MHSalud
Revista en Ciencias del Movimiento Humano y Salud
URL: http://www.revistas.una.ac.cr/mhsalud

DOI: http://dx.doi.org/10.15359/mhs.14-1.6
URL: http://www.revistas.una.ac.cr/mhsalud
CORREO: revistamhsalud@una.cr

EFFECTS OF 10-MONTH OF MODERATE TO VIGOROUS PHYSICAL ACTIVITY PROGRAM ON VO_2MAX AND PERCENTAGE OF BODY FAT IN CHILDREN WITH OVERWEIGHT AND OBESITY

EFECTO DE UN PROGRAMA DE ACTIVIDAD FÍSICA DE MODERADA A VIGOROSA DE DIEZ MESES SOBRE EL VO_2MÁX Y EL PORCENTAJE DE GRASA CORPORAL EN NIÑOS CON SOBREPESO Y OBESIDAD

Javier Arturo Hall-López[1],
Paulina Yesica Ochoa-Martínez[1],
Adrián Zamudio Bernal[1],
Ricardo Sánchez León[1],
Luis Gerardo Uriarte Garza[1],
Bartolomé Jesús Almagro Torres[2],
José Moncada-Jiménez [3,4] *and*
Pedro Sáenz-López Buñuel[2]

[1]*Faculty of Sports, Autonomous University of Baja California, México.*
[2]*Department of Integrated Didactics, University of Huelva, Spain.*
[3]*School of Physical Education and Sports, University of Costa Rica, Costa Rica.*
[4]*Human Movement Sciences Research Center,University of Costa Rica.*
Corresponding Author: pochoa@uabc.edu.mx

Abstract

Aim: To evaluate the effect of a program of physical activity with moderate to vigorous under CATCH model on body fat percentage and aerobic capacity in overweight or obesity children. **Method:** Twenty-six children (15) male and (11) female (age 9.4±0.3 years), diagnosed with overweight or obesity according to age and gender by their body mass index (BMI) participated in a program of physical activity with moderate to vigorous under the model of CATCH, 2 times a week over a period of 10 months, consisting of exercise intensity of 56% evaluated by the system for observing fitness instruction time (SOFIT), before and after the program body fat percentage was evaluated determined by the equation Slaughter et al., 1988 with the anthropometrics measurements of triceps and media calf skinfolds. Aerobic capacity (maximum oxygen consumption $VO_{2máx}$ was determined through the test course navette 20 meters by the equation of Leguer et al., 1984. As statistical analyses student T test for paired samples, was used, also percentage changes (Δ %) were calculated. **Results:** The results showed significant improvement ($p<0.05$) comparing before and after the program in $VO_{2máx}$ ($\Delta\% = 11.3$, $p \leq 0.001$) and ($\Delta\% = -2.4$, $p = 0.022$) in body fat percentage. **Conclusion:** Physical activity with moderate to vigorous intensity under the CATCH model was able to improve aerobic capacity and reduce the percentage of body fat in overweight or obese children.

Keywords: Pediatric Obesity, Adipose Tissue, Exercise.

Resumen

Objetivo: Evaluar el efecto de un programa de actividad física con intensidad moderada a vigorosa bajo el modelo CATCH sobre el porcentaje de grasa corporal y capacidad aeróbica en niños con sobrepeso u obesidad. **Método:** Veintiséis niños (15 hombres y 11 mujeres) (edad = 9.4 ± 0.3 años), diagnosticados con sobrepeso u obesidad por su índice de masa corporal, participaron en un programa de actividad física con intensidad moderada a vigorosa bajo el modelo de CATCH, 2 veces por semana por un periodo de 10 meses, compuesto por ejercicios de intensidad moderada a vigorosa (56%) evaluado por el sistema para observar el tiempo de instrucción de actividad física (SOFIT), antes y después del programa se evaluó el porcentaje de grasa corporal con la ecuación de Slaughter et al. (1988), valorando los pliegues cutáneos de tríceps y pantorrilla; La capacidad aeróbica con el test Course Navette de 20 metros calculando el consumo máximo de oxígeno (VO_2máx) por la ecuación de Léguer et al. (1984). **Resultados:** Se encontró una reducción significativa en el porcentaje de grasa corporal ($\Delta\%$ = -2.4, $p = 0.022$) y un aumento significativo en el VO_2máx ($\Delta\%$ = 11.3, $p \leq 0.001$). **Conclusión:** La actividad física con intensidad moderada a vigorosa bajo el modelo de CATCH fue capaz de mejorar la capacidad aeróbica y reducir el porcentaje de grasa corporal en niños con sobrepeso u obesidad.

