

Predictors healthy physical condition from Social Determinants in Colombian schoolchildren: Multicenter study

Predictores de condición física saludable desde Determinantes Sociales en escolares colombianos: Estudio multicéntrico

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Abstract. Today it is necessary to analyze health and living conditions with the so-called Social and Economic Determinants approach as relevant variables to determine the healthy physical condition behavior of school children. The objective was to estimate the best predictive model of the Social Determinants of Health and of the healthy physical condition of Colombian school children. The present was a socio-sport study, through a quantitative descriptive statistical analysis. A total of 3458 school children aged 10 to 18 from 10 cities in Colombia participated. A survey was applied to establish the Social Determinants of Health and the healthy physical condition was objectively evaluated through the extended version of the ALPHA FITNESS battery. As results, the following were obtained: a higher percentage of 15-year-old men had a healthy physical condition, age, being active, unhealthy habits, leisure activities and body mass index, and socioeconomic level, coexistence and educational level showed a statistically significant association with healthy physical condition. It is concluded that the body mass index (BMI), the permanence of the father, the number of daily meals, being a beneficiary of a school restaurant, the number of hours that he sleeps at night, are the social determinants of health that are associated with the healthy physical condition variable, in turn, the binary logit model has a good predictive capacity (70.1%).

Key words: Public Health, Motor Activity, Social Determinants of Health.

Resumen. Hoy en día es necesario analizar las condiciones de salud y de vida con el llamado enfoque de los Determinantes sociales y económicos como variables relevantes para determinar el comportamiento de la condición física saludable de los escolares. El objetivo fue estimar el mejor modelo predictivo de los Determinantes Sociales de la Salud y de la condición física saludable de los escolares colombianos. El presente fue un estudio socio deportivo, mediante un análisis estadístico descriptivo cuantitativo. Participaron 3458 escolares de 10 a 18 años de 10 ciudades de Colombia. Se aplicó una encuesta para establecer los Determinantes Sociales de la Salud y se evaluó objetivamente la condición física saludable a través de la batería ALPHA FITNESS en versión extendida. Como resultados se obtuvieron los siguientes: los hombres de 15 años en un mayor porcentaje tienen una condición física saludable, la edad, mantenerse activo, hábitos no saludables actividades de ocio e índice de masa corporal y nivel socioeconómico, convivencia y nivel educativo mostraron asociación estadísticamente significativa con la condición física saludable. Se concluye que el índice de masa corporal (IMC), la permanencia del padre, el número de comidas diarias, ser beneficiario de un restaurante escolar, el número de horas que duerme por la noche, son los determinantes sociales de la salud que se asocian a la variable condición física saludable, a su vez, el modelo logit binario tiene una buena capacidad predictiva (70,1%).

Palabras clave: salud pública, actividad motriz, determinantes sociales de la salud.

Introduction

The social determinants of health (from now on, DSS will be used to address them) play a fundamental role in the adoption of risk and protective factors for individuals, as well as in the development of diseases. Therefore, systematic and individualized processes are required to provide people with the knowledge to modify their lifestyles through a conscious attitude towards risk situations. (Fernández Regla et al., 2019) SHDs are defined as the circumstances in which people are born, grow, live, work and age (Palomino, et al, 2014). The analysis of inequalities is a challenge for global development, recognizing that heterogeneity in access to services and, consequently, in results from different areas of development, become obstacles to achieving sustainable development (United Nations. Trends in international migration 2015, Malmusi et al, 2014), these differences are

not only explained by aspects related to access to social services, but they also highlight the social and individual determinants of health and the public sports system as elements that increase them (Blanco-Becera et al., 2014) and do not guarantee equal opportunities in extracurricular sports activities (Jiménez et al., 2019).

