nutrición clínica y Dietética Hospitalaria

Artículo Original

Nutr Clín Diet Hosp. 2024; 44(1):74-83
DOI: 10.12873/441hernandez

Physical activity habits associated with health variables in Chilean male schoolchildren

Jordan HERNANDEZ MARTINEZ[1], Tiago VERA ASSAOKA[1], Camila GONZÁLEZ CASTILLO[1], María Angélica CASTILLO CERDA[1], Tomás HERRERA VALENZUELA[2], Eduardo GUZMÁN MUÑOZ[3,4], Braulio Henrique MAGANI BRANCO[5], Pablo VALDÉS BADILLA[6,7]

1 Department of Physical Activity Sciences, Universidad de Los Lagos, Osorno, Chile.
2 Universidad de Santiago de Chile (USACH), Santiago, Chile.
3 School of Kinesiology, Faculty of Health, Universidad Santo Tomás, Talca, Chile.
4 School of Kinesiology, Faculty of Health Sciences, Universidad Autónoma de Chile, Talca, Chile.
5 Cesumar University, Maringá, Paraná, Brazil.
6 Department of Physical Activity Sciences, Faculty of Education Sciences, Universidad Católica del Maule, Talca, Chile.
7 School of Education, Universidad Viña del Mar, Viña del Mar, Chile.

Recibido: 26/julio/2023. Aceptado: 20/noviembre/2023.

ABSTRACT

Introduction: Physical inactivity is a factor that contributes to increased cardiometabolic risk, such as overweight and obesity in schoolchildren.

Aim: To associate physical activity habits with morphological variables (body mass index [BMI], waist circumference [WC], body fat, and fat-free mass), blood pressure, glycemia, handgrip strength (HGS), and countermovement jump (CMJ) in Chilean male schoolchildren. In addition, to compare physically active (PA) schoolchildren to physically inactive (PI) schoolchildren on morphological variables, blood pressure, glycemia, HGS, and CMJ.

Material and methods: A cross-sectional study analyzed 160 schoolchildren with a mean age of 7.12 ± 4.5 years distributed into PA schoolchildren (n=75) and PI schoolchildren (n=85). A logistic regression was performed to identify the association between physical activity habits with factors of morphological variables (BMI, WC, body fat, and fat-free mass), blood pressure, glycemia, HGS, and CMJ. In addition, to compare the differences in physical activity habits (physically active vs. physically inactive), a student's t-test was performed for independent samples.

Results: Logistic regression showed that physical activity is protective factor against excess body fat of 46% (OR= 0.46; 95%CI= 0.22 to 0.95; *p*= 0.03), hyperglycemia of 25% (OR= 0.25; 95%CI= 0.12 to 0.51; *p*< 0.0001), high blood pressure of 31% (OR= 0.31; 95%CI= 0.15 to 0.67; *p*= 0.002), and HGS dominant hand of 40% (OR= 0.40; 95%CI= 0.19 to 0.83; *p*= 0.014).

Conclusion: Physical activity protected against excess body fat, hyperglycemia, hypertension, and decreased HGS in Chilean male schoolchildren. PA schoolchildren exhibited lower body fat, reduced risk of hyperglycemia and hypertension, and improved HGS and CMJ compared to PI schoolchildren.

KEYWORDS

Exercise, Nutritional Status, Body Composition, Health Status, Physical Fitness, Pediatrics.

ABBREVIATIONS

BMI: Body mass index.

HGS: Handgrip strength.

WC: Waist circumference.

PA: Physically active.

PI: Physically inactive.

CMJ: Countermovement jump.

Correspondencia:
Pablo Valdés-Badilla
valdesbadilla@gmail.com

OR: Odds ratios.

ISAK: International Society for the Advances in Kinanthropometry.

SBP: Systolic blood pressure.

DBP: Diastolic blood pressure.

ES: Effects size.

SPSS: Statistical Package for the Social Sciences.

INTRODUCTION

Physical inactivity is a global problem that significantly impacts the world population, ranking as the fourth leading risk factor for mortality according to the World Health Organization[1]. Recent studies have shown a concerning trend of a physically inactive (PI) lifestyle among young individuals, with 78% of boys and 85% of girls affected[2]. Physical inactivity is a factor that contributes to increased cardiometabolic risk, such as overweight and obesity in schoolchildren[3]. Childhood obesity has increased worldwide, with 158 million obese people, and by 2030 this figure is expected to increase to 254 million[4]. Latin American countries have shown the highest increase in childhood obesity[4]. Specifically, Chile is in sixth place in childhood obesity worldwide and first place in Latin America according to the Global Nutrition Reports[5], with 58.3% of obesity in Chilean schoolchildren[6]. A PI lifestyle leads to obesity in schoolchildren[7], raises 25% high blood pressure[8], 19% hyperglycemia[9], and increased risk of morbidity and mortality[10].

A study by Wang, Li[11] reported an association between physical inactivity with an increased risk of hyperglycemia (OR= 1.79, 95 %CI= 1.10 to 2.91, $p< 0.05$) in Chinese schoolchildren. Similar to that reported by Bustos-Barahona, Delgado-Floody[12], Chilean schoolchildren with unhealthy lifestyles had the highest proportion of students with abdominal obesity (30.6%, $p= 0.009$) and hypertension (40.9%, $p< 0.001$). On the contrary, there are ways to prevent and treat these alterations in the nutritional as well as cardiometabolic status of schoolchildren[13]. Leading a physically active (PA) lifestyle leads to preventing obesity in schoolchildren along with a lower cardiometabolic risk[14,15].

Regular physical activity practice is an effective non-pharmacological treatment used in obese schoolchildren with cardiometabolic risk[16]. In a systematic review with a meta-analysis conducted by Quirk, Blake[17], it was reported that PA children have a lower body mass index (BMI, OR= 0.41, 95%CI= -0.70 to -0.12, $p= 0.006$) and risk of having hyperglycemia (OR= 0.52, 95%CI= -0.97 to -0.07, $p= 0.02$) compared to PI children. In a study conducted by Bustos-Barahona, Delgado-Floody[12] in Chilean schoolchildren with a PA lifestyle, a lower BMI ($p< 0.001$) was detected together with a greater jump length ($p= 0.002$) in comparison with those who were PI, with a positive association in handgrip strength (HGS, $\beta= 0.17$, $p= 0.010$) together with a lower risk of hypertension ($\beta= 0.14$, $p=0.030$). A study by Meredith-Jones, Haszard[18] on preschoolers reported that those who led a PA lifestyle had 14.3% less body fat than those who were PI.