Palabras clave: Obesidad Infantil, Tejido Graso, Ejercicio Aeróbico.

Introduction

Obesity is an epidemic health problem that affects many children in the world, regardless of gender, ethnic group or socioeconomic level. According to the International Obesity Task Force (IOTF) 20% of children and adolescents present obesity (Kelly et al., 2013). In Mexico, the National Health and Nutrition Survey (ENSANUT 2012) reported a 34.4% combined prevalence of overweight and obesity in school children aged 5 to 11 years (Janssen et al., 2013). Being a negative contributing factor associated with several pathological consequences and complications related with cardiovascular risk, mortality and quality of life of the population (Ebbeling and Ludwig, 2010).

Although obesity has a multifactorial etiology, the excess consumption of food dense in content of saturated fat, refined carbohydrates and sedentary lifestyle are factors that cause an imbalance between caloric consumption and energy expenditure resulting in obesity (Broyles et al., 2010). Evidence clearly shows than excess of visceral fat is determinant factor for insulin resistance that led progressively to diabetes mellitus and cardiovascular diseases (Rank et al., 2013). There is evidence that lack of physical activity is a risk factor for the onset of metabolic syndrome (Blanchard et al., 2013). In this context, overweight and obese population should receive special attention since early ages (Kelly et al., 2013).

Broyles et al. (2010) have shown high correlation between childhood obesity, obese parents and lifestyle habits. For this reason, it is necessary to find ways to induce healthy life habits as include balanced diet and physical activity in children family in order to avoid risk of develop overweight and obesity (Ebbeling and Ludwig, 2010). To minimize these health problem children's physical activity has been recommended and considered as important fact of health (Blanchard et al., 2013). Moreover, children are more sensitive to attempts of modify their body weight than adults, especially in terms of body fat percentage (Tailor et al., 2007, Lizana et al., 2011, Hall et al., 2013).

The 20-meter test Course Navette test, has been evaluated in 1 142 026 children and adolescents from more than 50 countries, has been commonly used in the school setting to determine the maximum oxygen consumption (VO_{2max}) as physiological parameter, which is numerically defined as the speed and capacity in which a person breathes air from the environment, is transported by the respiratory and cardiovascular systems, metabolizes oxygen (O_2) as a source of energy for muscle cells when carrying out physical activity (Welk et al., 2011). In the field of health, results of longitudinal studies clearly show that children with low VO_{2max} values evaluated by the 20-meter Course Navette test show obesity, metabolic and cardiovascular diseases (Ruiz et al., 2011). To diminish these feature, multiple intervention programs have been successfully implemented to prevent childhood overweight and obesity, the most related reference in accordance to the improvements is the Coordinated Approach to Child Health (CATCH), carried out by a research team from four universities (University of California at San Diego, University of Minnesota, Tulane University and University of Texas Health Science Center at Houston).

CATCH program has been extensively evaluated in more than 80 scientific journals, a longitudinal research that covered 96 schools (56 intervention and 40 control) in four US states (California, Louisiana, Minnesota, and Texas) with 5100 students in grades 3 through 5 from various ethnic and cultural backgrounds. To implement CATCH program in schools, many components of health promotion were considered, including a program to reduce the consumption of fat, saturated fat and sodium in children's diets, increase the amount of physical activity and prevent smoking (Perry et al., 1990). The program also included changes in the environment, where the physical activity component focused on physical education being provided 5 times per week and physical education teachers were instructed to involve children in physical activity and increase physical activity from moderate to vigorous intensity at least 50% of class time (Kelder et al., 2003). CATCH program had positive results in producing positive dietary changes and physical activity behaviors, the students who participated in CATCH consumed less fat and participated in more physical activities outside of school. Three years after the intervention, it was observed that the low fat consumption and high levels of physical activity were higher among participants compared to children in control group (Osganian, et al., 2003), allowing its implementation as public health policy in the school environment (Janssen et al., 2013). Therefore, the aim of this study was to evaluate the effect of a program of physical activity with moderate to vigorous under CATCH model on body fat percentage and aerobic capacity in overweight or obesity children.