The health-related physical condition, (CFS, so called from here on), is defined as the ability of a person to perform activities of daily living with vigor, and refers to those components of the physical condition that are related to health: aerobic capacity; musculoskeletal capacity; motor capacity, and body composition (Ruiz et al., 2011). Different studies show the relationships between CFS levels and the DSS, showing as a result that physical practice promotion strategies must be assumed in order to improve the health of adolescents and young people, where interventions should focus on favoring people's healthy lifestyles, increase the level of physical exercise practice in a greater percentage in women, better access to health services, health promotion programs and prevention of chronic no communicable

diseases among others. (Secchi et al., 2014; Carrillo, Aldana, & Gutiérrez, 2015; Arriscado et al., 2014; Fernández, Canet, & Giné-Garriga, 2016; Palomino et al., 2017).

This highlights the importance of assessing the healthy physical condition of adolescents and young people and seeking relationships with the DSS, therefore, the objective of the research was to establish the CFS predictive the DSS in Colombian schoolchildren.

Materials and methods

Participants

It was a socio-sports study, by means of a quantitative descriptive statistical analysis. The population was made up of school children between 12 and 18 years old from public and private schools in the cities of Manizales, Armenia, Pasto, Popayán Valledupar, Tuluá Riosucio, Villamaría, Chinchiná and Dosquebradas, where a probability sampling was carried out (simple random sampling). A 95% confidence interval, 84% statistical power, and an expected correlation of 0.30 were taken into account. A representative sample size of 345 schoolchildren per city was established, for a total of 3,458 schoolchildren who met the inclusion criteria. The selection was made at random in public and private schools in the cities, taking into account a proportion of 60% public and 40% private. Consent and informed consent were obtained in accordance with the provisions of resolution 008430 of the Colombian Ministry of Social Protection and the Helsinki declaration. The Committee on Institutional Bioethics has approved the proposal.

Techniques and instruments

Survey and observation techniques were used as techniques. The instruments used were the DSS survey format and the ALPHA battery field tests extended format (Secchi et al., 2014; Ruiz et al., 2011). The body composition was established from measuring the size, for this the portable stadiometer (SECA 206®; Hamburg Germany) (range 0 - 220 cm) of 1 mm precision was used. The weight was measured with Tanita floor scale (model TBF-10GS™, Arlington Heights, IL 60005, USA) with a maximum capacity of 200 kg and a minimum of 100 g. With these variables, the BMI in Kg / m² was calculated, adopting the cut-off limits recommended by the World Health Organization (WHO), the waist perimeter was evaluated with a plastic measuring tape with a precision of 1 mm (Holtain Ltd., Crymych Dyfed, RU) and the fat percentage was determined from the tricipital and subscapular skin folds, which were measured with an adipometer (Lange) of 1.0 mm accuracy, this percentage of body fat was estimated from the equations proposed by Slaughter et al, (1988) and used in different investigations such as those of Castro et al, (2108 and Zamora et al, (2018) using the triceps and subscapular folds. Skeletal muscle capacity was determined with the test of manual clamping force using a dynamometer with adjustable grip (TKK5101 Grip D; Takey, Tokyo Japan) and the explosive force of lower limbs by testing the long jump feet to feet together, the motorcycle capacity was determined by the 4 x 10 m agility speed test and aerobic capacity was evaluated with the Léger test (Castro et al., 2010; Vicente-Rodríguez et al., 2012Léger et al, 1994). The final healthy

physical condition was found according to the provisions of the ALPHAFITNESS battery protocol, taking into account first establishing each of the components and then the total sum of them determines the healthy physical condition. It is clear that in the case of this study, below 3.0 it is defined as unhealthy physical condition

Statistic analysis

Central tendency and variability or dispersion measures were calculated for quantitative variables included in the study and which allowed univariate descriptive analysis. The bivariate analysis was developed from the possible relationships between the variables of the study, applying parametric tests of Chi-square relationship. Significance was determined with a p<0.05. From the statistically significant relationships in the bivariate analysis, the multivariate analysis of binary logistic regression was performed. The statistical analysis was performed in the SPSS version 24 program (licensed by the Universidad Autónoma de Manizales).

Results

A total of 3,458 schoolchildren participated in the study, with an average age of 14.98 ± 1.98 years, distributed according to sex in a 1:1 ratio, with a greater percentage studying in official schools, and belonging to the middle socioeconomic stratum.

Table 1 shows how, by age, men aged 15 and over are found to have a higher percentage of healthy physical condition compared to women.