While there is evidence on the risks of physical inactivity[3,11,12] and the benefits of regular physical activity practice[12-18] on BMI, body composition, blood pressure, glycemia and physical fitness in schoolchildren. It is not known if there is an association between physical activity habits (PA vs. PI) with variables of the health status of schoolchildren from specific localities in Chile. It is considered that the response to physical activity habits may vary according to the sociodemographic zone[19].

AIM

The main aim of this study is to associate physical activity habits with morphological variables (BMI, waist circumference [WC], body fat, and fat-free mass), blood pressure, glycemia, HGS, and countermovement jump (CMJ) in Chilean male schoolchildren. Secondarily, to compare PA schoolchildren to PI schoolchildren on morphological variables, blood pressure, glycemia, HGS, and CMJ. The hypothesis posits that physical activity protects against excess body fat, high blood pressure, hyperglycemia, and decreased HGS[12,17]. Secondly, it is expected that PA schoolchildren will exhibit lower body fat, improved glycemia, and blood pressure levels, as well as enhanced HGS and CMJ performance when compared to PI schoolchildren[12,17,20].

MATERIAL AND METHODS

This study is a cross-sectional, descriptive, and comparative study with a quantitative approach[21]. This study was a non-probabilistic random sampling stratified by age[22]. The participants were 160 male schoolchildren (aged 7.12 ± 4.5 years) from Osorno city, Chile (Osorno is a city and commune in the southern zone of Chile, capital of the province of Osorno, in the Los Lagos Region. It is located 917.8 km south of Santiago, and 232 km west of the Argentina of San Carlos de Bariloche city) belonging to a private subsidized educational establishment during the months of October and November 2022, who underwent morphological variables, blood pressure, fasting glucose, HGS, and CMJ assessments during the morning in a room set up in the establishment, which was carried out by a nurse and physical education teachers, distributing according to physical activity habits to PA schoolchildren ($n= 75$) and PI schoolchildren ($n= 85$). The sample size calculation was made from a population of 280 male children enrolled in one school in Osorno city, Chile. The calculation estimate was of 155 male schoolchildren. This was carried out as recommended in a previous study by Fang, He[23]. For this calculation, a confidence level of 95% and a margin of error of 5% were used. These analyses were performed using GPower software (version 3.1.9.6, Franz Faul, Universiät Kiel, Germany). We included: (*i*) male children between 5 to 12 years old; (*ii*) the PA schoolchildren may or not have been enrolled in sports workshops at the educational establishment; and regularly practicing moderate physical activity (between 150 to 300 min per week) or vigorous physical activity (between 75 to 150 min per week) for more than six months[24]; (*iii*) the PI schoolchildren did not meet the international recommendations for physical activity practice[24]. The exclusion criteria were: (*i*) having a musculoskeletal, neurological and/or cardiorespiratory disorder that prevented them from performing the assessments. Figure 1 shows the sample selection process.

All schoolchildren had to accept the criteria for using and handling the data by signing an informed consent by parents and/or guardians and an informed assent from the children authorizing the use of the information for scientific purposes. The research protocol was reviewed and approved by the Scientific Ethics Committee of the Universidad Autónoma de Chile (approval number: 18-2018) and was developed following the guidelines of the Helsinki Declaration regarding research involving human subjects.

Morphological variables

Bipedal height was measured by placing a tape measure (Bodymeter 206, SECA, Germany; accuracy of 0.1 cm) on the wall and utilizing the Frankfort plane in a horizontal position. The body weight was determined using an electronic scale (InBody 570®; accuracy of 0.1 kg), and the BMI was computed by dividing the body weight by the square of the bipedal height (kg/m^2). To measure the WC, a fiberglass tape measure was used, which was attached at the height of the last floating rib, after which the child was instructed to breathe in and then breathe out, and the circumference was marked[25]. The International Society for the Advances in Kinanthropometry (ISAK) provided guidelines for all measurements[26]. A tetrapolar bioimpedance (InBody 570®, Seoul, Korea) with eight tactile point electrodes was used to determine body composition with the following variables: body fat percentage and fat-free mass percentage. The assessments were carried out by a nurse in the morning between 08:00 to 10:00 am on an empty stomach

