelerometers were programmed to collect 5 second-epochs and then reintegrated to 60 seconds for the analysis (counts per minute=cpm-) using the Meterplus software (SanTech, San Diego, CA, USA). A valid day was defined as having 10 or more hours of wear time. Non-wear time was defined as at least 60 consecutive minutes of zero counts, with allowance for two minutes of <100 cpm. Every minute of wear time was classified according to the cut-off points proposed by Evenson and

Gill [14] for children, i.e., Sedentary= ≤ 100 cpm; Light=101-2,295; Moderate=2,296-4,011; and Vigorous= ≥ 4,012. The total number of minutes per day was the sum of the number of minutes for each of the four levels of activity. The final data of analysis were the Total, Sedentary, Light, Moderate, Vigorous and the sum of the moderate and rigorous activity (MVPA). Participants with at least four valid days (three weekdays and one weekend day) were included in the analysis.

Anthropometry

Height, body weight, hip and waist circumferences, and triceps skinfold using the methods described by Lohman et al. [15] were measured in duplicate by trained personnel using portable calibrated equipment, and the average of the two measurements was used as final value. Standing height was measured without shoes using a SECA portable stadiometer. Body weight was assessed using a SECA electronic scale, with participants wearing only school pants and a shirt. Triceps skinfold was measured with a Lange skinfold caliper. Waist circumference was measured at the level of the umbilicus with the subject supine. Waist-to-hip ratio (WHR) was calculated.

Statistical analysis

A Student t test was used to evaluate group differences in mean values of Tables 1, 2 and 3, and a stepwise multivariable analysis was done for the data of Table 4. An SPSS statistical package version 21 was used to perform the analysis.

Results

Effect of gender on physical activity and anthropometry in the 358 children

Table 1 shows data by gender and globally. There was no gender difference for total time of activity but there were differences for the four categories of activity: boys had shorter time of sedentary (Sed) activity than girls and longer times for light (Lig), moderate (Mod) and vigorous (Vig) activities. In addition, there was a negative gradient of time of activity with intensity so that time of activity decreased with increasing intensity going from Sed → Lig → Mod → Vig, and in contrast, there was a positive gradient of variability with intensity, i.e., the coefficient of variation (CV) went from 6% in Total time to 50% in vigorous time.

None of the anthropometric variables nor age had gender differences but an interesting observation was the low variability of height (CV=6%) versus that of weight (CV=27%), suggesting that weight problems were already present in the participants in this study.

Physical Activity and day of the week

Table 2 shows the data of the categories of PA as a function of day of the week. Friday, Saturday and Sunday are at the top of Table 2 as they were the only days that showed significant differences between themselves and/or with Monday to Thursday. Friday was clearly different from the rest of days as it had significantly longer times for Total, Lig, Mod and Vig activities than nearly all other days (exception Sunday in Mod and Vig activities). These Friday differences hold in the subset of children who have a Friday in their PA measurements. In contrast, Monday to Thursday never differed between them and grouped them as Weekday. Saturday and Sunday had the shortest Total time but this was due to a decrease in sedentary activities and there was a tendency of more Lig or Mod activities on weekends than on weekdays. In the multiple regression analysis we used a three category classification for day of the week (Friday/Weekend/Weekday).