Table 1. Distribution of participants according to age, physical condition and gender.

Age (Years)	Physical condition	Gender		Total
		Male	Female	
12	Not healthy	118 54.9%	97 45.1%	215 100.0%
	Healthy	128 45.9%	151 54.1%	279 100.0%
13	Not healthy	136 56.2%	106 43.8%	242 100.0%
	Healthy	109 43.6%	141 56.4%	250 100.0%
14	Not healthy	141 53.6%	122 46.4%	263 100.0%
	Healthy	107 45.0%	131 55.0%	238 100.0%
15	Not healthy	122 51.0%	117 49.0%	239 100.0%
	Healthy	127 47.7%	139 52.3%	266 100.0%
16	Not healthy	100 48.8%	105 51.2%	205 100.0%
	Healthy	151 52.2%	138 47.8%	289 100.0%
17	Not healthy	106 48.2%	114 51.8%	220 100.0%
	Healthy	153 53.9%	131 46.1%	284 100.0%
18	Not healthy	95 46.1%	111 53.9%	206 100.0%
	Healthy	143 54.6%	119 45.4%	262 100.0%

Tables 2 and 3 show the summary of the relationship between intermediate social determinants and healthy physical condition, showing that the variables that show a statistically significant association are age, way of travelling to school, being a beneficiary of the school restaurant, consumption of liquor, consumption of liquor at home in the last 6 houses, how many hours you sleep at night, relax and enjoy your free time, physical activity, physical exercise, sport and body mass index.

By relating the Social Structural Determinants to healthy physical condition in tobacco 4, it is shown that there is a

statistically significant association with the type of school, socioeconomic status, marital status of the parents, with whom the child lives (father) and the educational level of the mother (Table 3).

Table 2.

Relationship between intermediate social determinants and healthy physical condition		
Intermediate determinants	Chi square	P value
Sex	1239	0.266
Age	17.812	0.000*
way to go to school	17.669	0.000*
Beneficiary of the school restaurant	24.133	0.000*
Consume at least breakfast-lunch-meal	0.931	0.628
Cigarette consumption in the last 6 months	0.237	0.627
Alcohol consumption in the last 6 months	6.950	0.008*
Drinking liquor with whom you live in the last 6 months	5.330	0.021*
Drug use in the last 6 months	0.419	0.517
Number of hours of sleep at night	6.182	0.04*
Relax and enjoy the free time	5.693	0.017*
Performs physical activity	14.195	0.000*
Do physical exercise	9.973	0.002*
Do sport	22.596	0.000*
Body mass index	14.27	0.000*

Table 3.

Relationship between structural social determinants and healthy physical condition		
Structural social determinants	Chi square	P value
Type of school	25.873	0.000*
Socioeconomic status	6.472	0.039*
Membership in the health system	3.188	0.527
Type of housing	0.836	0.934
Condition of the dwelling	1.209	0.546
Civil status of parents	10.008	0.040*
With whom the child lives "father"	6.124	0.013*
With whom the child lives "mother"	0.339	0.560
With whom the child lives "Siblings"	1.071	0.301
With whom the child lives "grandparents"	1.331	0.249
Educational level of the father	3.093	0.213
Educational level of the mother	7.204	0.027*

Table 4 shows the Logit model for the condition of being healthy as a function of factors such as body mass index (BMI), fatherhood, number of meals consumed per day, being a beneficiary of school restaurant and number of hours of sleep at night, all coefficients are statistically significant, which allows us to conclude that these variables present association with the physical condition variable.

What graph 1 shows is that not being a beneficiary of the school restaurant increases the chances of having an unhealthy physical condition.