Methodology

Participants

A quasi-experimental design was conducted where the independent variable (program of physical activity with moderate to vigorous intensity under CATCH model in overweight or obese children) was manipulated to measure its effect on the dependent variables (percentage of body fat and aerobic capacity), in order to determine the degree of change produced by the

treatment establishing a cause-effect relationship, the research followed the ethical principles regarding human experimentation proposed by the Helsinki declaration; all the subjects provided a written consent in order to participate in the study (Puri, Suresh, Gogtay, & Thatte, 2009), that was approved by the research program of the Faculty of Sports of the Autonomous University of Baja California; Protocol # 149/2/C/ 9/18. The study was carried out in the Elementary School Teniente Andres Arreola of Mexicali, Baja California, Mexico, with children in the fifth grade.

Participants were 26 overweight or obese children, 15 male and 11 female, with a mean age of 9.4 ± 0.3 years. The following inclusion criteria were used: a) to participate voluntarily, b) to be born in 2006, c) to be classified with overweight or obese assessed by body mass index (BMI) (≥ 85th percentile and < 95th percentile BMI for age and gender) and obesity (≥ 95th percentile BMI for age and gender) Center for Disease Control and Prevention (CDC) references through the Epi Info software version 3.5.1 d) not have performed a systematical routine of exercise in the previous three months. The only exclusion criteria were to possess any sort of acute or chronic complication that would hinder exercise.

Measures

To determine body weight and height, a scale with stadiometer (Seca, model 220, Hamburg, Germany) was used with precision of 100 g and 0.1 cm, respectively. Measurements were performed according to the standards of the Society for the Advancement of Cineanthropometry (ISAK, 2006). With the values of weight and height, the body mass index (BMI) was calculated as follows: BMI = weight (kg) / height (m^2).

To determine the percentage of body fat through the skinfold thickness equation (SKF) of Slaughter et al (1988), also anthropometric measurements were conducted by a level two antropometrist following the guidelines set by the ISAK, skinfolds (mm) of triceps and media calf were taken using a Rosscraft Inc. Slimguide skinfold caliper. SKF was calculated using the formula for boys %BF= 0.735(SKF triceps + SKF media calf) + 1.0 and for girls %BF= 0.610(SKF triceps + SKF media calf) + 5.1.

The aerobic capacity was determined with the 20-meter Course Navette test, which has been validated in children and adolescents aged 6 to 17 years (r = 0.70) (Léger et al., 1984). The test establishes the aerobic capacity by measuring indirectly through the $VO_{2max.}$ In the Course Navette test, a lap is one 20 meters were children move running in that distance from one end to the other, by the instruction of a synchronized rhythm given by a sound emitted from a recording in a laptop, the interval of beeps is calculated as requiring a speed at the start of 8.5 km/h. The test ended when the participants could not finish the race shifts with the pace and did not reach the line or their voluntary withdrawal of the test derived from fatigue. After completing the test, the evaluator recorded the levels and turns performed by the participants and according to these values the VO_{2max} was estimated with the following formula: VO_{2max} ($ml/kg^{-1}/min^{-1}$) = 31.025 + 3.238 (V) - 3.248 (E) + 0.1536 (VE); Where V is the speed of the last level reached during the

test in km/h (V = 8 + 0.5 x last level reached), and E represents the age in years.

