The effect of exercise on cardiovascular risk markers in Mexican school-aged children: comparison between two structured group routines

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Abstract

Objective. To assess the effects of two groups of exercise routines on cardiovascular disease risk markers. **Material and Methods.** An intervention study was conducted with 319 Mexican school-aged children in which routines were implemented Monday through Friday for 12 weeks. Routine A was the reference group, with 20 min of less intense activity and routine B was the new group with 40 min of aerobic exercises. Body mass index (BMI), waist circumference, fat mass percentage (FM%), systolic and diastolic blood pressure, lipids, lipoproteins, glucose and insulin were measured before and after the intervention. **Results.** Routine A had an effect on diastolic pressure, while routine B had an effect on BMI, FM%, blood pressure and triglycerides. Routine B had a greater effect on blood pressure than routine A. The prevalence of obesity, high blood pressure and hypertriglyceridemia decreased in both groups. **Conclusion.** Aerobic exercise is an effective health promotion strategy to reduce some cardiovascular disease risk markers.

Key words: exercise; cardiovascular diseases; obesity; children; Mexico

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Resumen

Objetivo. Evaluar el efecto de dos rutinas grupales de ejercicio sobre marcadores de riesgo cardiovascular. **Material y métodos.** Intervención en 319 escolares mexicanos. Las rutinas fueron implementadas por 12 semanas (rutina A (referencia): 20 min con ejercicios menos intensos vs rutina B (nueva): 40 min con ejercicios aeróbicos). Se midieron al inicio y al final el índice de masa corporal (IMC), masa grasa (%MG), presión arterial sistólica y diastólica, lípidos, lipoproteínas, glucosa e insulina. **Resultados.** La rutina A tuvo efecto sobre la presión diastólica; la B tuvo efecto sobre el IMC, %MG, presión arterial y triglicéridos. La rutina B tuvo mayores efectos en la presión arterial que la rutina A. Las prevalencias de obesidad, hipertensión arterial e hipertrigliceridemia disminuyeron en ambos grupos. **Conclusiones.** El ejercicio aeróbico es una estrategia de promoción exitosa para reducir algunos marcadores de riesgo cardiovascular.

Palabras clave: ejercicio; enfermedad cardiovascular; obesidad; escolares; México

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An increase in sedentary activities and low physical activity (PA) patterns are the main risk factors for obesity, diabetes and cardiovascular disease (CVD).[1,2] Mexican children spend 4.1 hours/day on sedentary activities[3] and a high prevalence of risk markers has been reported among Mexican children.[4] Meanwhile, the importance of physical activity as an effective strategy to prevent obesity and reduce the risk of CVD has been recognized.[2,5] Aerobic exercise promotes better oxygen transportation, increases HDL cholesterol and decreases blood pressure, total and LDL cholesterol, insulin resistance and abdominal obesity.[5,6] Nevertheless, recommendations on how to achieve specific health benefits are controversial.

To achieve changes in CVD risk factors in children and prevent obesity, the Center for Disease Control and Prevention suggests at least 60 minutes of moderate-intensity PA on most days of the week,[7] while the American Dietetic Association recommends 30 minutes five times/week,[8] and other authors recommend 30-40 minutes 3 to 5 times per week during 12 weeks.[9]

Though some PA interventions have shown contradictory results in terms of reducing obesity and CVD,[1,5,8,10] improvements in triglycerides and blood pressure from PA have been strongly demonstrated,[9,11-13] and the only non-randomized trial in Mexican children showed that a 20 minute exercise routine reduces these markers.[14] In addition, while schools have been proposed as an ideal setting to promote PA,[1,15,16] Mexican school-aged children only spend 12 min/week on moderate to vigorous PA and physical education classes do not meet national recommendations.[17]

In this study, we describe the design, implementation and evaluation of a new routine as compared to a reference routine and its effect on CVD risk markers in Mexican school-aged children.

Material and Methods

Subjects

Children between 8 and 12 years of age from two public elementary schools in Toluca, Mexico State were invited to participate (n=564); those with chronic diseases, who could not exercise or were underweight (body mass index (BMI) ≤5th percentile) (n=11) were excluded. Schools were selected by convenience. Of 171 schools in the city, 58 were located near the research center, 10 had more than 400 children, and six had adequate playgrounds. Only two agreed to participate. All school authorizations were obtained. The children agreed to participate and their parents signed informed consent.