The model has a good predictive capacity (70.1%) and is more capable of predicting the unhealthy (96.2%) than the

Table 4.
Logit Model for Healthy Physical Condition

Variables	B	Exp(B)	Wald	Sig.
BMI (Kg/cms2)	0.051	1.052	17.608	0.000**
With whom the child lives (Father)	0.177	1.193	4.056	0.044*
Number of meals eaten in the day	0.078	1.081	5.113	0.024*
It's beneficiary of the school restaurant	-0.831	0.435	108.071	0.000**
Hours of sleep at night	0.172	1.187	100.933	0.000**
Constant	-1.521	0.219	20.42	0.000

(*: Significant (p-value<0.1); **: Highly significant (p-value<0.01))

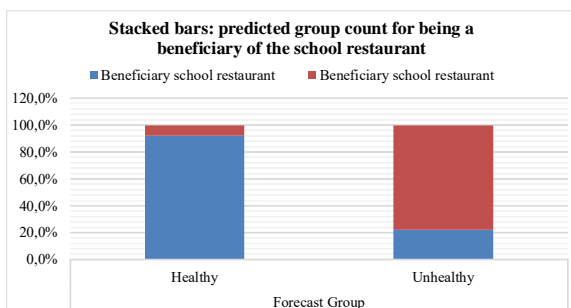


Figure 1.
Prognosis of healthy physical condition (being a beneficiary of a school restaurant)

Table 5.
Predictive efficiency of the model

Observed	Forecasted		Right percentage	Hosmer and Lemeshow test		
	Health condition			Chi square	gl	Sig.
	Healthy	Unhealthy				
Healthy	121	941	11.4	18.75	8	0.016
Unhealthy	92	2304	96.2			
Overall percentage			70.1			

healthy, Table 5. This allows us to predict that, as with a one unit increase in BMI, the probability of having an unhealthy physical condition increases by 1.25% while keeping all other variables constant. Having a grandparent increases the probability of having a healthy physical condition by 4.4%, likewise eating one more meal by 1.9%, and sleeping one more hour by 3.5%, finally, not being a beneficiary of the restaurant decreases the probability of having a healthy physical condition. The Hosmer and Lemeshow test shows that the model has an acceptable fit, and meets the validation assumptions. This allows for a prediction of an individual who has the following characteristics: lives with grandparents, eats three meals a day, is not a beneficiary of a school restaurant, sleeps 7 hours and has a BMI of 20.7 kg/cm2, the estimated model has a 75.89% probability of having an unhealthy physical condition.

Discussion

The results found in the present study show great similarity for the age variable with the research works of Prieto et al., (2015) where the mean was 12.9 ± 2.6 years, of Delgado-Floody et al, (2019), who worked with schoolchildren with a mean age of 12.00 ± 1.23 years, by Martínez et al, at ages $11.87 \pm 0, 38$ years but different from the average age in the studies by Martínez- Baena et al., (2018), who worked with schoolchildren with ages 14.4 ± 2.8 years.

Both men and women from the age of 15 onwards have an unhealthy physical condition, which increases with age. These data are consistent with studies that state that as schoolchildren increase in age their physical condition and physical activity levels decrease (Hernández-Mosqueira, 2015; Cervantes-De la Torre, 2017; Rosa-Guillamon et al., 2019, Zurita-Ortega, 2018).

In the present study the Intermediate Determinants age, staying active, unhealthy habits, leisure activities and BMI and the Structural Determinants socioeconomic level, cohabitation and educational level showed a statistically significant association with healthy physical condition. It should be noted that a large number of studies establish a relationship between physical condition and many of the variables that in the present study showed an association. For example, in relation to age, they show that this relationship is negative, i.e. the older the person, the less physical condition, which denotes non-linearity (Bauman et al., 2009; Palomino et al., 2017; Prieto Benavidez et al., 2015; Delgado-Floody et al, 2019), those that show how it is in adulthood where physical activity practice increases again and physical condition improves (Humphreys and Ruseski 2010) those that establish how BMI is closely related to diet, physical activity practice and parents' schooling (Bucco-dos Santos, & Zubiaur-Gonzales 2013; Díaz-Martínez et al, 2013; Cubidos de Carrillo, 2015; Zurita-Ortega et al., 2018;), who propose how sleep restriction is a risk factor associated with the presence of obesity (Duran et al., 2012; Reverter-Masia et al., 2017), those who mention the importance of staying active, i.e., engaging in physical activity, physical exercise and sport, and their relationship with different social and cultural aspects (Alvarez, et al., 2020) those that show that schoolchildren with physically active parents are more

inclined to practice sport (Zurita-Ortega, 2018, Solis-Urra et al, 2019).