In order to quantify the physical activity during the moderate to vigorous program under CATCH model, the System for Observing Fitness Instruction Time (SOFIT) was used, SOFIT is an objective tool for assessing the quality of physical education instruction that provides a measure of student activity levels and has been calibrated using heart rate monitors and validated using accelerometers (Mckenzie et al., 1992). Onset of the physical education lessons, trained observers randomly select 4 students (2 girls and 2 boys) based on the order in which they arrived at the class, using the procedures outline in the SOFIT manual, in summary observers record intensity of physical activity using a time-sampling system of 10-seconsd observe and 10-seconds records intervals while being paced by audio prompts from a mp3 player; The coded intensity of physical activity was scored as 1=lying down; 2=sitting; 3=standing; 4=walking; 5=very active. To identify moderate-to-vigorous physical activity the codes 4=walking and 5=very active were combined as the proportion of time than students are engaged in these codes. Two evaluators were trained following the SOFIT protocol standard and 100% of the observations were evaluated with high reliability (Kappa index = 0.083) (Szklo, 2007).

Measurements were performed at the baseline pre-test and immediately upon post-test of ten months duration of the program.

Procedures

The physical activity program consisted of two sessions per week of 50 minutes, divided into 5 minutes of warm-up, 40 minutes of aerobic component and 5 minutes of cool-down. Participants completed 10 months of moderate to vigorous physical activity program under CATCH model. This model was based on outlined that students should engage in moderate-to-vigorous physical activity at least 50% of the physical education lesson, with activities with an energy expenditure similar to walking or running when physical education classes were applied by the goal was establish pedagogical and physical effort activities that should engage the students in fun and pleasurable activities.

Statistical Analysis

Descriptive statistical procedures are presented as mean ± standard deviation; Shapiro-Wilk Test was used in order to confirm the normality of the data and T test for paired samples was applied for the values comparison of body fat percentage and aerobic capacity before and after the program of physical activity with moderate to vigorous under CATCH model, the statistical analysis were performed at significant level of $p<0.05$. Also, percent changes (Δ %) were calculated [(Media post – Media pre)/Media pre] x 100 (Vincent, 1999). Statistical analyses were performed using the statistical software (SPSS for Windows version 21, IBM Corporation, New York, USA).

Results

The descriptive statistics of the subjects evaluated are shown in table 1. Moderate to vigorous physical activity was found to be on average 56% during all sessions. Figure 1 shows the baseline fat percentage of participants (28.7 ± 5.3%) and post-test (28.0 ± 5.1%) A significant reduction in body fat percentage was founded (Δ% = -2.4, p = 0.022). As sown in Figure 2 the VO_{2max} was 32.6 ± 2.1 ml/kg-^{1}/min-^{1} pre-test and 36.3 ± 2.8 ml/kg-^{1}/min-^{1} post-test, significant increase in VO_{2max} was attained after the program (Δ% = 11.3, p ≤ 0.001).

Table 1. Mean and standard deviation (M ± SD) and normal values of the body fat percentage and aerobic capacity variables.

Variables	Pre-test (n=26)		Post-test (n=26)	
	M ± SD	Shapiro-Wilk Test	M ± SD	Shapiro-Wilk Test
Body Fat (%)	28.7 ± 5.3	.046	28.0 ± 5.1	.117
$VO_{2máx}$ (ml·kg-^{1}·min-^{1})	32.6 ± 2.1	.691	36.3 ± 2.8	.836

Note: Values of mean and standard deviation (±) of the percentage of body fat, determined by the equation of Slaughter et al., 1988 and aerobic capacity determined by the equation of Leguer et al., 1984.

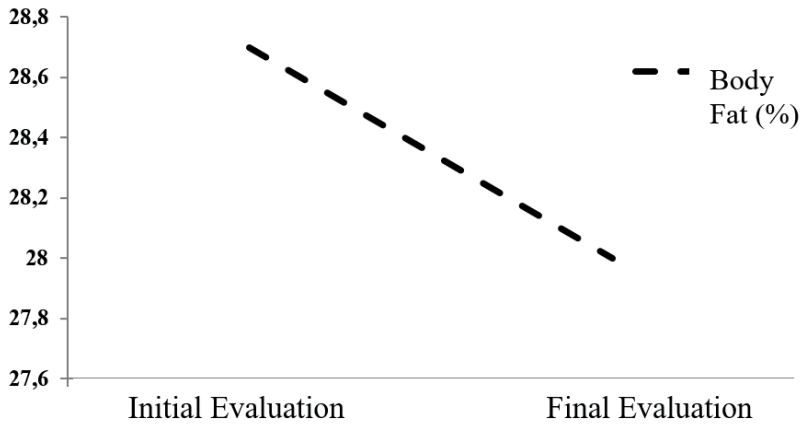

Figure 1. Changes T test for paired samples analysis values in body fat percentage baseline and after 10 months participating in moderate to vigorous physical activity program under CATCH model in overweight or obese children (n = 26).