Both schools are urban public elementary schools. According to information provided by the principal, children belong to a medium socio-economic level and most of the parents are government employees. Exercise exposure among all children was the same. Children in both schools receive 1 hr/week of physical education classes in accordance with institutional guidelines and a health promoter is sent to each school for physical education classes.

The study was approved by the Institutional Review and Ethics Board of the National Institute of Perinatology, Mexico City.

Instruments and Procedures

We designed the routines under the supervision of a physical educator from the Mexican National Sport Commission. Each routine included different fitness, gym, aerobics and dance exercises. Children in routine A received the reference activity (20 min of less intensity) while children in routine B received the new activity (40 min of aerobic exercises). Both routines included an initial-phase with warm-up exercises, a middle-phase with aerobic exercises and a final-phase for relaxation, in accordance with national guidelines.[18]

The middle-phase reflected the main difference between routines. Routine A (10 min) included marching, forward and backward walking without moving arms, separate arm and leg elevations, lunges and slow dance moves. Routine B (30 min) included more difficult exercises involving more effort, coordination and intensity. All exercises included simultaneous movements of arms and legs.

Before implementation, routines were tested in a pilot group to evaluate their feasibility. Music used was selected according to rhythms for exercise. Routines were conducted by a certified physical education trainer after school from Monday through Friday during 12 weeks (August- November 2008). Trained personnel supervised exercise sessions daily. Implementation and duration time for routines were based on previous studies.[5,11]

A fitness test was performed for each participant to determine their initial physical fitness level, according to national recommendations.[18] A validated PA questionnaire was administered before and after the intervention to obtain self-reported usual physical activity level (PAL) and hours/day spent on sedentary activities.[19]

To evaluate routine intensity, a computer heart rate monitor (Polar RS400, Kempele, Finland) was used to record mean and highest heart rates (HR) throughout the intervention. Each child was monitored monthly. All HRs were averaged and the %HRmax was calculated using the predicted maximal HR equation proposed by Tanaka et al.[20]

Anthropometric (weight, height, waist circumference), clinical (blood pressure) and biochemical measurements (glucose, total cholesterol, HDL cholesterol, LDL cholesterol, and triacylglycerol (TAG)) were obtained in August and December 2008 using the methodology described elsewhere.[14,21] Fat mass percentage (FM%) was measured using bioelectrical impedance analysis (Quantum II Desktop BIA, RJL) with the equation for the pediatric population. Overweight was defined as BMI ≥85th percentile and obesity as ≥95th percentile.[22] The risk level for abdominal obesity was defined as waist circumference ≥90th percentile, by sex and age.[23] High FM% was defined as ≥30% for girls and ≥25% for boys.[24] Pre-hypertension and hypertension were defined as the average of two measurements ≥90th percentile and ≥95th percentile, respectively.[25] Cutoff levels for biochemical risk variables were: high glucose ≥100 mg/dL,[26] high insulin concentrations ≥15 μU/ml,[27] high HOMA ≥3.16,[28,29] high TAG ≥150 mg/dl,[26] high total cholesterol ≥200 mg/dL,[30] high LDL cholesterol ≥130 mg/dL[26] and low HDL cholesterol <40 mg/dL.[26]After intervention, children's satisfaction was assessed with an informal questionnaire.

Data analysis

The sample size (n=131) was calculated based on the effect of a 20 min exercise routine on systolic blood pressure,[14] with a confidence level of 95% and a power of 80% (EPIDAT version 3.1). Baseline differences were identified using Student's t-test, Mann-Whitney U and Chi-square tests. Data were analyzed by sex, age (≤9, 10, and ≥11 year old) and weight status. Differences before and after the intervention were identified using paired Student's t-test or Wilcoxon tests. Mann-Whitney U was used to identify differences in heart rate and a general linear model was used to compare differences among the effects on CVD risk markers between groups. The Statistical Package for Social Science (SPSS Inc, Chicago TL Version 16) was used for all statistical analyses. Differences were considered significant when $p<0.05$. Intention to treat and complete case analysis was conducted. Children lost to follow up were assumed to have maintained baseline values (baseline observation carried forward imputation).