Based on the above associations, it was found that the social determinants of health that predict healthy physical condition are BMI, living with the father, number of meals he consumes per day, being a beneficiary at the school restaurant and hours he sleeps at night, which are modifiable, an aspect that invites to continue insisting on processes of construction and implementation of effective nutrition programs, lifestyles and social coexistence that help improve the physical condition of schoolchildren as well as other studies suggest (Wilkinson, 2016 ; Carulla, et al., 2019; Ochoa-Martínez et al., 2018).

The importance of addressing the issue of DSS, becomes relevant from the results of this study because it shows how to continue promoting the practice of physical activity, the recommendations made by the WHO on a frequent basis should be stressed, the duration and time of its practice and requires governmental entities to pay close attention to the not only social but also behavioural problems that this causes and that are becoming public health problems. In addition, they provide new data on the relation DSS and healthy physical condition where the importance of the subject Physical Education in school and in the various programs of extracurricular physical activity must be emphasize and the direct relationship with the health of schoolchildren.

References

- Alvarez CE, Herrera Monge MF, Herrera González E, Villalobos Víquez G, Araya Vargas A. (2020). Sobrepeso, obesidad, niveles de actividad física y autoestima de la niñez centroamericana: un análisis comparativo entre países. *Retos*, 37, 238-243
- Arriscado D, Muros J, Zabala M, & Dalmau J. (2014). Relación entre condición física y composición corporal en escolares de primaria del norte de España (Logroño). *Deporte y ejercicio*, 30(2), 385-394.
- Azar A, Franetovic G, Martínez M, Santos H. (2015). Determinantes individuales, sociales y ambientales del sobrepeso y la obesidad adolescente en Chile. *Rev Med Chile*; 143: 598-605
- Bauman A. et al. (2009) «The International Prevalence Study on Physical Activity: Results from 20 Countries» *International Journal of Behavioral Nutrition and Physical Activity*. Vol. 6, núm. 21. [Links]
- Blanco-Becerra LC, Miranda-Soberanis V, Barraza-Villarreal A, Junger W, Hurtado-Díaz M, Romieu I. (2014). Effect of socioeconomic status on the association between air pollution and mortality in Bogota, Colombia. *Salud Pública Mex*; 56(4):371-378. <http://dx.doi.org/10.21149/spm.v56s2.5175>
- Bucco-dos Santos L, & Zubiaur-Gonzalez M. (2007). Desarrollo de las habilidades motoras fundamentales en función del sexo y del índice de masa corporal en escolares. *Cuadernos de Psicología del Deporte*, 13(2), 63-72.
- Carrillo R., Aldana L. & Gutiérrez A. (2015). Diferencias en la actividad física y la condición física entre los escolares de secundaria de dos programas curriculares oficiales de Bogotá, Colombia. *Deporte y ejercicio*, 32(5), 2228-2234. doi: 10.3305/nh.2015.32.5.9583