Note: The percentage of body fat of overweight or obese children (n = 26) was determined by the equation of Slaughter et al., 1988. % = 0.735 (triceps fold (mm) + calf fold mm)) + 1.0 and in women% = 0.610 (triceps (mm) + calf (mm)) + 5.1; before and after 10 months of the moderate to vigorous physical activity program under CATCH model (T test for paired samples analysis p = 0.022).

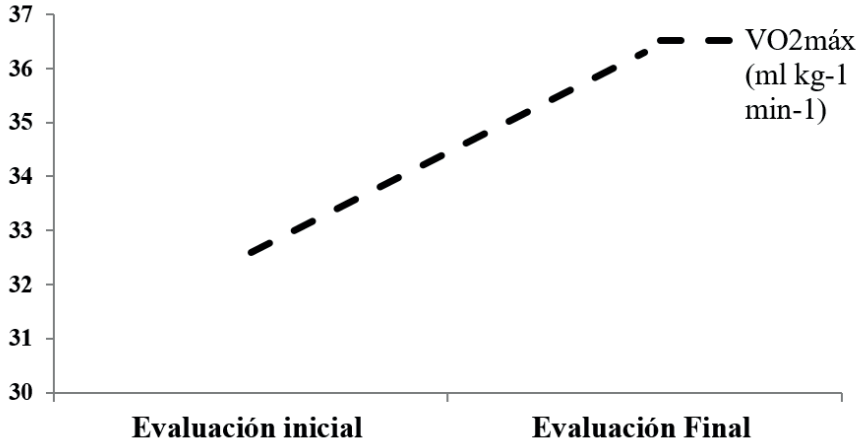

Figure 2. Changes T test for paired samples analysis values in aerobic capacity baseline and after 10 months participating in moderate to vigorous physical activity program under CATCH model in overweight or obese children (n = 26).

Note: The aerobic capacity of overweight or obese children (n = 26) was determined by the 20-meter test course navette (Léger, 1984), estimated with the formula VO2max = 31.025 + 3.238V-3.248E + 0.1536VE (V is the velocity of the last level reached during the test in Km / h (V = 8 + 0.5 x last level reached) and E represents the age in years; Before and after 10 months of the moderate to vigorous physical activity program under CATCH model (T test for paired samples analysis p = 0.001).

Discussion

The objective of the study was to evaluate the effect of a moderate to vigorous intensity physical activity program under CATCH model on the percentage of body fat and aerobic capacity in overweight and obese children. The main findings of the present study were that 10 months participation of moderate to vigorous intensity physical activity program under CATCH model by children diagnosed with overweight and obese according to age and gender improve VO_{2max} and reduce body fat percentage. These findings are positive, because related references correlates high values of VO_{2max} whit a lower presence of obesity and cardiovascular diseases in children (Ruiz et al., 2011). In other research conducted by Welk et al. (2011), show significant improvements (VO_{2max} 4.5 $ml \cdot kg^{-1} \cdot min^{-1}$) in aerobic capacity of overweight and obese children participants in 6 month attendance in physical exercise, physical education, physical activity or sports.

Regarding the assessment of physical fitness in the present study the Course Navette 20-meter test was proposed as a valid instrument in children and adolescents from 6 to 17 years of age, it was chosen for inexpensive, validated, easy to apply, replicable reliable and provides information related to children's health (Léger et al., 1984; Welk et al., 2011).

The results of aerobic capacity on this study was consistent with other controlled trials in obese children who used moderate to vigorous intensity physical activity (Huang et al., 2013). We emphasized attending the CATCH session with aerobic work activities two sessions per week. We compare or data with Stanley et al. (2013), and the results partial contradict those than found better biological adaptations in aerobic capacity, at least three sessions per week and at least six months of physical exercise are required.