Variable	Global		Masculine	Feminine	Differences **
	N=358	CV	N=156	N=202	
MVPA	54.8 ± 19.2	35%	62.3 ± 20.4	49.0 ± 16.1	<0.0005 M>F
Vigorous	19.1 ± 9.6	50%	21.9 ± 10.9	16.9 ± 7.7	<0.0005 M>F
Moderate	35.7 ± 11.4	32%	40.4 ± 11.7	32.1 ± 9.9	<0.0005 M>F
Light	207.0 ± 34.1	16%	217.2 ± 35.6	199.2 ± 30.8	<0.0005 M>F
Sedentary	540.2 ± 59.0	11%	526.7 ± 61.7	550.6 ± 54.8	<0.0005 F>M
Total	802.0 ± 52.0	6%	806.2 ± 51.6	798.8 ± 52.1	NS 0.18
Age (yrs)	9.6 ± 0.8	8%	9.6 ± 0.8	9.6 ± 0.8	NS 0.89
Weight (kg)	35.9 ± 9.7	27%	36.6 ± 10.0	35.4 ± 9.4	NS 0.26
Height (cm)	136.2 ± 7.5	6%	136.0 ± 7.0	136.3 ± 7.9	NS 0.69
HWR	0.89 ± 0.06	7%	0.90 ± 0.06	0.89 ± 0.06	NS 0.13
Waist (cm)	68.5 ± 11.1	16%	69.3 ± 12.0	67.9 ± 10.3	NS 0.25
Hip (cm)	76.6 ± 8.9	12%	76.8 ± 9.2	76.4 ± 8.7	NS 0.66
TSF (mm)	16.5 ± 6.3	38%	16.2 ± 6.8	16.8 ± 6.0	NS 0.33

Physical activity data are mean of means of 2,049 days in 358 children.

*CV= Coefficient of Variation. MVPA= Moderate+Vigorous PA.

HWR= Hip/Waist Ratio. TSF= Tricipital Skinfold.

**Gender differences: NS= non-significant (Sig>0.05).

Table 1: Mean ± SD and gender differences in Physical Activity (minutes/ day) and in anthropometric data*

Day of week	N	Physical Activity in minutes/day (Mean ± SD)				
		Total	Sedentary	Light	Moderate	Vigorous
Friday	318	832 ± 104 ^a	556 ± 99	217 ± 52 ^a	38 ± 16 ^b	21 ± 14 ^b
Saturday	306	783 ± 104 ^c	521 ± 97 ^c	209 ± 51 ^d	36 ± 18	18 ± 13
Sunday	263	755 ± 108 ^e	494 ± 98 ^c	205 ± 49	37 ± 19 ^e	19 ± 15
Monday	302	809 ± 99	556 ± 97	201 ± 46	34 ± 14	18 ± 12
Tuesday	275	814 ± 98	552 ± 95	207 ± 47	36 ± 16	18 ± 12
Wednesday	276	818 ± 100	559 ± 99	206 ± 47	34 ± 15	19 ± 13
Thursday	309	815 ± 99	552 ± 91	208 ± 44	35 ± 14	19 ± 12
Global	2049	805 ± 104	542 ± 99	208 ± 48	36 ± 16	19 ± 13

a=Longer than the rest. b=Longer than the rest except Sunday. c=Shorter than Monday to Friday.

d=Longer than Monday. e=Longer than Monday & Wednesday.

Table 2: Physical activity differences in the four categories of activity according to day of the week in the 2,049 measurements.

Variable	Category	N	Physical Activity in minutes/day (Mean ± SD)				
			Total	Sedentary	Light	Moderate	Vigorous
School type	Non Tuition	1284	799 ± 104	533 ± 100	209 ± 48	38 ± 17	19 ± 13
	Tuition	765	814 ± 105	558 ± 96	206 ± 49	32 ± 14	18 ± 12
Age (yrs)	7-8	505	802 ± 101	515 ± 95	225 ± 53	40 ± 17	22 ± 15
	9	892	803 ± 104	544 ± 97	206 ± 46	35 ± 16	18 ± 12
	10-11	652	809 ± 106	561 ± 100	197 ± 43	33 ± 15	18 ± 13
School Grade	2 nd	119	801 ± 102	518 ± 87	223 ± 55	39 ± 16	22 ± 12
	3 ^d	535	802 ± 104	523 ± 96	222 ± 49	38 ± 17	20 ± 13
	4 th	992	805 ± 103	548 ± 100	204 ± 47	35 ± 16	18 ± 13
	5 th	403	806 ± 108	561 ± 98	192 ± 43	34 ± 15	19 ± 13

Total=Significant difference only in School Type (Tuition > Non Tuition).