Results

Intention to treat analysis

Of 319 children, 190 (59.6%) were girls (8 to 12 years of age). The proportion of girls and boys was the same among age categories (p=0.374). Figure 1 presents the percentages of normal weight, overweight and obesity by sex and age, and divided by study group.

Before intervention, children in routine A had higher DBP levels and lower TAG concentrations than children in routine B (Table I). Girls had higher insulin, TAG concentrations and HOMA index than boys ($p<0.022$). BMI, waist circumference, FM%, SBP, insulin concentrations, insulin resistance and HDL cholesterol increased by age ($p<0.030$). Prevalence of CVD risk markers did not differ between groups by sex or age. Children in routine B had a higher prevalence of hypertriglyceridemia (p=0.035) and a lower prevalence of high DBP (p=0.045). No other differences were observed between groups (Table II).

Most children (95%) were classified as beginners (fitness test) and all were classified as sedentary

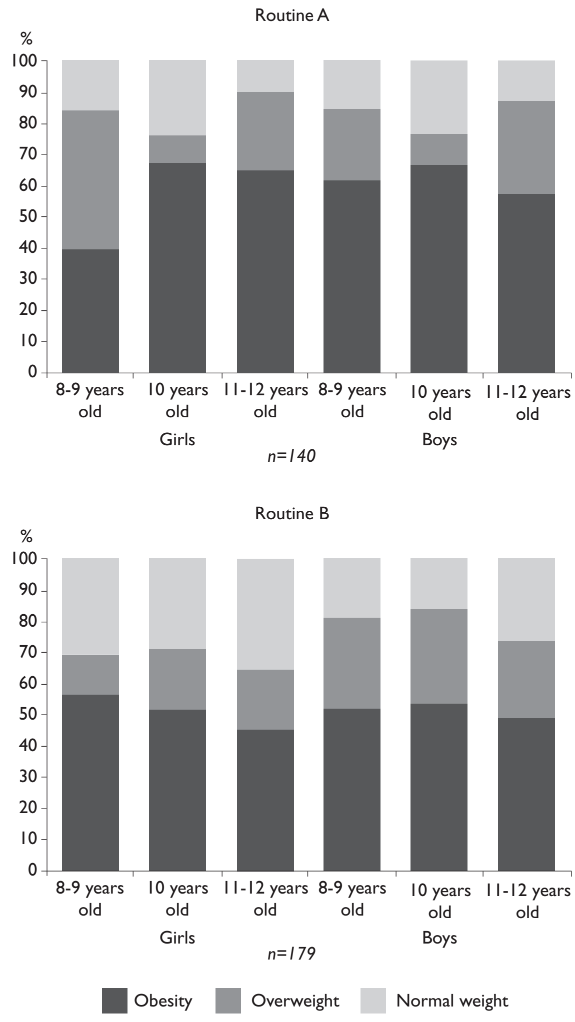

Figure 1. Percentage of normal weight, overweight and obesity in girls and boys by age group. Toluca, Mexico State; 2009.

TABLE I
DIFFERENCES IN ANTHROPOMETRIC, CLINICAL AND BIOCHEMICAL BASELINE VARIABLES, BY STUDY GROUP. TOLUCA, MEXICO STATE; 2009

	Routine A (n=140)	*Routine B (n=179)*	*p value*
Age (years)*	10.00 (8.00 – 12.02)	10.01 (8.00 – 12.08)	0.458
Boys‡	40.7 (57)	40.2 (72)	0.929
Girls‡	59.3 (83)	59.8 (107)	
Body mass index*	19.25 (13.36-30.22)	19.19 (12.61-33.15)	0.823
Waist circumference (cm)§	70.65±10.60	71.96±11.83	0.308
% Body fat mass*	25.05 (11.70-42.89)	25.08 (10.00-59.00)	0.771
Systolic blood pressure (mmHg)*	92.00 (60.00-118.00)	94.00 (59.00-124.00)	0.326
Diastolic blood pressure (mmH)*	57.50 (27.00-79.00)	49.00 (24.00-78.00)	0.001#
Glucose (mg/dL)§	96.64±8.66	96.35±7.61	0.752
Insulin (µU/mL)*	5.96 (1.30-26.40)	5.63 (0.15-57.00)	0.971
Insulin resistance (HOMA)*	1.43 (0.30-7.13)	1.32 (0.30-11.81)	0.992
Total cholesterol (mg/dL)§	169.28±23.37	171.55±27.79	0.439
LDL cholesterol (mg/dL)§	105.52±21.73	102.66±25.08	0.288
HDL cholesterol (mg/dL)§	44.80±7.09	43.57±6.65	0.114
Triglycerides (mg/dL)§	91.25 (43.00-271.50)	109.00 (42.00-281.00)	0.001#

