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Full Length Research Paper

Physical activity in Mexican urban school children: Differences by nutritional status and school type

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Childhood obesity and physical inactivity are the major risk factors for morbidity and premature mortality. This study aimed to determine the practice of physical activity (PA) and physical inactivity, physical fitness and self-efficacy for PA in Mexican urban schoolchildren and their relationship by nutritional status and school type. A cross-sectional study was carried out in 396 schoolchildren, their weight, height and waist circumference were evaluated. A six-minute walk test (6MWT), practice of PA and physical inactivity questionnaire (CAINM), and Self-Efficacy Questionnaire for PA (SQPA), were applied. The frequency of overweight and obesity was high both public school (45%) and private (51%). We found significant differences in the type of PA by private school students (running, cycling and playing soccer) compared to public school students (swimming, dancing and playing tennis). In boys the average screen time (TV, movies and video games) was higher (3.6 ± 2.1 h) than in girls (2.7 ± 1.6 h) ($p<0.01$). The students registered more than 50% of negative responses regarding the self-efficacy to perform PA in SQPA. The total distance traveled in 6MWT was higher in schoolchildren without abdominal obesity than with abdominal obesity, both for private (548.7 ± 70.8 m vs 526.1 ± 54.3) and public schools (541.4 ± 67vs 509.3 ± 51.5) ($p<0.05$). In addition to a high prevalence of overweight and obesity in urban Mexican schoolchildren, evidence was found that students did not comply with the recommendation to spend less than two hours of screen time. The students presented low self-efficacy for physical activity, and abdominal obesity is conditioning to lower physical fitness.

Keywords: Physical inactivity, childhood obesity, self-efficacy, schoolchildren.

INTRODUCTION

The childhood obesity is a global public health problem; more than 40 million children under the age of five are overweight or obese in the world (World Health Organization, 2016). Mexico ranks fourth in the world in prevalence of overweight and childhood obesity, affecting three out of ten school students (Barquera et al., 2010).

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The State of Hidalgo is located in the central-eastern region of Mexico, 29 of its 84 municipalities belong to the Metropolitan Area of Mexico City, with more than one million inhabitants (Tovar, 2011). The data available for the State of Hidalgo indicate a prevalence of overweight or obesity of 30.4% in students, with urban municipalities being more affected (35.4%) than rural ones (23.2%); ranking in different stages of nutritional transition depending on the changes in the patterns of food consumption and physical activity (PA) (Galván et al., 2011).

The good PA practices contribute to maintaining an adequate body composition, improving bone density, lipid profile, and preventing cardiovascular diseases (Manonelles et al., 2008) while physical inactivity is a risk factor for the development of obesity, heart disease, insulin resistance, musculoskeletal disorders and its complications (Varo et al., 2003; World Health Organization, 2016). For school children and teenagers it has been recommended to perform moderately-vigorous intensity PA with a minimum duration of 60 minutes a day and a maximum limit of two hours of screen time, such as watching television or playing video games (World Health Organization, 2010). There are objective methods available, such as heart rate monitoring, use of motion sensors and doubly-labeled water to assess PA; and subjective methods, such as self-report through interviews, questionnaires or journals; both procedures have advantages and disadvantages, the PA purpose should be assessed to select the most appropriate instrument (Rodríguez and Terrados, 2006).

Objective

This study aimed to determine the practice of physical activity and physical inactivity, physical fitness and self-efficacy for physical activity in Mexican urban schoolchildren, and their relationship by school type and nutritional status

MATERIALS AND METHODS

Analytical cross-sectional study of students from two public and two private schools of urban municipalities in the state of Hidalgo, Mexico. The reference population of this study consisted of a conglomeration of 15 private and public schools, located in urban locations (>2500 inhabitants) that had a population ≥300 students per school belonging to five municipalities of Hidalgo, Mexico, who in previous studies registered a prevalence ≥40% of overweight or obesity (Galván et al., 2011). After that, four schools were randomly selected and the total number of students enrolled in the third and fourth years of elementary school in the 2014-2015 school year (n=435) was included. The power of the sample was enough to find a significant correlation r=0.15 ($p < 0.005$) between BMIZ and the hours of physical inactivity. We included students who agreed to participate in the study, and who did not have any physical impediments to perform the assessments of PA.