- Carulla JG, Muntaner-Mas A, Sampol PP. (2019). Asociación entre el desplazamiento activo al colegio y la composición corporal y el rendimiento académico en escolares de 10-12 años. *Retos*, 36, 376-383
- Castro M, Muros JJ, Cofre C, Zurita F, Chacón R, Espejo T. (2018). Rates of overweight and obesity in schoolchildren of Santiago (Chile). *Journal of sport and Health Research*. 10(2): 251-256
- Cervantes- De la Torre K, Amador A, Arrazola D. (2017). Nivel de actividad física en niños de edades de 6 a 12 años en algunos colegios de Barranquilla-Colombia, en el año 2014-2015. *Biociencias*, Volumen 12 Número 1, 17–23.
- Cubidos de Carrillo R, Aldana Alarcón LF, Gutiérrez Galvis AR. (2015). Diferencias en la actividad física y en la condición física entre los estudiantes en edad escolar de dos programas de currículo público en Bogotá, Colombia. *Nutr. Hosp.* [en línea]., vol.32, n.5, pp.2228-2234. ISSN 1699-5198. <http://dx.doi.org/10.3305/nh.2015.32.5.9583>.
- Delgado-Floody P, Caamano-Navarrete F, Palomino-Devia C, Jerez Mayorga D, Martínez-Salazar C. (2019). Relationship in obese Chilean schoolchildren between physical fitness, physical activity levels and cardiovascular risk factors. *Nutr Hosp*; 36(1):13-19. DOI: <http://dx.doi.org/10.20960/nh.1932>
- Díaz Martínez X, Mena Bastías C, Chavarría Sepúlveda P, Rodríguez Fernández A, Valdivia-Moral PA. (2013). Nutritional condition of school children according to physical exercising, feeding and schooling of the family. *Revista Cubana de Salud Pública*. 2013;39(4):640-650
- Durán S, Fuentes N, Vásquez SQ, Cediell G, Díaz V. (2012). Relationship between nutritional status and sleep in school children from the san miguel commune, santiago, chile. *Rev Chil Nutr* Vol. 39, N°1, Marzo, 30-37. <http://dx.doi.org/10.4067/S0717-75182012000100003>
- Fernández I, Canet O, & Giné-Garriga M. (2016). Assessment of physical activity levels, fitness and perceived barriers to physical activity practice in adolescents: cross-sectional study. *European Journal of Pediatrics*, (176), 57-65. doi: 10.1007/s00431-016-2809-4
- Fernández Regla M, Thielmann K, Bormey Quiñones MB. (2012). Individual and social health determinants in the family medicine. *Rev Cubana Salud Pública [Internet]*. 2012 Sep [citado 2019 Oct 14]; 38(3): 484-490. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-34662012000300014&lng=es.
- Hernández-Mosqueira C, Fernandes Da Silva S, & Fernandes Filho J. (2015). Physical fitness reference tables for females in the 10 to 14 age range in Chillán (Chile). *Rev. salud pública*. 17(5): 667-676, DOI: <http://dx.doi.org/10.15446/rsap.v17n5.4167>
- Humphreys B, & Ruseski J. (2007) «Participation in Physical Activity and Government Spending on Parks and Recreation» *Contemporary Economic Policy*. Vol. 25, núm. 4. [Links]
- Jiménez R, Dalmau JM, Gargallo E, & Arriscado D. Diferencias en los estilos de vida de escolares españoles y