The most related Mexican references in elementary school context than have been study the incidence of perform physical activity showed in 16 weeks improvements on systolic pressure, triglyceride concentration and total cholesterol but there were no changes in BMI, waist circumference and serum insulin (Perichart-Perera et al., 2008). Other research evaluated the impact of 18-month intervention for prevention obesity in 4th and 5th graders based on the ecological model in healthy behaviors; however, despite the intervention time the prevalence of obesity was not modified (Safdie et al., 2013). These results partially contradict other study that found a significant decrease in BMI when Mexican children aged 6 to 10 months intervened (Bacardi-Gascon et al., 2013, Elizondo-Montemayor et al., 2013). It should be noted that previous studies emphasized their intervention in diet, which provides the greatest influence on body fat percentage changes (Gonzalez et al., 2012).

In physical culture area, has been widely recommended that health professionals have knowledge in body fat percentage assessment (Lizana et al., 2011, Hall et al., 2013). Moreover it is necessary to understand the results of children and parents and lead the achievements of change in body composition (Slaughter Et al., 1998; Tailor et al., 2011, Welk et al., 2011).

Regarding the intensity of physical activity in the present research the goal was that children should engage in moderate-to-vigorous physical activity at least 50% of the lesson time, studies carried out in Mexico using the exact measurement protocol and where teachers used the mandatory curriculum of Physical Education conducted in a pedagogical model of competencies reported 38.2% (Pérez Bonilla, 2009), 29.2% (Jennings-Aburto et al., 2009), 52% (Gharib et al., 2015) and 41% (Hall et al., 2017), 37.9 (Hall et al., 2017), in the context of these studies physical education class was perceived the lack of didactic material to have more opportunity to participate, a great amount of time in which the students remained standing while the teacher organizes the group to participate, long lines to have the opportunity to participate and the times of transition among the activities were very long. Other research that measured the effective time of physical education class using motion sensors resulted in 46.1% of moderate vigorous physical activity (Flores et al., 2017). Therefore it would be appropriate to combine the objectives and goals of the Mexican physical education program in basic education and the recommendations established by the National Association for Sport and Physical Education (NASPE) mentioning that the physical education classes to be taught by the teachers should be designed for the student to participate in moderate to vigorous intensity above 50% of the class time (NASPE, 2009, Banville , 2006) thus contribute to physical activity health benefits for children and young people as established by the World Health Organization (WHO, 2014), with

emphasis in overweight and obese children where there is a higher incidence of cardiovascular and metabolic diseases (Broyles Et al., 2010).

The present study has some limitations, first than there is a single arm with no baseline to establish stability in the measures with a control group, the sample size is relatively small, the results were not stratify by gender and we not evaluate co variables in the group. However, despite these limitations, we used validated measurement instruments and we conduct with an appropriate physical activity design with CATCH. These results highlight the importance to carry out more research that clarifies the possibilities of effect on the studied variables in order to have results that serve as a reference for performing interventions aimed to prevent or minimize the problem of obesity

Conclusions

In summary, the results from this current study add a much-needed contribution to our understanding that physical activity with moderate to vigorous intensity under CATCH model was able to improve aerobic capacity and reduce percentage of body fat in overweight or obese children. However in the future, it will be appropriated more studies to better clarify the underlying mechanism between physical exercise on body fat in children with overweight and obesity.

Acknowledgment

The research was funded by the 18th internal research call of the Autonomous University of Baja California, Mexico. Protocol with key 149/2/C/9/18, and the Call of Academic Mobility Scholarships 2015 and 2016 to conduct short-term research mobility and academic exchange in order to complete the research between the University of Huelva, University of Costa Rica and the Autonomous University of Baja California.

References

Bacardi-Gascon, M., Perez-Morales, M. E., y Jimenez-Cruz, A. A six month randomized school intervention and an 18-month follow-up intervention to prevent childhood obesity in Mexican elementary schools. *Nutricion Hospitalaria, 27*(3),755-762, 2012.

Blanchard, C., Shilton, T. y Bull, F. Global Advocacy for Physical Activity (GAPA): global leadership towards a raised profile. *Glob Health Promotion, 20*(4), 113-121, 2013.