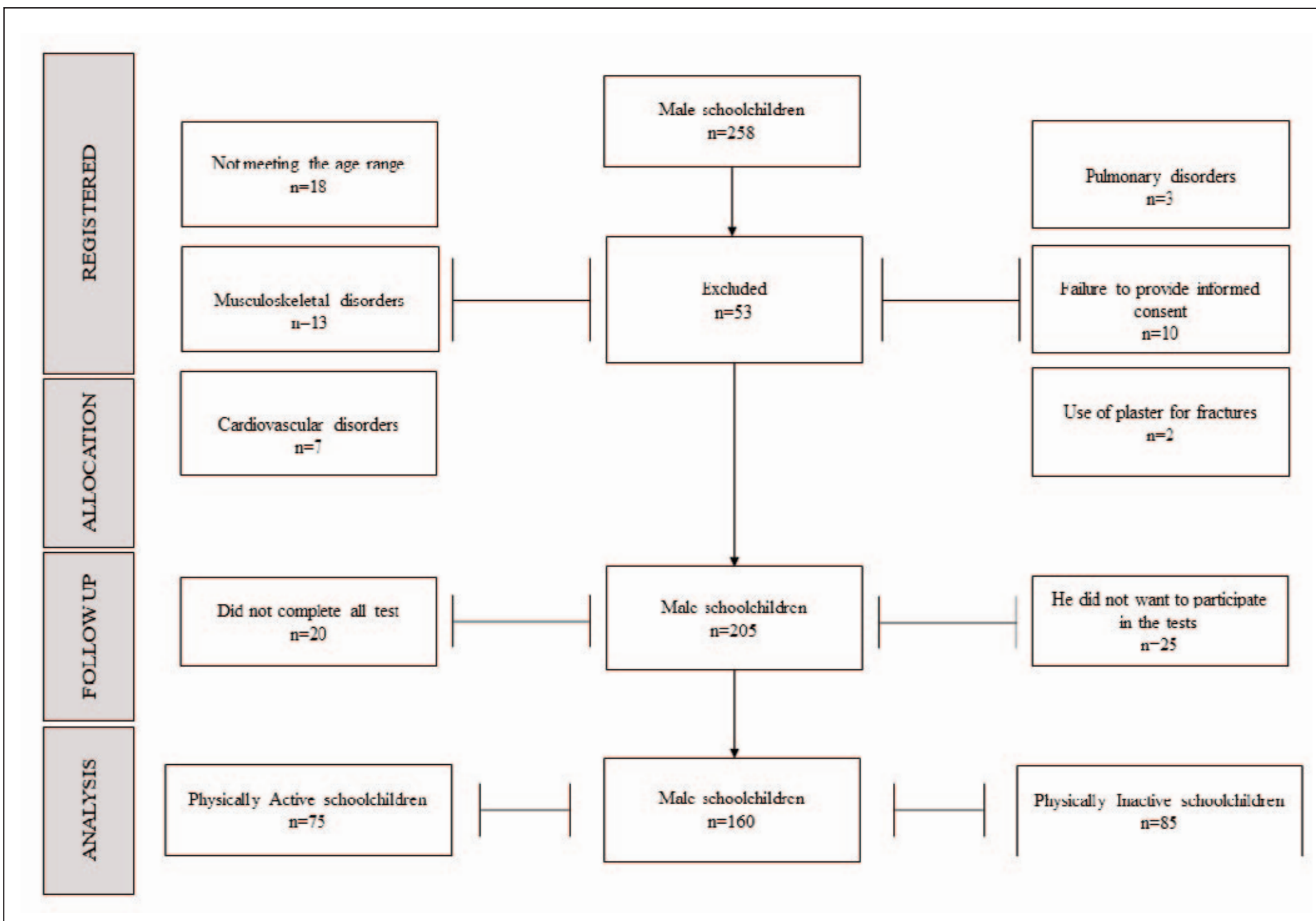


Figure 1. Flowchart of the recruitment process

in light clothing in a heated room. The schoolchildren were instructed to urinate beforehand according to the protocol for bioelectrical impedance analysis[27].

Blood pressure

Guidelines from previous studies were followed to measure blood pressure[28,29]. The schoolchildren were placed in a sedentary position for the measurement in triplicate (5 min between measurements) and after a 15 min rest period. The arm was supported on the table with its middle part at heart level, and a digital electronic monitor (OMRON®, model HEM 7114) was used to measure systolic blood pressure (SBP) and diastolic blood pressure (DBP). The cuff was placed on the arm's anterior surface, 2-3 cm above the ante ulnar fossa, equally modifying the upper and lower margins of the cuff. The children were instructed not to drink stimulant substances such as coffee, energy drinks, sugary drinks, or chocolate and not to exercise 30 minutes before blood pressure measurement. A nurse conducted each measurement in a quiet, climate-controlled environment in the morning from 08:00 to 10:00 am. In order to detect high blood pressure, the cut-off point used was ≥130 SBP (mm/Hg) and ≥80 DBP (mm/Hg)[30].

Glycemia

The glycemia of the day was detected by taking a sample of capillary blood extracted from a small puncture of the nail bed of each schoolchild. The sample is deposited in a reactive tape connected to a glucometer, giving us the glycemia value that the patient presents at that moment. All measurements to determine cardiometabolic risk were performed by a nurse in a laboratory with optimal conditions for these measurements. The≥ 126 mg/dL cut-off point was used to determine hyperglycemia in children[31].

Handgrip Strength (HGS)

The HGS was assessed according to previous recommendations[32]. Three trials were conducted to obtain maximum voluntary isometric HGS in the dominant and non-dominant hands, with 2 min rest between them. In each trial, subjects were required to perform their maximal effort for 5 seconds while listening to a motivational verbal. Each trial was performed with the children seated upright in a chair. The shoulder was in abduction and neutral rotation, while the hip, knee, and elbow were flexed at a 90° angle. The wrist was slightly extended (0° to 30°), and the forearm was neutral. The adjustable digital dynamometer (Jamar®, PLUS+, Sammons Preston, Patterson Medical, Illinois, USA) was used with the most comfortable position for the evaluated children.

Countermovement jump (CMJ)

As recommended by the CMJ test was carried out. With their arms on the iliac crests, the subjects executed maximal effort leaps on an Ergojump® Globus mobile contact platform (ErgoTest, Codogne, Italy). The exact site of takeoff and landing was standardized, and during the flight phase, participants extended their knees and ankles fully. Three maximal jumps were performed with a 2- to 3-min rest between each attempt, and the best of the three was recorded. The CMJ data showed that the vertical jump height was 0.98 for reliability.

Statistical analysis

Data were analyzed with SPSS 25.0 statistical software (SPSS 25.0 for Windows, SPSS Inc., Chicago, IL, USA). The data were presented as mean ± standard deviation. The Kolmogorov-Smirnov test was used to determine the normality of the data, while Levene's test was used to determine the homogeneity of variance. A normal distribution was observed for all data. A logistic regression was performed to identify the association between physical activity habits with factors of morphological variables (BMI, WC, body fat, and fat-free mass), blood pressure, glycemia, HGS, and CMJ. These results were presented as odds ratios (OR) with their respective 95% confidence intervals (95%CI). In addition, to compare the differences in physical activity habits (physically active vs. physically inactive), a student's t-test was performed for independent samples. The effect size (ES) was calculated by Cohen[33], which categorizes effects as small (0.20–0.49), moderate (0.50–0.79), or large (>0.80). The formula for calculating d was: d= (M1-M2)/SD[34]. The level of significance was defined as p< 0.05.

RESULTS

The PA schoolchildren vs. PI schoolchildren in the morphological variables presented a mean in body fat of 21% vs. 27.6%, fat-free mass 20.1 kg vs. 17.4 kg, BMI 21.7 kg/m^2 vs. 22 kg/m^2 and WC 69.4 cm vs. 71.6 cm. While in the variables of glycemia and blood pressure the PA schoolchildren vs. PI schoolchildren presented a mean of 95.3 mg/dL vs. 103 mg/dL in glycemia, 101.5 mm/Hg vs. 112.5 mm/Hg in SBP, and 66.3 mm/Hg vs. 73.1 mm/Hg in DBP. Finally, in the HGS and CMJ variables in PA schoolchildren vs. PI schoolchildren, the mean was 18.3 kg vs. 13.9 kg for HGS dominant hand, 16.7 kg vs. 12.9 kg for HGS non-dominant hand, and in CMJ 15.2 cm vs. 12.2 cm. These results are presented in Table 1.