* Difference analyzed with Mann-Whitney U test, median (range).
‡ Difference analyzed with Chi-square test, % (n)
§ Difference analyzed with Student's t-test , mean±SD
\# p <0.05

TABLE II
BASELINE AND FINAL PREVALENCE OF CARDIOVASCULAR DISEASE RISK MARKERS, BY STUDY GROUP. TOLUCA, MEXICO STATE; 2009

Prevalence	*Routine A (n= 140)*			*Routine B (n=179)*		
	Baseline	*Final*	*p value**	*Baseline*	*Final*	*p value**
Overweight/obesity (%)	43.6	38.6	0.042‡	48.6	42.5	0.001‡
Abdominal obesity (%)	23.6	25.2	0.157	25.7	26.3	0.655
High fat mass percentage (%)	35	36.4	0.414	36.3	35.8	0.317
High systolic blood pressure (%)	1.4	0	0.046‡	2.2	0	0.032‡
High diastolic blood pressure (%)	10	0	0.001‡	3.4	0	0.020‡
High glucose (%)	35.7	33.7	0.162	27.9	25.3	0.197
High insulin (%)	9.3	11.1	0.593	12.4	15.6	0.109
Insulin resistance (%)	14.3	13.3	0.808	16.4	14.0	0.572
High total cholesterol (%)	8.6	5.7	0.102	15.1	12.3	0.398
High LDL cholesterol (%)	23.7	20.7	0.617	29.2	25.8	0.233
Low HDL cholesterol (%)	12.2	13.6	0.275	15.7	11.8	0.366
High triglycerides (%)	13.6	10	0.040‡	22.9	17.9	0.021‡

* Differences from baseline to final prevalence analyzed by chi-square test.
‡ p<0.05

(PAL=1.02), spending 4.2 hours/day on sedentary activities. Overweight and obese children had lower PAL than normal-weight children (1.01 *vs*. 1.02, p=0.008); boys had higher PAL than girls (1.02 *vs*. 1.01, p=0.012).

The participation rate in the intervention was 90% for both routines. Children in routine B showed higher heart rates (Figure 2) and more children in routine B achieved the aerobic exercise threshold of 120 beats/min (81.9 *vs*. 65.9%, p= 0.002) and worked at a higher %HRmax (65.44% *vs*. 62.03%, p<0.001). Children in routine A presented a significant decrease in DBP, with a positive effect shown in 47%. Fat mass percentage, BMI, SBP, DBP and TAG decreased in the children in routine B, with a positive effect ranging between 38-45% of children. Mean changes for the variables are presented in Table III.