Banville, D. (2006). Analysis of exchanges between novice and cooperating teachers during internships using the NCATE/NASPE standards for teacher preparation in physical education as guidelines. *Research Quarterly for Exercise and Sport, 77*(2), 208-221.

Broyles, S., Katzmarzyk, P. T., Srinivasan, S. R., Chen, W., Bouchard, C., Freedman, D.S. y Berenson, G. S. The pediatric obesity epidemic continues unabated in Bogalusa, Louisiana. *Pediatrics,125*(5), 900-905, 2010.

Ebbeling, C. B. y Ludwig, D. S. Pediatric obesity prevention initiatives: more questions than answers. *Archives of Pediatrics and Adolescent Medicine, 164*(11),1067-1069, 2010.

Elizondo-Montemayor, L., Gutierrez, N. G., Moreno, D. M., Martinez, U.,Tamargo, D. y Trevino, M. School-based individualised lifestyle intervention decreases obesity and the metabolic syndrome in Mexican children. *Journal of Human Nutrition and Dietetics, 26(1)*,82-89, 2013.

Encuesta Nacional de Salud y Nutrición 2012 ENSANUT2012 data revisited. (n.d.). Retrieved may 29, 2016, from the Instituto Nacional de Salud Publica; 2013. website, http://ensanut.insp.mx/

Flores-Moreno, P., Salazar, C., Gómez-Figueroa, J., Barreto-Villa, Y., Valdovinos-González, O., Vicente-Rivera, J., y Del Río-Valdivia, J. (2017). Medición del tiempo efectivo de la clase de educación física y su impacto en el gasto calórico en escolares de nivel primaria del municipio de Colima, México. *Sportis, 3,* 34-49.

Gharib, H., Galavíz, K., Lee, R., Safdie, M., Tolentino, L., Barquera. S. y Lévesque, L. (2015). The Influence of Physical Education Lesson Context and Teacher Behaviour on Student Physical Activity in Mexico. *RETOS, 28,* 160-164.

Gonzalez, A., Boyle, M. H., Georgiades, K., Duncan, L., Atkinson, L. R. y MacMillan, H. L. (2012). Childhood and family influences on body mass index in early adulthood: findings from the Ontario Child Health Study. *BMC Public Health, 12,755.*

Hall López, J. A., Ochoa Martínez, P. Y., Borbón Román, J. C. y Monreal Ortíz, L. R.

(2013). Prevalencia de Porcentaje de Grasa Corporal, Obesidad Abdominal y Estado Nutricional en una Escuela Primaria de Mexicali Baja California México. *International Journal of Morphology,31*(4),1269-1275.

Hall-López, J, A., Ochoa-Martínez, P, Y., González-Terrazas, J, C., y González-Ramírez, J. R. (2017). Duración, intensidad y contexto de clases de Educación Física impartidas por profesores y estudiantes de licenciatura . *Sportis, 3,* 577-597.

Hall-López, J, A., Ochoa-Martínez, P, Y., Zuñiga, R., Monreal, L, R., y Sáenz- López, P. (2017). Moderate-to-vigorous physical activity during recess and physical education among mexican elementary school students. *RETOS,* 31, 137-139.

Huang, S. Y., Hogg, J., Zandieh, S. y Bostwick, S. B. (2012) A ballroom dance classroom program promotes moderate to vigorous physical activity in elementary school children. *American Journal of Health Promotion, 26*(3), 160-165.

Janssen, I., Medina, C., Pedroza, A. y Barquera, S. (2012). Screen time in Mexican children: findings from the 2012 National Health and Nutrition Survey (ENSANUT 2012). *Salud Publica de Mexico,55*(5), 484-491, 2013.

Kelder, S. H., Mitchell, P. D., McKenzie, T. L., Derby, C., Strikmiller, P. K., Luepker, R. V. y Stone, E. J. (2003). Long-term implementation of the CATCH physical education program. *Health Education & Behavior, 30*(4),463-475.

Kelly, A. S., Barlow, S. E., Rao, G., Inge, T. H., Hayman, L. L., Steinberger, J. y Council on Clinical, C. (2013). Severe obesity in children and adolescents: identification, associated health risks, and treatment approaches: a scientific statement from the American Heart Association. *Circulation,128*(15), 1689-1712.