Logistic regression analyses for physical activity habits in Chilean male schoolchildren no reported significant associations in BMI (OR= 0.64; 95%CI= 0.32 to 1.26; p= 0.20), WC (OR= 1.06; 95%CI= 0.53 to 2.13; p= 0.85), and fat-free mass (OR= 1.14; 95%CI= 0.57 to 2-25; p= 0.70), however in body fat the physical activity was reported as protective factor of 46% (OR= 0.46; 95%CI= 0.22 to 0.95; p= 0.03). In addition, physical activity was a protective factor in hyperglycemia of 25% (OR= 0.25; 95%CI= 0.12 to

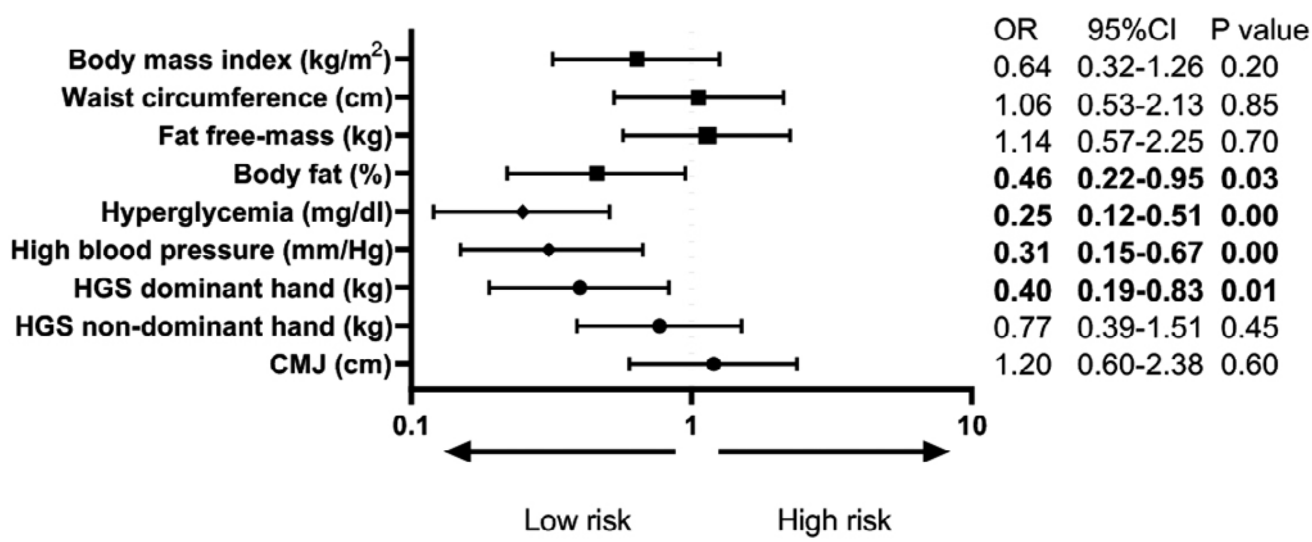
Table 1. Characteristics of Chilean male schoolchildren according to physical activity habits

Variables	PA schoolchildren (n=75)	PI schoolchildren (n=85)	*p* value
Body fat percentage (%)	21.0±9.20	27.6±9.32	**< 0.001**
Fat-free mass (kg)	20.1±7.33	17.4±6.92	0.130
Body mass index (kg/m^2)	21.7±6.17	22.0±6.15	0.860
Waist circumference (cm)	69.4±12.2	71.6±8.50	0.400
Fasting glucose (mg/dL)	95.3±13.7	103.0±8.28	**< 0.001**
Systolic blood pressure (mmHg)	101.5±12.1	112.5±11.6	**< 0.001**
Diastolic blood pressure (mmHg)	66.3±11.6	73.1±8.93	**< 0.001**
HGS dominant hand (kg)	18.3±9.34	13.9±3.59	**< 0.001**
HGS non-dominant hand (kg)	16.7±5.90	12.9±3.80	**< 0.001**
Countermovement jump (cm)	15.2±2.18	12.2±2.54	**< 0.001**

PA: physically active. PI: physically inactive. HGS: handgrip strength.

0.51; *p*= 0.000), high blood pressure of 31% (OR= 0.31; 95%CI= 0.15 to 0.67; *p*= 0.002), and HGS dominant hand of 40% (OR= 0.40; 95%CI= 0.19 to 0.83; *p*= 0.014). On the contrary, in HGS non-dominant hand (OR= 0.77; 95%CI= 0.39 to 1.51; *p*= 0.45) and CMJ (OR= 1.20; 95%CI= 0.60 to 2.38; *p*= 0.60) were no significant associations. These results are presented in Figure 2.

When comparing the PA schoolchildren vs. PI schoolchildren in morphological variables, no significant differences were reported in BMI (F= 1.00; *p*= 0.86; % change= 13.8; ES= 0.04 *trivial effect*), WC (F= 2.14; *p*= 0.40; % change= 3.17; ES= 0.20 *small effect*) and fat-free mass (F= 1.12; *p*= 0.13; % change= 13.4; ES= 0.37 *small effect*). However, significant differences were reported in favor of PA schoolchildren in



CMJ: countermovement jump.

Figure 2. Association between physical activity habits with morphological variables, blood pressure, glycemia, handgrip strength and countermovement jump in Chilean male schoolchildren

body fat (F= 1.02; *p*= 0.005; % change= 31.4; ES=0.71 *moderate effect*). These results are presented in Figure 3.

The same was true for glycemia (F= 2.77; *p*= 0.008; % change= 8.07; ES= 0.68 *moderate effect*), SBP (F= 1.08; *p*= 0.000; % change= 10.8; ES= 0.92 *large effect*), DBP (F= 1.70; *p*= 0.009; % change= 10.2; ES= 0.65 *moderate effect*), HGS dominant hand (F= 6.75; *p*= 0.002; % change= 24.0; ES= 0.62 *moderate effect*), HGS non-dominant hand (F= 2.41; *p*= 0.003; % change= 22.7; ES= 0.76 *moderate effect*) and CMJ (F= 1.34; *p*= 0.000; % change= 19.7; ES= 1.26 *large effect*), significant differences were reported in favor of PA schoolchildren compared to PI schoolchildren. These results are presented in Figure 4.

DISCUSSION

The main aim of this study was to associate physical activity habits with morphological variables (BMI, WC, body fat, and fat-free mass), blood pressure, glycemia, HGS, and CMJ in Chilean male schoolchildren. Secondarily, to compare PA schoolchildren to PI schoolchildren on morphological variables, blood pressure, glycemia, HGS, and CMJ. Among the main findings, it was reported that physical activity was associated as a protective factor for body fat, hyperglycemia, hypertension, and HGS dominant hand. Significant differences were also reported in favor of PA schoolchildren in body fat, glycemia, SBP, DBP, HGS dominant and non-dominant hands, and CMJ compared to PI schoolchildren. Therefore, the hypotheses are partially confirmed.