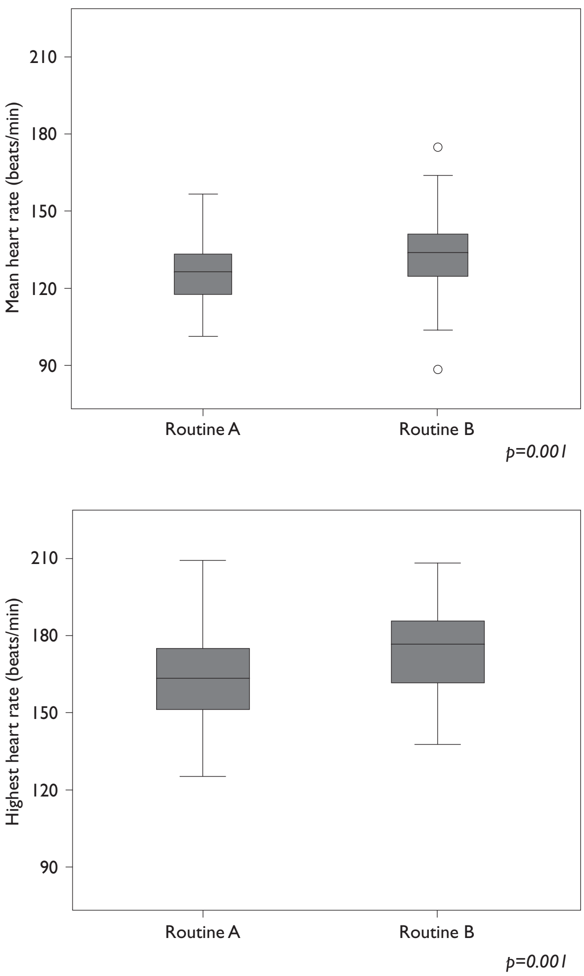

FIGURE 2. DIFFERENCES IN HEART RATE MEASURED DURING THE INTERVENTION, BY STUDY GROUP (N=319).

The effect on CVD risk markers was not different between boys and girls. In routine A, there was a greater effect on DBP for overweight or obese children than for those with normal weight (-12.06 vs -6.78 mmHg, p=0.029). A greater effect on DBP was shown for younger children (-14.22 mmHg for 8-9 years old; -7.54 for 10 years old; -3.36 mmHg for 11-12 years old; p=0.001). For children in both groups with baseline alterations, a greater effect on all CVD risk markers was observed compared to children with normal values (p<0.041). The prevalence of overweight and obesity, hypertriglyceridemia and high blood pressure decreased for both groups (Table II). Inter-group differences showed that routine B had a greater effect on SBP and DBP compared to routine A (Table III).

Complete case analysis

Of the 319 children in the intervention, 105 (33%) dropped out, mainly because they had another evening activity or did not had enough time. Baseline characteristics were similar between participants and those who dropped out (p>0.05).

Greater intra-group differences were observed for the same CVD risk markers. Additionally, a positive effect on FM% (-2.83±1.65%) and HDL (2.86±3.67mg/dL) (p<0.010) was shown for children in routine A. Inter-group differences were also similar.

After six months of intervention, all children continued to be sedentary (PAL =1.02); no differences were observed between groups. Most of the children (98%) reported that they liked the routines; 88% said they would like to practice them again.

Discussion

To our knowledge, this is the second school-based study done in Mexico to report positive effects on some CVD risk markers in children. Routine B showed a greater improvement in SBP and DBP, likely associated with aerobic exercise. These results will enable guidelines to be proposed to develop better exercise programs for Mexican school-aged children.

The positive effect of exercise on SBP and DBP values was in accordance with results reported in previous studies; in Mexican children, reductions in blood pressure were observed with a 20 min exercise routine,[14] and in African-American teenage girls, aerobic exercise proved to reduce blood pressure more than the regular physical education classes.[31]

In terms of the reductions shown in the prevalence of BMI and overweight/obesity, our results are similar to previous studies with 6-10 year old chil-

TABLE III
COMPARISON OF CHANGES IN CARDIOVASCULAR DISEASE RISK MARKERS, BY STUDY GROUP. TOLUCA, MEXICO STATE; 2009.

*Change in variables (delta values)**	*Routine A (n=140)*	*Routine B (n=179)*	*p value‡*
Body mass index	-0.67 (-0.17 to 0.05)	-0.09 (-0.96 70 -0.84)‡	0.675
Abdominal circumference (cm)	0.16 (-0.14 to 0.46)	0.15 (-0.12 to 0.42)	0.960
Body fat mass (%)	-2.06 (-2.62 to -1.50)	-1.88 (-2.45 to -1.31)§	0.662
Systolic blood pressure (mmHg)	0.26 (-1.65 to 2.17)	-3.22 (-4.65 to -1.79)§	0.004&
Diastolic blood pressure (mmHg)#	-5.64 (-8.58 to -2.70)§	-9.51 (-12.02 to -7.00)§	0.001&
Glucose (mg/dL)	0.60 (-1.21 to 2.41)	-0.88 (-1.70 to -0.06)	0.114
Insulin (μU/mL)	0.91 (0.16 to 1.66)	1.17 (0.44 to 1.90)	0.643
Insulin resistance (HOMA)	0.26 (0.06 to 0.46)	0.15 (-0.01 to 0.31)	0.429
Total cholesterol (mg/dL)	1.08 (-1.83 to 3.99)	-0.70 (-3.38 to 1.98)	0.378
HDL cholesterol (mg/dL)	1.61 (0.42 to 2.80)	0.89 (-0.21 to 1.99)	0.567
LDL cholesterol (mg/dL)	-1.75 (-5.84 to 2.34)	-0.26 (-3.44 to 2.92)	0.385
Triglycerides (mg/dL)#	-3.10 (-8.83 to 2.63)	-7.65 (-12.38 to -2.92) c	0.301