Evaluation Instruments

Anthropometric measurements of weight, height and waist circumference (WC) were performed with trained personnel and standardized techniques according to international quality control recommendations in the collection of anthropometric data (Lohmann et al., 1988). Weight in school children was measured with a SECA® scale model 813 (Seca Corp., Germany); height was measured with a SECA® stadiometer model 213 (Seca Corp., Germany); and to measure CC, a SECA® tape, model 201 (Seca Corp., Germany) was used. Weight and height data were entered and validated and processed using the Anthro Plus program to calculate Z-scores of body mass index according to age (BMIZ) and height for age (HAZ) (World Health Organization, 2011). Students with values <-2 BMIZ were classified as underweight, with values ≥ -2 to 1 BMIZ as normal, overweight from 1 to 2 BMIZ and obese with values >2 BMIZ; students with values <-2 ZHA were classified as low height, with values -2 to 2ZHA as normal height and high height with values >2 ZHA; abdominal obesity was determined when CC was >90th percentile for age and gender (Fernández et al., 2004). Fifteen students who did not have complete PA evaluations were removed from the analysis; 19 who had implausible values of BMIZ (<-5.0 and / or>5.0) and /or HAZ (<-6.0 and >6.0); 3 cases with low height and 2 underweight.

A Six-Minute Walk Test (6MWT) was applied to students by walking a circuit as fast as possible without running for 6 minutes. The starting heart rate (SHR) was measured by the number of radial pulsations per minute with a resting period of 3 minutes prior to initiating the 6MWT; for the exertion heart rate (EHR) a post-test evaluation was performed, 15 seconds after completion, and one minute later to determine the recovery heart rate (RHR), following the protocol of the American Thoracic Society (2002); the total distance traveled in meters (TDT) was obtained and the delta heart rate (ΔHR) was calculated by the difference of the EHR and the RHR.

The practice of physical activity and physical inactivity were assessed with the activity and physical inactivity questionnaire for Mexican students (CAINM) (Hernández et al., 2000). The practice of physical activity, such as household chores, walking, running, etc. were considered if they were performed with a minimum duration of 30 minutes for each activity, taking the Ainsworth compendium as reference (Ainsworth et al., 2000). Daily averages of physical inactivity of screen time hours of watching TV, movies and playing video games, hours

using transportation, time spent reading or doing homework, and the time at which children go to sleep and wake up were measured, both on weekdays and on weekends (Gortmaker et al., 1999).

The students' perception of their ability to perform physical activity was evaluated with the Self-Efficacy Questionnaire for Physical Activity for Children (SQPA) (Aedo and Ávila, 2009), formed by 12 items with dichotomous reply that evaluates three factors; Factor I. Search for positive alternatives towards physical activity (items 1,8 and 12); Factor II: Ability to face possible barriers to perform physical activity (items 2, 5, 6, 7 and 10); and Factor III: Expectations of ability or competition (items 8 and 11).

Data analysis strategy

An exploratory analysis was performed and the distribution of the data was verified by the Kolmogorov-Smirnov test. Results were compared with proportions, averages, standard deviation (SD) and confidence intervals (CI) of 95% of the evaluated variables, by gender, school type and nutritional status; making comparisons between groups with Mann-Whitney and Chi-square test. Correlation (Pearson) between physical inactivity hours and nutritional status indicators was evaluated. Significant differences were considered from a p value <0.05, all statistical analyzes were performed using the Stata 14 software.

Ethical considerations

This research was approved by the Ethics Committee of the Health Sciences Institute of the Universidad Autónoma del Estado de Hidalgo, which is governed by principles of medical research in humans (Declaration of Helsinki). In all cases there is an informed consent signed by the parent or guardian and the child's assent was requested to make the assessments.