A systematic review with meta-analysis by Simmonds, Llewellyn[35] in children reported that those with excess body fat (obesity) at this stage of their life are 5 times more likely to be obese in adulthood (OR= 5.21; 95%CI= 4.50 to 6.02; *p*< 0.001), which can negatively impact their physical and mental health affecting their social, emotional well-being and self-esteem in children[36]. Regular physical activity practice

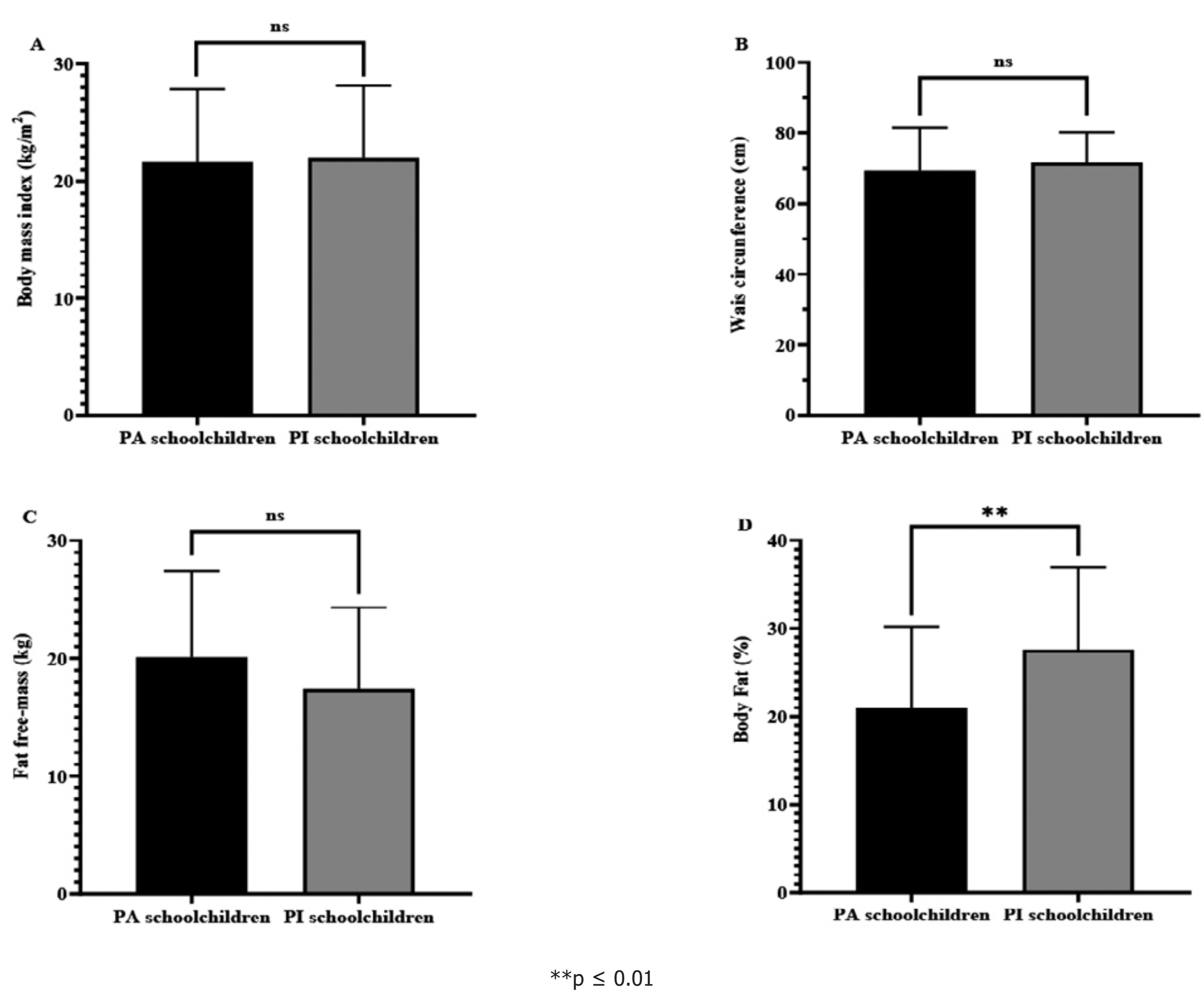
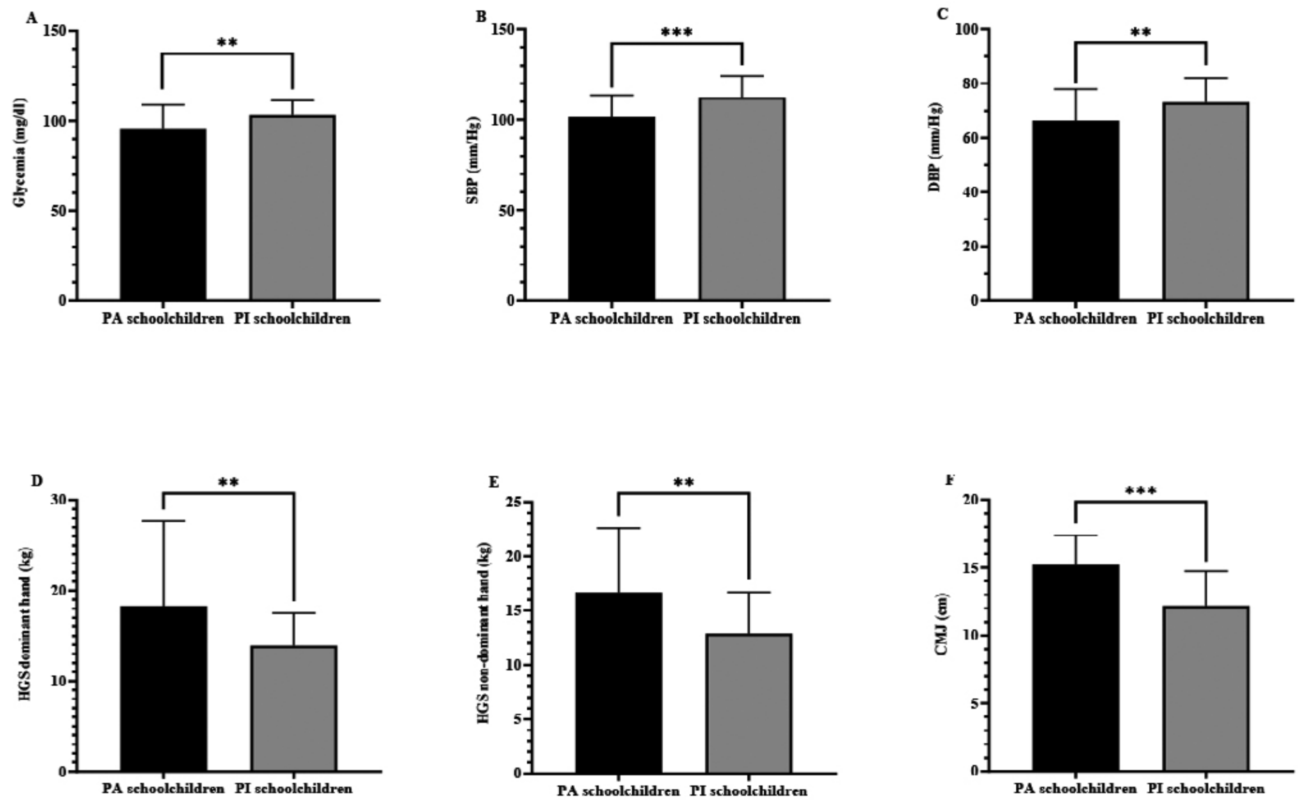


Figure 3. Comparison between physically active schoolchildren and physically inactive schoolchildren in morphological variables



SBP: systolic blood pressure. DBP: diastolic blood pressure. HGS: handgrip strength. CMJ: countermovement jump. **p ≤ 0.01. ***p < 0.001.