* Change in score (final mean minus baseline mean)
‡ Mean (95% confidence interval) analyzed by general linear model
§ Significant intra-group change analyzed by Wilcoxon test.
# Adjusted by baseline value or concentration.
& Significant inter-group change, $p<0.05$

dren using similar interventions (short term, aerobic exercise).[32,33] And while prevalence of overweight/obesity decreased in both groups, the reduction was significant for routine B, which was associated with longer duration (200 min/week *vs*. 100 min/week); this result is consistent with a meta-analysis that proposed that 155-180 min a week of moderate to intense exercise is needed to reduce weight and body fat.[32] In accordance with other studies, a reduction in FM% was observed for routine B,[1,5,27,33-35] and the reductions were similar with those found in 9-10 year-old children from Spain.[36]

TAG concentrations and the prevalence of hypertriacylglycerolemia also decreased in the children in routine B, in accordance with what has been reported previously for school-aged children from different countries.[6,12] Also similar to previous studies, children with baseline alterations showed greater changes than children with normal values.[6,9,11,12,34]

As was the case for the results of a previous Mexican study, no positive effects were observed for glucose, insulin, insulin resistance, total cholesterol or LDL cholesterol;[14] other studies have shown inconsistent results for these markers,[34,37] with some of the positive interventions having also included dietary modifications or an educational component.[13,38] In addition, Andersen et al. proposed that 90 min sessions are needed to modify insulin resistance, which seems to be the central feature of the CVD factors cluster.[39]

Furthermore, it has been hypothesized that genetics affect exercise performance and the capacity of exercise to change body composition, blood pressure and other biochemical serum concentrations.[40] Therefore, due to Hispanics having an increased risk of diabetes and CVD associated with both genetics and cultural background,[41] comparing our data with that of children with different ethnic and geographic conditions could be biased because of the difference in responses to exercise interventions among children with different backgrounds.[40,41]

A high attrition rate is one of the main limitations of this study. Due to the dropout rate of 33%, the analysis presented is based on intention to treat.[2,5] In addition, school selection and individual routine designation was not possible, resulting in baseline differences between groups.

Since diet was not measured, the possibility that some subjects may have increased or decreased their dietary intake cannot be ruled out. In addition, children may modify some lifestyle behaviors just to be included in the study. Furthermore, no follow up measures were possible to evaluate the effect of the results and the usual PA among children was measured subjectively and therefore may not provide an accurate description of activity. Puberty was another variable that was not assessed and it is well known to be associated with body fat and insulin resistance.

In this study, children were able to exercise at an average of 60% HRmax and the intervention lasted only three months, lower than the recommendation for achieving positive results.[11,12] In addition, since daily HR was not measured for all children, the wide intra- and inter-individual variation of this measurement could be a source of bias.[10] This variation was minimized by controlling confounding factors. In addition, the inability to control children individually was an obstacle during intervention. Insufficient playground space was another limitation.

Finally, while both exercise routines had positive effects on some CVD risk markers, routine B had a greater positive effect on high blood pressure. The low exercise patterns, high prevalence of obesity and high proportion of CVD risk alterations in these children are consistent with previous findings in Mexico.[4,21,14] We propose that school physical education classes and/or extracurricular exercise programs provide aerobic exercises with moderate to vigorous intensity, at least five times/week, with 40 minutes duration.

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Declaration of conflicts of interest

We declare that we have no conflicts of interest.