- migrantes. *Espiral. Cuadernos del Profesorado*, 2019, 12(25), 40-48.
- Léger L, Lambert A, Goulet A, Rowan C, et al. Capacity aerobic des Quebecons de 6 a 17 ans: test navette de 20 metres avec paliers de 1 minute. *Can J Appl Sport Sci* 1984; 9:64-9.
- Malmusi D, & Ortiz G. Desigualdades sociales en salud en poblaciones inmigradas en España: revisión de la literatura. *Revista Española de Salud Pública*, 2014; 88, 687-701. <http://dx.doi.org/10.4321/S1135-57272014000600003>
- Martínez Martínez J, de los Reyes-Corcuaera M, Borrell-Lizana V & Pastor-Vicedo JC. (2018). Assessment of the physical condition levels of schoolchildren aged 11-12 years, through the application of the ALPHAFITNES Battery. *SPORT TK: Revista Euroamericana de Ciencias del Deporte*, vol. 7 n.o 2, (Supl. 1).
- Martínez-Baena A, Mayorga-Vega D, Viciano J. (2018). Predictive factors of physical activity in Spanish students based on their weight status. *Retos*, 33, 74-80
- Naciones Unidas. Trends in international migration 2015). Nueva York: Naciones Unidas, 2015 [citado octubre 2019]. Disponible en: <http://www.un.org/en/development/desa/population/migration/publications/populationfacts/docs/MigrationPopFacts20154.pdf>
- Ochoa-Martínez PY, Hall-López JA, Solano-Pineda I, Monreal Ortiz LR, Chacón-Araya Y, Moncada-Jiménez J. (2018). Prediction of body fat through body adiposity index and bioelectrical impedance analysis in a sample of physically active Mexican students. *Retos*, 34, 128-131
- Palomino-Devia C, Gonzalez Jurado JA., Ramos-Parrací CA. (2017). Composición corporal y condición física de escolares colombianos de educación secundaria y media de Ibagué. *Biomédica* 37:408-15. doi: <https://doi.org/10.7705/biomedica.v34i2.3455>
- Palomino P, Grande ML, Linares M. (2014). La salud y sus determinantes sociales: desigualdades y exclusión en la sociedad del siglo XXI. *Revista Internacional de Sociología (RIS)*. 72:71-91. (Consultado el 22/07/2018.) Disponible en: <http://apsredes.org/wp-content/uploads//08/laSaludYSusDeterminantes.pdf>.)
- Prieto-Benavides DH, Correa-Bautista JE y Ramírez-Vélez R. Niveles de actividad física, condición física y tiempo en pantallas en escolares de Bogotá, Colombia: Estudio FUPRECOL. *Nutr Hosp*. 2015;32(5):2184-2192. DOI:10.3305/nh.2015.32.5.9576
- Reverter-Masia J, Hernández-González V, Jové-Deltell C, & de Vega Cassasas M. (2017). Physical activity in adolescents. Is there scientific evidence of how physical exercise affects sleep in the adolescent population? *JONNPR*. ;2(7):298-303 298 DOI: 10.19230/jonnpr.1483
- Rosa-Guillamon A, García-Canto E, Crrillo-López PJ. (2019). Actividad física, condición física y autoconcepto en escolares de 8 a 12 años. *Retos*, 35, 236-241
- Ruiz J, España-Romero V, Castro J, Artero E, Ortega F, Jiménez D, Cuenca M, Chillón P, Girela MJ, Mora J, Gutiérrez Á, Suni J, Sjöström M, Castillo M. (2011). Batería ALPHA-Fitness: Test de campo para la evaluación de la condición física relacionada con la salud en niños y adolescentes. Manual de instrucciones. [Disponible en: <http://www.u.g.r.es/~cts262/ES/documentos/MANUALALPHAFitness.pdf>]
- Secchi JD, García G, España-Romero V, & Castro-Piñero J. (2014). Condición física y riesgo cardiovascular futuro en niños y adolescentes argentinos: una introducción de la batería ALPHA. *Archivos Argentinos de Pediatría*, 112(2), 132-140.
- Slaughter MH, Lohman TG, Boileau RA, Stillman PJ, Van Loan MD, Bembem, DA. (1988). Skinfolds equations for estimation of body fatness in children. *Rev Med Hered*. 2013; 24:33-39. and youth. *Hum Biol*, 60:709-723
- Solis-Urra P, Fernández-Cueto N, Nanjarí R, Huber-Pérez T, Cid-Arnes MP, Zurita-Corvalán N, Rodríguez-Rodríguez F, Cristi-Montero C. (2019) A mejor condición física mejores resultados de una ley contra la obesidad. *Retos*, 36, 17-21
- Vicente-Rodríguez, G., Rey-López, J. P., Mesana, M. I., Poortvliet, E., Ortega, F. B., Polito, A.,... Moreno, L. A. (2012). Reliability and intermethod agreement for body fat assessment among two field and two laboratory methods in adolescents. *Obesity*, 20(1), 221-228
- Wilkinson A, Miller E, Koehly L, Daniel C. & Forman M. (2016). Correlates of Physical Activity Differ by Sex and Country of Birth Among Mexican-Heritage Youth. *Journal of Immigrant and Minority Health*, 1-8.
- Zamora Salas JD, Laclé Murray A. (2018). validez del porcentaje de grasa corporal por pliegues cutáneos comparado con la dilución de óxido de deuterio en escolares costarricenses. *Archivos latinoamericanos de nutrición*; Vol. 68Nº 1, 71-79
- Zurita-Ortega F, Ubago-Jiménez JL, Puertas-Molero P, González-Valero G, Castro-Sánchez M, Chacón-Cuberos R. (2018). Physical activity levels of Primary Education students in Granada. *Retos*, 34, 218-221.