Figure 4. Comparison between physically active and physically inactive schoolchildren in glycemia, blood pressure, handgrip strength, and countermovement jump

over 2 years has decreased from 28.92% to 21% body fat in Poland schoolchildren[37]. Similarly, Ito, Sugiura[20] reported a significant association (OR= 0.93; 95%CI= 0.88 to 0.98; *p*= 0.006) in PA Japanese children with lower body fat than PI. Similar to what was reported in the present study, PA schoolchildren presented a 46% lower risk of excess body fat and a lower percentage of body fat when compared to PI schoolchildren. However, no significant differences in fat-free mass between PA schoolchildren vs. PI schoolchildren, and no significant associations were reported. Similar Engan et al.[38], no significant associations were reported between physical activity habits with fat-free mass (OR= 0.1; 95%CI= -0.1 to 0.2; *p*= 0.44) in Norwegian children. This condition may be because prenatal (maternal diet during pregnancy and genetic defects) and postnatal (physical activity, hormones, dietary protein, and obesity) factors influence the acquisition of fat-free mass during early life[39].

Another result reported was that no significant differences were found as significant associations in BMI and WC according to physical activity habits in schoolchildren. Like Engan, Vollsæter[38], in Norwegian children, no significant associations were reported in BMI (OR= -0.10; 95%CI= -0.29 to 0.09; *p*= 0.28) according to physical activity habits. In another study by Dampoudani, Giakouvaki[40] no significant associations were reported for WC (OR= 0.93; 95%CI= 0.72 to 1.20; *p*= 0.58) according to physical activity habits in Greek pre-adolescents. However, the BMI presents a variability in detecting excess body fat in children of 41%, while the WC presents a variability of 71% in detecting excess fat in the abdominal area[41]. At the same time, body fat analysis in schoolchildren by bioimpedance with Inbody showed a concordance correlation coefficient of 0.98 with dual X-ray absorptiometry[42]. This condition supports the results in the present study in which physical activity was a protective factor against excess body fat in Chilean male schoolchildren. Leading a PA lifestyle during childhood helps to have better physical fitness and a lower risk of cardiometabolic diseases, leading to a better health-related quality of life associated with a better physical and mental health status[43].

According to World Health Organization[44], leading a PA lifestyle during childhood leads to a lower risk of hypertension and hyperglycemia associated with a better health status than a PI lifestyle. These results are reported in the present study where PA schoolchildren have lower SBP, DBP, and glycemia compared to PI schoolchildren, together showing significant associations with a lower risk of hypertension and hyperglycemia in PA schoolchildren. Similar to that reported by Bustos-Barahona, Delgado-Floody[12], physical activity is associated with a protective effect on high blood pressure (β= 0.14; *p*= 0.030) in Chilean schoolchildren. Similarly, Quirk, Blake[17], in a meta-analysis, reported that PA children have a lower risk of having hyperglycemia (OR= 0.52; 95%CI= 0.07 to 0.97; *p*= 0.02) compared to PI children. The reduction in blood pressure with physical activity is thought to be due to attenuation in peripheral vascular resistance, which may be due to neurohormonal and structural responses with reductions in sympathetic nerve activity and an increase in arterial lumen diameters[45,46]. While glycemia during moderate to vigorous physical activity is predominantly supplied by the liver resulting in an increase in glucagon levels and a reduction in circulating insulin levels, increasing counter-regulatory hormones using glucose as an energy substrate[47]. Another result reported in the present study was significant differences in favor of PA schoolchildren in HGS dominant and non-dominant hands and in CMJ compared to PI schoolchildren and a significant association between physical activity and HGS dominant hand. Similar results to those reported by Bustos-Barahona, Delgado-Floody[12], where physical activity was associated as a protective factor in HGS dominant hand (β= 0.17; *p*= 0.010) in Chilean schoolchildren. Adaptations generated at the neural level may account for increased HGS in children rather than stimulation of muscle hypertrophy[48,49]. These strength gains have multiple benefits for schoolchildren's physical and mental health[50].

The limitations of the present study include: (*i*) the sample selection (non-probabilistic random sampling stratified by age) that only allows the analysis of association and not allow extrapolation of the results to other realities; (*ii*) not assessing the level of physical maturation of the participants; (*iii*) not analyzing eating habits or sleep quality that could influence the results of blood pressure and glycemia; (*iv*) not analyzing other variables such as cholesterol and triglycerides that could help to detect cardiometabolic risk factors; (*v*) categorizing physical activity habits according to time of practice and not by more direct methods such as accelerometry. Among the strengths are: (*i*) the simplicity of the assessments, which would allow their use and implementation in physical activity programs aimed at children in educational stages in different places, such as schools, hospitals, clinics, and community centers, among others; (*ii*) the analysis of the influence of physical activity habits on the variables analyzed; *(iii)* the possibility to analyze the children and adolescents along of years, i.e., longitudinal assessments *(iv)* public policies organization to children and adolescents and *(v)* non-communicable diseases control, treatment, prevention, and health promotion strategies.

CONCLUSION

Physical activity protects against excess body fat, hyperglycemia, hypertension, and decreased HGS in Chilean male schoolchildren. PA schoolchildren exhibited lower body fat, reduced risk of hyperglycemia and hypertension, and improved HGS and CMJ compared to PI schoolchildren. Therefore, promoting regular physical activity practices in the local school context is crucial, both at public and private levels.

ACKNOWLEDGMENTS

The author PVB Acknowledgments: Chile's National Research and Development Agency (in Spanish, ANID) for the awarded FONDECYT (code: 11220035) project.