Sedentary=All significantly different from all others except Grade 2nd vs 3d.

Light=All significantly different from all others except School Tuition vs Non Tuition & Grade 2nd vs 3d.

Moderate=All significantly different from all others except Grade 2nd vs 3d.

Vigorous=All significantly different from all others except Grade 2nd vs 3d.

Age categories were pooled due to low number of children of 7 and 11 years of age.

Table 3: Physical Activity (min/ day) differences according to type of school, age and school grade in the 2,049 measurement.

Physical activity and school, age and grade

Table 3 shows the differences between two categories of schools, three categories of age and four of grade. It should be noted that the differences in the footnote of Table 3 refer to differences evaluated vertically in the same column so that each category is compared with all other categories of the same variable, i.e., comparisons are made for all grade combinations (Grade 2 vs. 3, 4 and 5, Grade 3 vs. 4 and 5, Grade 4 vs. 5).

Table 3 can be summarized by stating that age, grade and type of school were associated with activity but that these associations were not the same for sedentary activity than for the other categories, i.e., there was a positive gradient in sedentary activity (increased vertically from first to last category of each variable) and a negative gradient in the other three categories (decreased vertically from first to last category of each variable). These outcomes suggest that sedentarism tends to increase and the other activities to decrease, as age and grade increase (3^d grade on). The children of tuition schools showed a similar pattern as they were more sedentary and had less Moderate and Vigorous physical activity than children of non-tuition schools.

Multivariate analysis of categories of activity

We used a stepwise multivariable analysis using eight independent variables (3 categorical and 5 continuous) for each of five PA categories as the dependent variable. Thus, there were a total of 10 regression models as the analysis were done separately for boys and girls in view of

the gender differences shown in Table 1. To facilitate the presentation of the multivariate analysis we show in Table 4 the sign of the regression coefficients of only the variables that were significantly associated with activity in each model (the sign of variables not significantly associated were omitted in the table).

The sign enables to evaluate how the eight independent variables affected the times of activity in the 10 models, i.e., a positive sign in a continuous variable means activity increased as the variable increased, and a negative sign, the opposite. The results of the 10 models of regression confirmed most of the information seen in the univariate analysis of Tables 2 and 3, i.e., in the categorical variables, there were positive signs in most of the coefficients of the Light to Vigorous categories confirming a tendency to increased activity on Friday and Weekends, and that these activities were higher in Non-tuition than Tuition schools. An interesting observation was that sedentarism behaved differently according to gender in Non-Tuition schools, i.e., it decreased in boys but increased in girls.

In regard to the continuous variables, two of them (age, skinfold) showed negative coefficients for the Mod, Vig and MVPA categories. This negativity confirms that activity tends to decrease as age and skinfold increase. School grade was also negatively associated in boys but not in girls, suggesting that girls may be more conscious of their body weight than boys in these first years of schooling. The pattern of the WHR in the model show positive coefficients for girls and negative for boys in the Vig and MVPA activities, suggesting that an enlarged waist (more than overweight) may stimulate a girl to perform more intensive activities whereas the opposite occurred in boys.

Discussion

Very few schools, less than 3%, were willing to participate in our study. Nevertheless we consider it is important to report our results as the participating schools were probably those more willing to improve their physical activity programs so that the deficits in these 24 schools would be expected to be worse in the schools that refused to participate. Our failure to recruit the more than 400 schools invited to participate, leads us to think that a sizable proportion of them were not following the 2010 recommendation of the Mexican Federal Ministry of Education to increase school time allotted for physical activity [16]. In this regard, The Center for Control and Prevention of Disease (CDC) [17,18] and