Léger, L.; Lambert, J.; Goulet, A.; Rowan C. y Dinelle, Y. [Aerobic capacity of 6 to 17-year-old Quebecois--20 meter shuttle run test with 1 minute stages].(1984). *Canadian journal of applied sport sciences, 9*(2):64-9.

Lizana Arce, P. J., Almagià Flores, A. A., Simpson Lelievre, M. C., Olivares Barraza, R., Binvignat Gutiérrez, O., Ivanovic Marincovich, D. y Berral de la Rosa, F. J. (2011). Inconsistency Between the Body Fat Percentages Estimated Through Anthropometric Measurements and Manual Bioimpedance in Children and Adolescents. *International Journal of Morphology, 29*(4),1364-1369.

Marfell-Jones, M.; Olds, T., Stewart, A. y Carter, L. *International standards for anthropometric assessment.* Potchefstroom, South Africa, ISAK, 2006.

Mckenzie, T. L.; Sallis, J. F. y Nader, P. R. (1992). Sofit - System for Observing Fitness Instruction Time. *Journal of Teaching in Physical Education, 11*(2),195-205.

Osganian, S. K., Parcel, G. S. y Stone, E. J. (2003). Institutionalization of a school health promotion program: background and rationale of the CATCH-ON study. *Health Education & Behavior, 30*(4),410-417.

Perichart-Perera, O., Balas-Nakash., M., Ortiz-Rodríguez, V., Morán-Zenteno, J. A., Guerrero-Ortiz, J. L. y Vadillo-Ortega, F. (2008). A program to improve some cardiovascular risk factors in Mexican school age children. *Salud Publica de Mexico, 50*(3):218-26.

Perry, C. L., Stone, E. J.; Parcel, G. S.; Ellison, R. C.; Nader, P. R.; Webber, L. S. y Luepker, R. V. (1990). School-based cardiovascular health promotion: the child and adolescent trial for cardiovascular health (CATCH). *Journal of School Health, 60*(8),406-413.

Rank, M., Siegrist, M., Wilks, D. C., Langhof, H., Wolfarth, B., Haller, B. y Halle, M. (2013). The cardio-metabolic risk of moderate and severe obesity in children and adolescents. *Journal of Pediatrics,163*(1),137-142.

Ruiz, J. R., Castro-Pinero, J., Espana-Romero, V., Artero, E. G., Ortega, F. B., Cuenca, M. M. y Castillo, M. J. (2011). Field-based fitness assessment in young people: the ALPHA health-related fitness test battery for children and adolescents. *British Journal of Sports Medicine,45*(6),518-524.

Safdie, M., Jennings-Aburto, N., Lévesque, L., Janssen, I.,Campirano-Núñez, F., López-Olmedo, N., Aburto, T. y Rivera J. A. (2013). Impact of a school-based intervention program on obesity risk factors in Mexican children. *Salud Publica de Mex ,55*:3,374-87.

Slaughter, M. H., Lohman, T. G., Boileau, R. A., Horswill, C. A., Stillman, R. J., Van Loan, M. D. y Bemben, D. A. (1988). Skinfold equations for estimation of body fatness in children and youth. *Human Biology.,60*(5),709-723.

Stanley, J., Peake, J. M. y Buchheit, M. (2013). Cardiac parasympathetic reactivation following exercise: implications for training prescription. *Sports Medicine.,43*(12),1259-1277.

Szklo M, Nieto J. (2007). Epidemiology: beyond the basics (2nd ed.) Jones & Bartlett Learning.

Tailor, A. M., Peeters, P. H., Norat, T.,Vineis, P. y Romaguera, D. (2010). An update on the prevalence of the metabolic syndrome in children and adolescents. *International Journal of Pediatric Obesity, 5*(3),202-213.

Welk, G. J., De Saint-Maurice Maduro, P. F., Laurson, K. R. y Brown, D. D. (2011). Field evaluation of the new FITNESSGRAM(R) criterion-referenced standards. *American Journal of Preventive Medicine,41*(2),131-142.

Recieved: March 13, 2017

Accepted: June 15, 2017