REFERENCES

1. World Health Organization. The Global Health Observatory. 2023. [Internet]. [Accessed 22 August 2023]. Available from: https://www.who.int/data/gho/indicator-metadata-registry/imr-details/3416.
2. World Health Organization. A new WHO-led study indicates that most of the world's adolescents are not getting enough physical activity, and that this puts their current and future health at risk. 2019. [Internet]. [Accessed 22 August 2023]. Available from: https://www.who.int/es/news/item/22-11-2019-new-who-led-study-says-majority-of-adolescents-worldwide-are-not-sufficiently-physically-active-putting-their-current-and-future-health-at-risk#:~:text=A%20nivel%20mundial%2C%20la%20prevalencia,en%20torno%20al%2085%25).
3. Soares PPdS, Rodrigues GD. A Burden of Physical Inactivity in School-Age Students: The Early Beginning of Cardiometabolic Risk. International Journal of Cardiovascular Sciences. 2021;34 (3):262–3. Available from: https://doi.org/10.36660/ijcs.20210100.
4. Global Atlas on Childhood Obesity. The first global atlas on childhood obesity by the World Obesity Federation (WOF) shows that no country has a better than fifty percent chance of meeting their target for tackling childhood obesity. 2021. [Internet]. [Accessed 23 August 2023]. Available from: https://www.worldobesity.org/membersarea/global-atlas-on-childhood-obesity#:~:text=The%20atlas%20presents%20data%20for,nation%20guidelines%20for%20healthy%20diets.
5. Global Nutrition Reports. Country Nutrition Profiles. The burden of malnutrition at a glance. 2022. [Internet]. [Accessed 24 August 2023]. Available from: https://globalnutritionreport.org/resources/nutrition-profiles/latin-america-and-caribbean/south-america/chile/
6. Junta Nacional de Auxilio Escolar y Becas. El Mapa Nutricional es una herramienta de reporte estadístico del estado nutricional de la población escolar. 2022. [Internet]. [Accessed 23 August 2023]. Available from: https://www.junaeb.cl/mapa-nutricional/
7. Nur Zati Iwani AK, Jalaludin MY, Roslan FA, Mansor F, Md Zain F, Hong JYH, et al. Cardiometabolic risk factors among children who are affected by overweight, obesity and severe obesity. Front Public Health. 2023; 11:1097675. https://doi.org/10.3389/fpubh.2023.1097675.

8. Angi A, Chiarelli F. Obesity and Diabetes: A Sword of Damocles for Future Generations. Biomedicines. 2020; 8(11):478. https://doi.org/10.3390/biomedicines8110478.

9. Galuska DA, Gunn JP, O'Connor AE, Petersen R. Add. ressing Childhood Obesity for Type 2 Diabetes Prevention: Challenges and Opportunities. Diabetes Spect. 2018; (4):330-5. https://doi.org/10.2337/ds18-0017.

10. Lindberg L, Danielsson P, Persson M, Marcus C, Hagman E. Association of childhood obesity with risk of early all-cause and cause-specific mortality: A Swedish prospective cohort study. PLoS Med. 2020; 17(3):e1003078. https://doi.org/10.1371/journal.pmed.1003078.

11. Wang S, Li W, Qiao Y, Wang S, Zhang T, Liu E, et al. Abnormal glucose in pre-school children and the association with obesity/physical activity: A large population-based study. Diabetes Metab Res Rev. 2021; 37(7):e3442. https://doi.org/10.1002/dmrr.3442.

12. Bustos-Barahona R, Delgado-Floody P, Martínez-Salazar C. Lifestyle associated with physical fitness related to health and cardiometabolic risk factors in Chilean schoolchildren. Endocrinol Diabetes Nutr. 2020; 67(9):586-93. https://doi.org/10.1016/j.endinu.2020.02.005.

13. Pandita A, Sharma D, Pandita D, Pawar S, Tariq M, Kaul A. Childhood obesity: prevention is better than cure. Diabetes Metab Syndr Obes. 2016; 9:83-9. https://doi.org/10.2147/DMSO.S90783.

14. Wyszyńska J, Ring-Dimitriou S, Thivel D, Weghuber D, Hadjipanayis A, Grossman Z, et al. Physical Activity in the Prevention of Childhood Obesity: The Position of the European Childhood Obesity Group and the European Academy of Pediatrics. Front Pediatr. 2020; 8:535705. https://doi.org/10.3389/fped.2020.535705.

15. Vanderloo LM, Maguire JL, Dai DWH, Parkin PC, Borkhoff CM, Tremblay MS, et al. Association of Physical Activity and Cardiometabolic Risk in Children 3-12 Years. J Phys Act Health. 2020; 16:1-7. https://doi.org/10.1123/jpah.2020-0028.

16. Calcaterra V, Zuccotti G. Physical Exercise as a Non-Pharmacological Intervention for Attenuating Obesity-Related Complications in Children and Adolescents. Int J Environ Res Public Health. 2022; 19(9):5046. https://doi.org/10.3390/ijerph19095046.

17. Quirk H, Blake H, Tennyson R, Randell TL, Glazebrook C. Physical activity interventions in children and young people with Type 1 diabetes mellitus: a systematic review with meta-analysis. Diabet Med. 2014; 31(10):1163-73. https://doi.org/10.1111/dme.12531.

18. Meredith-Jones K, Haszard J, Moir C, Heath AL, Lawrence J, Galland B, et al. Physical activity and inactivity trajectories associated with body composition in pre-schoolers. Int J Obes. 2018; 42(9):1621-30. https://doi.org/10.1038/s41366-018-0058-5.

19. Mascherini G, Catelan D, Pellegrini-Giampietro DE, Petri C, Scaletti C, Gulisano M. Changes in physical activity levels, eating habits and psychological well-being during the Italian COVID-19 pandemic lockdown: Impact of socio-demographic factors on the Florentine academic population. PloS One. 2021;16(5):e0252395. https://doi.org/10.1371/journal.pone.0252395.

20. Ito T, Sugiura H, Ito Y, Noritake K, Ochi N. Relationship between the skeletal muscle mass index and physical activity of Japanese children: A cross-sectional, observational study. PloS One. 2021;16(5):e0251025. https://doi.org/10.1371/journal.pone.0251025.

21. Cuschieri S. The STROBE guidelines. Saudi J Anaesth. 2019; 13(Suppl 1):S31-S34. https://doi.org/10.4103/sja.SJA_543_18.

22. Setia MS. Methodology Series Module 5: Sampling Strategies. Indian J Dermatol. 2016; 61(5):505-9. https://doi.org/10.4103/0019-5154.190118.

23. Fang Y, He W, Hu X, Wang H. A method for sample size calculation via E-value in the planning of observational studies. Pharm Stat. 2021; 20(1):163-74. https://doi.org/10.1002/pst.2064.

24. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med. 2020; 54(24):1451-62. https://doi.org/10.1139/apnm-2020-0467.

25. Yamanaka AB, Davis JD, Wilkens LR, Hurwitz EL, Fialkowski MK, Deenik J, et al. Determination of Child Waist Circumference Cut Points for Metabolic Risk Based on Acanthosis Nigricans, the Children's Healthy Living Program. Prev Chronic Dis. 2021; 18:E64. https://doi.org/10.5888/pcd18.210021.