RESULTS

We report information from 396 school children, of whom 53% were male and 47% female, with a mean age of 9.4 ± 0.6 years; 37.6% were students from public school and 62.4% from private schools. The mean height was 134.1 ± 7.3 cm, the mean weight was 34.4 ± 8.7 kg, and the mean waist circumference was 64.7 ± 8.9 cm; finding significant differences only in BMIZ among boys and girls ($p < 0.01$), and without differences by type of school (Table I).

In the 6MWT an average distance of 542.4 ± 68.2 m was recorded, with no differences between gender and type of school. Girls had higher RHR compared to boys ($p < 0.01$), and significant differences were found in SHR, EHR and RHR by school type ($p < 0.001$); without differences in ΔHR by gender or type of school (Table I).

In physical inactivity, male students reported a greater daily average of hours of screen time (3.6 ± 2.1) compared to girls (2.7 ± 1.6) ($p < 0.001$). Private school students reported a higher average of hours using some type of transportation system (1.14 ± 0.9) compared to public school students (0.88 ± 0.8) ($p < 0.001$). When estimating time spent doing homework and/or reading, differences were found between students in public schools (1.4 ± 0.6) and students in private schools (1.3 ± 0.6) ($p < 0.001$); on average, students reported sleeping 10 hours a day, with no gender differences or type of school (Table I).

The frequency of physical activity and recreation performed by students, such as running, playing soccer, basketball and tennis, have a higher frequency in boys compared to girls ($p < 0.01$); and in activities such as dancing and gymnastics, there was a higher frequency in girls ($p < 0.01$). In students from public schools, a greater frequency was found in activities such as running, cycling and playing soccer; while the frequency of activities such as swimming, dancing and playing tennis was greater in private schools, with these differences being significant in relation to public schools (Table I).

The 25% of students were overweight and 24% were obese, with 13% higher prevalence of overweight or obesity in boys than in girls ($p < 0.05$), without registering significant differences by school type. The 13% of students presented abdominal obesity, with no significant differences between boys and girls, or by type of school (Table II).

The majority of students registered more than 50% of negative responses regarding the self-efficacy to perform physical activity in the QPA; and differences were only observed in items 7 and 10, where 52% of normal-weight students (NW) answered positively "Doing physical activity even though they have a lot of homework" and 42% "Getting physical activity even though I have other classes in the afternoon" (42%), being in both cases 10 percentage points higher in comparison to overweight or obese children ($p < 0.05$). In the other items, positive and negative responses were very similar among normal-weight students with overweight or obesity (Figure 1).

The total distance traveled (TDT) in 6MWT was lower in schoolchildren with abdominal obesity in public school (509.3±51.5) and private (526.1±54.3 m), compared to those without abdominal obesity (541.4±67.5 and 548.7±70.8m, respectively) ($p<0.05$); but without detecting differences by nutritional status with BMIZ (Figure 2).

In the evaluation of the relationship between hours of physical inactivity and indicators of nutritional status, we found a low correlation of hours of screen time versus waist circumference ($r=0.13$, $p=0.01$) and with BMIZ ($r=0.13$, $p=0.01$); of hours of transportation with BMIZ ($r=0.11$, $p=0.02$) and with hours of screen time ($r=0.17$, $p<0.01$).

Table 1. Anthropometric characteristics, physical fitness, inactivity and physical activity in students by gender and type of school.