Variable	Physical Activity categories									
	Sedentary		Light		Moderate		Vigorous		Mod+Vig	
	Masc	Fem	Masc	Fem	Masc	Fem	Masc	Fem	Masc	Fem
Categorical Variables										
F vs WD	—	—	—	Pos	Pos	Pos	—	Pos	Pos	Pos
We vs WD	Neg	Neg	Pos	Pos	—	—	—	Pos	—	Pos
School	Neg	Pos	—	—	Pos	Pos	—	—	Pos	Pos
Continuous Variables										
Age	Pos	—	Neg	—	Neg	Neg	Neg	Neg	Neg	Neg
TSF	—	—	—	—	Neg	Neg	Neg	Neg	Neg	Neg
Grade	Pos	Neg	—	Pos	Neg	—	Neg	—	Neg	—
WHR	—	—	Pos	—	—	Pos	Neg	Pos	Neg	Pos

Interpretation of signs. F vs. WD. Pos=Friday>Weekday.

WE vs. WD. Neg=Weekday>Weekend. Pos=Weekend>Weekday.

School. Neg=Tuition>Non-Tuition. Pos=Non-Tuition>Tuition.

Continuous variables. Pos=activity increases as variable increases. Neg=activity decreases as variable increases.

Note: The analysis were done separately for boys and girls. The signs of the coefficients not entering the regression models are omitted.

Table 4: Positive (Pos) and negative (Neg) signs of the regression coefficients of the variables significantly associated with the activity categories (P<0.05).

the American College of Sport Medicine [19] recommend that children should have at least one hour of moderate physical activity per day; and suggested that schools could play an important role to meet this recommendation. Other organizations such as the National Institute of Health [20], the U.S. Surgeon General [21], the U.S. Heart Association [20], and the World Health Organization [22], among others, follow this recommendation. In our study only 31% of the girls and 51% of the boys achieved the one hour per day recommendation. This deficit was less critical for Friday and Weekends, a finding that we believe obeyed to a lack of school homework that left them with more playtime. We were unable to find accelerometric measurements in Mexican children and the little available information reported by ENSANUT 2012 was obtained with a method that overestimates physical activity.

Another factor leading to increased sedentarism is video playing. It has been documented that as children grow, electronic entertainment displaces body movements [9,23-27]. The growing child becomes skilled in the use of computers and videogames until he is fully integrated in the electronic world [9,28]. In our study we observed that activity decreased with age. On the other hand, according to Drenowats et al. [11], this electronic integration occurs more frequently in children belonging to a high socioeconomic condition, as it occurred in our children from tuition schools that were more sedentary than those from non-tuition schools. This difference was not seen in our girls from tuition schools perhaps because they are less fascinated than boys by videogames [23].

Another interesting observation in our study was that activity decreased with school grade starting in the third grade. Beiusanu et al. [29] observe that children 7 to 10 years of age spend 2 to 3 hours doing their homework and that this time increases with school grade, and in addition, half of them take breaks while performing their homework, and the other half watch television or play videogames during breaks so that it all becomes a sedentary activity. Rutten et al. [30] have documented that the transition from elementary to secondary school leads to significantly more sedentarism especially in girls, as they spend up to three hours daily in their homework.

The problem of the interference of school homework with activity [29] is harder to overcome. In this regard, we have identified in Mexico a teaching system, developed by Célestin Freinet, that promotes afternoons free of homework dedicated to recreational activities. One of us (JP) visited four years a Freinet school and was impressed by its low prevalence of children obesity. But very few schools have adopted this scheme in our country.

Finally, in regard to the association between the Vigorous and MVPA activities and the WHR index in our study, with opposite tendencies for boys (negative associations) and girls (positive associations), suggest that girls may be more conscious of their body weight than boys in these first years of schooling [8,31] and that an enlarged waist may stimulate girls to perform more intensive activities whereas fat boys would tend to participate less in physical activities.

A regular practice of physical activity during the first decade of life is necessary to obtain an adequate growth and development, and adults should stimulate physically active practices in children and adolescents. When successful, it becomes a valuable legacy to the future adult. Schools offer an opportunity to increase physical activity in children and adolescents. Scholars are creative and should be included in finding new ways to generate playful activities in addition to those of the physical activity school programs.

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