26. Marfell-Jones MJ, Stewart A, De Ridder J. International standards for anthropometric assessment. 2012. Available from: http://hdl.handle.net/11072/1510.

27. Alberty R, Čillík I. Effect of after-school physical activity on body composition in primary school children: The Slovak "PAD" project. Physiol Rep. 2023; 11(1):e15540. https://doi.org/10.14814/phy2.15540.

28. Álvarez J, Aguilar F, Lurbe E. Blood pressure measurement in children and adolescents: key element in the evaluation of arterial hypertension. An Pediatr. 2022;96(6):536.e1-536.e7. https://doi.org/10.1016/j.anpede.2022.04.011.

29. Álvarez C, Ramirez-Campillo R, Martínez C, Vallejos-Rojas A, Jaramillo-Gallardo J, Salas C, et al. Hypertension in relation to nutritional status, physical activity and ethnicity in Chilean children aged 6 to 13. Nutr Hosp. 2016; 33(2):220-5. https://doi.org/10.20960/nh.93

30. Di Bonito P, Di Sessa A. New Diagnostic Criteria for Hypertension in Children and Adolescents: Lights and Shadows. Children (Basel). 2020;7(11):196. https://doi.org/10.3390/children7110196.

31. López-Jaramillo P, Velandia-Carrillo C, Gómez-Arbeláez D, Aldana-Campos M. Is the present cut-point to define type 2 diabetes appropriate in Latin-Americans? World J Diabetes. 2014; 5(6):747-55. https://doi.org/10.4239/wjd.v5.i6.747.

32. Fess E. Grip strength. In: Casanova JS, editor. Clinical assessment recommendations. 2 ed. Chicago: American Society of Hand Therapists; 1992.

33. Cohen J. A power primer. Psychol Bull. 1992; 112(1):155-9. https://10.1037//0033-2909.112.1.155.

34. Rendón-Macías ME, Zarco-Villavicencio IS, Villasís-Keever M. Statistical methods for effect size analysis. Revista alergia Mexico. 2021;68(2):128-36. Available from: https://www.scielo.org.mx/pdf/ram/v68n2/2448-9190-ram-68-02-128.pdf

35. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. Obes Rev. 2016;17(2):95-107. https://doi.org/10.1111/obr.12334.

36. Beynon C. Association between children living with obesity and Mental Health problems: a data analysis of the Welsh Health Survey, UK. BMC Public Health. 2023; 23(1):383. https://doi.org/10.1186/s12889-023-15293-8.

37. Ługowska K, Kolanowski W. The Impact of Physical Activity at School on Body Fat Content in School-Aged Children. Int J Environ Res Public Health. 2022;19(19):12514. https://doi.org/10.3390/ijerph191912514.

38. Engan M, Vollsæter M, Øymar K, Markestad T, Eide GE, Halvorsen T, et al. Comparison of physical activity and body composition in a cohort of children born extremely preterm or with extremely low birth weight to matched term-born controls: a follow-up study. BMJ Paediatr Open. 2019;3(1):e000481. https://doi.org/10.1136/bmjpo-2019-000481.

39. Orsso CE, Tibaes JRB, Oliveira CLP, Rubin DA, Field CJ, Heymsfield SB, et al. Low muscle mass and strength in pediatrics patients: Why should we care? Clin Nutr. 2019;38(5):2002-15. https://doi.org/10.1186/s12913-016-1423-5.

40. Dampoudani N, Giakouvaki A, Diamantoudi D, Skoufi G, Kontogiorgis CA, Constantinidis TC, et al. Physical Activity, Body Mass Index (BMI) and Abdominal Obesity of Pre-Adolescent Children in the Region of Thrace, NE Greece, in Relation to Socio-Demographic Characteristics. Children (Basel). 2022; 9(3):340. https://doi.org/10.3390/children9030340.

41. Bigornia SJ, LaValley MP, Benfield LL, Ness AR, Newby PK. Relationships between direct and indirect measures of central and total adiposity in children: what are we measuring? Obesity. 2013; 21(10):2055-62. https://doi.org/10.1002/oby.20400.

42. Lee LW, Liao YS, Lu HK, Hsiao PL, Chen YY, Chi CC, et al. Validation of two portable bioelectrical impedance analyses for the assessment of body composition in school age children. PloS One. 2017;12(2):e0171568. https://doi.org/10.1371/journal.pone.0171568.

43. Ortega FB, Ruiz JR, Castillo MJ. Physical activity, physical fitness, and overweight in children and adolescents: evidence from epidemiologic studies. Endocrinologia y Nutricion. 2013; 60(8):458-69. https://doi.org/10.1016/j.endonu.2012.10.006.

44. World Health Organization. Global Status report on physical activity. 2022. [Internet]. [Accessed 24 August 2023]. Available from: https://www.who.int/teams/health-promotion/physical-activity/global-status-report-on-physical-activity-2022.

45. Alvarez-Pitti J, Herceg-Čavrak V, Wójcik M, Radovanović D, Brzeziński M, Grabitz C, et al. Blood pressure response to exercise in children and adolescents. Front Cardiovasc Med. 2022; 9:1004508. https://doi.org/10.3389/fcvm.2022.1004508.

46. Hegde SM, Solomon SD. Influence of Physical Activity on Hypertension and Cardiac Structure and Function. Curr Hypertens Rep. 2015; 17(10):77. https://doi.org/10.1007/s11906-015-0588-3.

47. Chetty T, Shetty V, Fournier PA, Adolfsson P, Jones TW, Davis EA. Exercise Management for Young People With Type 1 Diabetes: A Structured Approach to the Exercise Consultation. Front Endocrinol. 2019;10:326. https://doi.org/10.3389/fendo.2019.00326.

48. Daloia LMT, Leonardi-Figueiredo MM, Martinez EZ, Mattiello-Sverzut AC. Isometric muscle strength in children and adolescents using Handheld dynamometry: reliability and normative data for the Brazilian population. Braz J Phys Ther. 2018; 22(6):474-83. https://doi.org/10.1016/j.bjpt.2018.04.006.

49. Demers I, Moffet H, Hébert L, Maltais DB. Growth and muscle strength development in children with developmental coordination disorder. Dev Med Child Neurol. 2020;62(9):1082-8. https://doi.org/10.1111/dmcn.14507.

50. dos Santos Duarte Junior M, López-Gil JF, Caporal G, Mello J. Benefits, risks and possibilities of strength training in school Physical Education: a brief review. Sport Sciences for Health. 2022;18:11-20. https://doi.org/10.1007/s11332-021-00847-3