	Total (n=396)	Boys (n=211)	Girls (n=185)	P*Value	Public (n=149)	Private (n=247)	P*Value
Anthropometry							
Age (years ± DE)	9.4 ± 0.6	9.3 ± 0.5	9.4 ± 0.6	0.590	9.3 ± 0.6	9.5 ± 0.6	0.001
Height (cm ± DE)	134.1 ± 7.3	133.9 ± 6.5	134.3 ± 7.9	0.870	133.2±7.6	134.6±6.9	0.060
Weight (Kg ± DE)	34.4 ± 8.7	34.3 ± 8.0	34.3 ± 9.5	0.340	33.5 ± 8.6	33.7 ± 8.6	0.160
Waist Circumference (cm ± DE)	64.7 ± 8.9	65.0 ± 9.0	64.2 ± 8.7	0.410	64.2 ± 8.6	64.9 ± 9.0	0.580
BMI	18.9 ± 3.5	19.1 ± 3.4	18.8 ± 3.6	0.213	18.8 ± 3.5	19.0 ± 3.5	0.406
BMIZ (Score)	1.0 ±1.3	1.1 ± 1.3	0.8 ± 1.2	0.010	0.9 ± 1.3	1.0 ± 1.2	0.482
HAZ (Score)	-0.1 ± 1.0	-0.11 ± 0.9	-0.12 ± 1.1	0.73	-0.16±1.1	-0.09±0.1	0.440
Physical Fitness (6 MWT)							
Total distance traveled (m)	542.4±68.2	540.4±76.2	544.7±57.8	0.550	537.1±65.4	545.7±69.2	0.190
SHR	90.5±10.4	90.3±10.0	90.9±10.9	0.700	88.6±10.4	91.8±10.3	0.001
EHR	118.8±12.8	117.9±12.4	119.9±13.2	0.150	114.9±12.8	121.2±12.2	0.001
RHR	102.7±9.8	101.6 ± 9.3	104.0±10.2	0.010	99.3±9.1	104.8±9.6	0.001
Δ HR	16.1±8.3	16.3 ± 8.5	15.9±8.1	0.750	15.6±8.4	16.4±8.2	0.250
Physical Inactivity (CAINM)							
Screen time hours	3.2±1.9	3.6±2.1	2.7±1.6	0.001	3.0±1.8	3.2±1.9	0.328
Transportation hours	1.0±1.0	1.06±0.9	1.01±0.90	0.481	0.88±0.8	1.14±0.9	0.001
Home work / reading hours	1.4±0.6	1.3±0.6	1.3±0.6	0.610	1.4±0.6	1.3±0.6	0.010
Sleep hours	10.0±0.9	10.0±1.0	10.0±0.9	0.420	10.0±0.9	9.9±0.9	0.070
Physical Activity (CAINM)							
Household chores (%)	92.2	91.0	93.5	0.352	93.9	91.1	0.304
Walking (%)	90.9	88.6	93.5	0.091	94.6	88.7	0.045
Running (%)	85.6	89.6	81.1	0.016	82.6	87.5	0.178
Bicycle (%)	78.0	74.4	82.2	0.063	85.2	73.7	0.007
Traditional games (%)	72.2	69.2	75.7	0.151	67.8	74.9	0.126
Football (%)	67.2	82.5	49.7	0.001	73.8	63.2	0.029
Basketball (%)	40.7	46.5	34.1	0.012	36.2	43.3	0.165
Swimming (%)	38.4	37.9	38.9	0.838	29.5	43.7	0.005
Dancing (%)	33.3	22.7	45.4	0.001	26.2	37.7	0.019
Volleyball (%)	30.6	27.5	34.1	0.157	30.1	30.4	0.915
Skateboard/skating (%)	30.5	32.7	28.1	0.322	29.5	31.2	0.731
Gymnastics (%)	19.9	13.7	27.0	0.001	22.8	18.2	0.267
Tennis (%)	17.7	22.3	12.4	0.010	8.7	23.1	0.001

BMIZ= Z score of Body Mass Index; HAZ= Z score for Height for Age; SHR= Starting Heart Rate; EHR= Exertion Heart Rate; RHR=Recovery Heart Rate;Δ HR = Delta Heart Rate. *Mann-Whitney test or Chi-squared test.

Table 2. Nutritional status of students according to Body Mass Index Z score (BMIZ) and waist circumference by gender and school type.

	Total % (IC 95%)	Boys % (IC 95%)	Girls % (IC 95%)	P*Value	Public % (IC 95%)	Private % (IC 95%)	P*Value
BMI Z score							
Normal weight	51 (46 - 56)	46 (38 - 52)	58 (50 - 65)	0.039	55 (46 - 62)	49 (42 - 55)	0.580
Over weight	25 (21 - 30)	28 (22 - 35)	22 (15 - 28)		23 (16 - 31)	26 (21 - 32)	
Obese	24 (19 - 28)	26 (20 - 32)	20 (14 - 27)		22 (15 - 29)	25 (19 - 30)	
Waist Circumference							
No abdominal obesity	87 (82 - 89)	86 (80 - 90)	88 (81- 91)	0.603	87 (80 - 91)	87 (81- 90)	0.986
Abdominal obesity	13 (10 - 17)	14 (09 – 19)	12 (08 - 18)		13 (08 - 19)	13 (09 - 18)	

*Chi-squared test

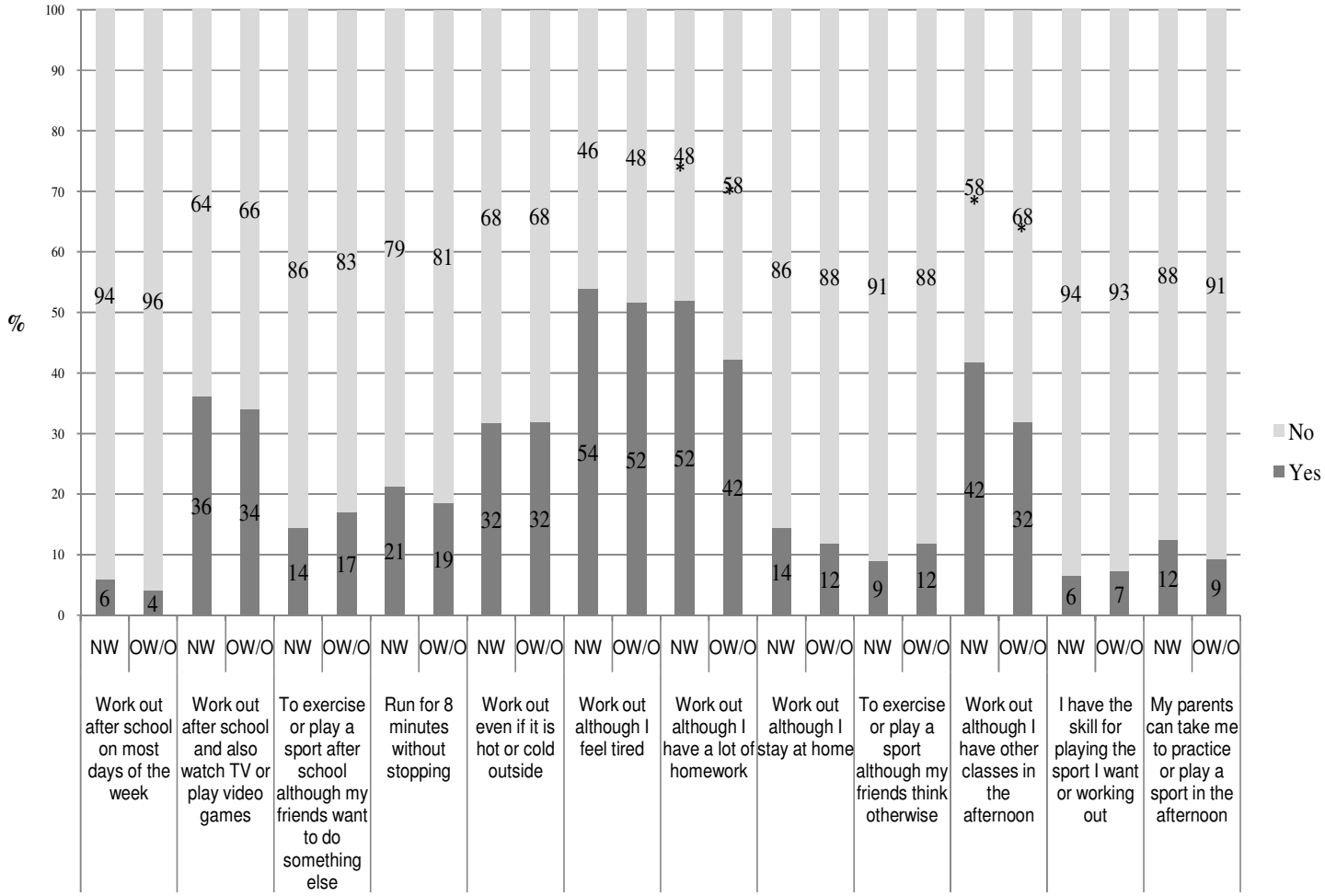

Figure 1. Percentage of positive and negative responses of students in the self-efficacy questionnaire for physical activity (QFA) by nutritional status according to Z-score of body mass index (BMIZ).
NW= Normal weight, OW/O=Overweight or Obese
*p<0.05 Chi-squared test

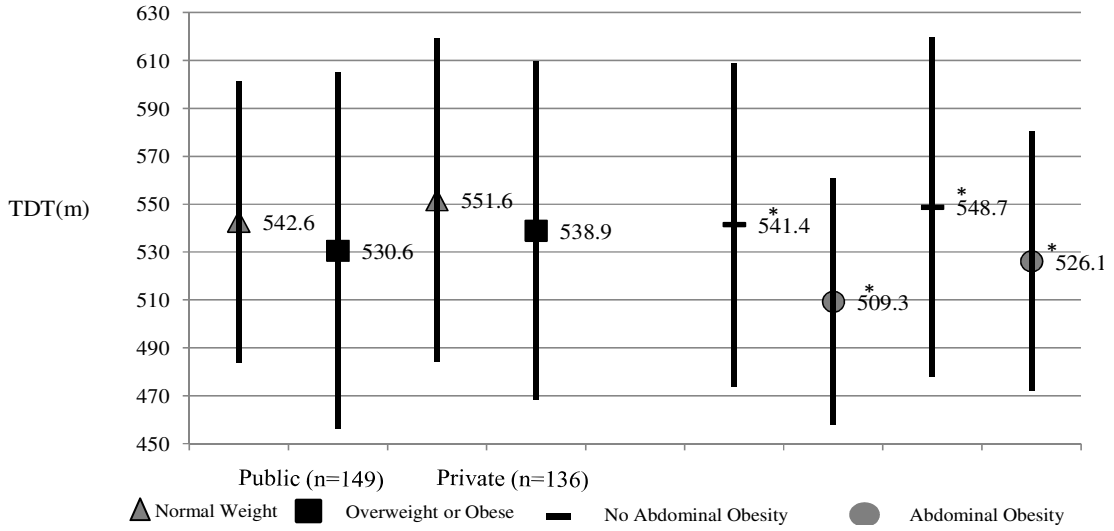

Figure 2. Average total distance traveled (TDT) of students in 6-minute walk test (6MWT) by school type and nutritional status according to BMI z scores and waist circumference.
*p<0.05 Mann-Whitney Test

DISCUSSION

According to the results of this study we found a higher value of BMIZ and prevalence of overweight or obesity in boys as compared to girls. This has been observed in some studies of Latin American students, where the prevalence of overweight or obesity is 2 to 5 percentage points higher in men than in women (Rivera et al., 2014). This situation may be due to the fact that male students are given greater autonomy over their diet and spend more time on sedentary activities.

In students with abdominal obesity, the total distance covered in the six-minute test was lower compared to that of those who did not have abdominal obesity, indicating that children with greater waist circumference present a cardio respiratory functional limitation when faced with greater physical demands and it is reflected in their physical performance when walking up to 100 meters less than recommended for healthy children (Gatica et al., 2012). Childhood obesity results in a cardio respiratory functional deterioration expressed in tolerance efforts, which causes disadvantages in aerobic physical performance and predisposes to negative health consequences and intellectual performance in the long term (López et al., 2009).

A high proportion of students were perceived as ineffective to perform physical activity, indicating that regardless of their nutritional status, students perceive as main barriers for performing PA in their free time factors related to the little time they have after attending school, to exercise even if they stay at home and in their interpersonal relationships because they depend on the approval of others to perform physical activity. This evidence must be considered before implementing a physical activity program for students, because success in acquiring the habit of exercise and its adherence depends on the individual's self-efficacy; so at an individual level, the child's confidence must be developed to perform PA, to provide him with suitable spaces, opportunities and moments to develop PA (Kwan et al., 2010; Kain et al., 2012).

To promote the performance of recreational and physical activities in students, we should start by considering what they practice in your daily life. Differences were found in the type of physical and recreational activities performed by students in public and private schools, which can not only be related to access to a larger and best sports infrastructure, but also to the fact that in private schools, greater importance is given to sports activities as part of the comprehensive education of the student than in public schools (Olivares et al., 2007). It is relevant that students from private schools showed higher HRs at different times of 6MWT measurement compared to public school students, suggesting a lower tolerance to physical effort by being more sedentary and using means of transportation. Although private school students have more sports infrastructure, this is not enough to perform daily moderate or vigorous physical activity as recommended by international organizations (World Health Organization, 2010). Therefore it is necessary to undertake physical education programs that not only bring thematic contents, but also improve the physical condition of the students, and involve the school community, managers, teachers, parents and students, to provide the times and necessary motivation (Briz et al., 2004).

The students in this study did not comply with the recommendation of spending less than two hours of screen time (watching TV, movies and playing video games), placing them at greater risk of suffering the consequences of physical inactivity. It was found that men spend more than three hours a day in front of screens; this sedentary behavior could be causing a tendency to a greater prevalence of overweight and obesity; as shown by a study of physical activity habits carried out in Spanish students, where it was found that a quarter of them spent 2 to 4 hours a day watching television, videos or DVDs, and their BMI was also higher (Llargués et al., 2009). A meta-analysis reported that the risk of obesity increased 13% for each hour of watching TV (Zhang et al., 2016).

The relationship of anthropometric variables with hours of physical inactivity was low, probably because instruments capture information from a short period of time and the nutritional status is the result of a process in the long term (Briz et al., 2004). In most of the instruments used to evaluate physical activity, no differences were found by nutritional status, indicating that the results of the PA evaluations may not be completely reliable, because in the case of objective methods, the interpretations may be incorrect due to the PA monitoring time (Briz et al, 2004; Olivares et al., 2007; Chaput et al., 2012) and in the case of PA evaluation questionnaires, it has been found that there are differences in the responses of the students, depending on their cognitive development and degree of understanding (Hernández et al., 2000; Briz et al., 2004; Aedo and Ávila, 2009). The use of other indicators of overweight and obesity, such as body fat, should also be considered in future research, as it has been found in other studies that BMI and CC may have weak associations with physical performance (Burns et al., 2013).

Among the strengths of this study is the use of different instruments to evaluate aptitude and habits of physical activity in school population; but the greatest weakness was to perform a single measurement which did not allow to establish a reliable relationship between physical activity and nutritional status. To measure physical activity in students and to record changes over time in the reduction of sedentary activities, it is recommended to use questionnaires to identify the practice of physical activity and sedentary behaviors, as well as heart rate

monitors, accelerometers, PA diaries, 6MWT and pedometers (Burns et al., 2013).

In conclusion, a schoolchildren population with high prevalence of overweight or obesity was found, in addition, boys and girls did not comply with the recommendation to spend less than two hours of screen time. The self-efficacy to perform physical activity in students from the study was low, and we found evidence of a lower physical performance in students with abdominal obesity. These unfavorable conditions in the practice of physical activity in Mexican urban students should be considered in the policies to promote physical activity. It is necessary that physical education programs in schools promote the development of the child's confidence so that he feels able to perform physical exercise and to include such activities in his daily life.

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