References

1. Zahner L, Puder J, Roth R, Schmid M, Guldimann R, Pühse U *et al.* A school-based physical activity program to improve health and fitness in children aged 6-13 years ("Kinder-Sportstudie KISS"): study design of a randomized controlled trial [ISRCTN15360785]. BMC Public Health 2006;6:147.
2. Marcus B, Williams D, Dubbert P, Sallis J, King A, Yancey A *et al.* Physical activity intervention studies: what we know and what we need to know: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity); Council on Cardiovascular Disease in the Young; and the Interdisciplinary Working Group on Quality of Care and Outcomes Research. Circulation 2006;114(24):2739-2752.
3. Hernández B, Gortmaker S, Colditz G, Peterson K, Laird N, Parra-Cabrera S. Association of obesity with physical activity, television programs and other forms of video viewing among children in Mexico city. Int J Obes Relat Metab Disord 1999;23(8):845-854.
4. Balas-Nakash M, Villanueva-Quintana A, Tawil-Dayan S, Schiffman-Selechnik E, Suverza-Fernández A, Vadillo-Ortega F et al. Estudio piloto para la identificación de indicadores antropométricos asociados a marcadores de riesgo de síndrome metabólico en escolares mexicanos. Bol Med Hosp Infan Méx 2008;65(3):100-109.
5. Kelley G, Kelley K. Aerobic exercise and lipids and lipoproteins in children and adolescents: a meta-analysis of randomized controlled trials. Atherosclerosis 2007;191(2):447-453.
6. Froberg K, Andersen L. Mini review: physical activity and fitness and its relations to cardiovascular disease risk factors in children. Int J Obes (Lond). 2005;29(Suppl 2):S34-39.
7. U.S. Department of Health and Human Services. U.S. Department of Agriculture. Dietary Guidelines for Americans, 2005. 6th Edition. Washington, DC: U.S. Government Printing Office, 2005.
8. Position of the American Dietetic Association: individual-, family-, school-, and community-based interventions for pediatric overweight. J Am Diet Assoc 2006;106(6):925-945.
9. Torrance B, McGuire K, Lewanczuk R, McGavock J. Overweight, physical activity and high blood pressure in children: a review of the literature. Vasc Health Risk Manag 2007;3(1):139-149.
10. Epstein L, Paluch R, Kalakanis L, Goldfield G, Cerny F, Roemmich J. How much activity do youth get? A quantitative review of heart-rate measured activity. Pediatrics 2001;108(3):E44.
11. Tolfrey K, Jones A, Campbell I. The effect of aerobic exercise training on the lipid-lipoprotein profile of children and adolescents. Sports Med 2000;29(2):99-112.
12. Tolfrey K, Jones A, Campbell I. Lipid-lipoproteins in children: an exercise dose-response study. Med Sci Sports Exerc 2004;36(3):418-427.
13. Nemet D, Barkan S, Epstein Y, Friedland O, Kowen G, Eliakim A. Short- and long-term beneficial effects of a combined dietary-behavioral-physical activity intervention for the treatment of childhood obesity. Pediatrics 2005;115(4):443-449.
14. Perichart-Perera O, Balas-Nakash M, Ortiz-Rodríguez V, Morán-Zenteno J, Guerrero-Ortiz J, Vadillo-Ortega F. A program to improve some cardiovascular risk factors in Mexican school age children. Salud Publica Mex 2008;50(3):218-226.
15. Pate R, Davis M, Robinson T, Stone E, McKenzie T, Young J *et al.* Promoting physical activity in children and youth: a leadership role for schools: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Physical Activity Committee) in collaboration with the Councils on Cardiovascular Disease in the Young and Cardiovascular Nursing. Circulation 2006;114(11):1214-1224.
16. Dobbins M, De Corby K, Robeson P, Husson H, Tirilis D. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6-18. Cochrane Database Syst Rev 2009;21(1):CD007651.
17. Jennings-Aburto N, Nava F, Bonvecchio A, Safdie M, González-Casanova I, Gust *et al.* Physical activity during the school day in public primary schools in Mexico City. Salud Publica Mex 2009;51:141-147.
18. Comisión Nacional de Cultura Fisica y Deporte. Pruebas de valoración fisica. Programa Nacional de Actividad Física 2001. Mexico City: CONADE, 2001.
19. Hernández B, Gortmaker S, Laird N, Colditz G, Parra-Cabrera S, Peterson K. Validity and reproducibility of a questionnaire on physical activity and non-activity for school children in Mexico City. Salud Publica Mex 2000;42(4):315-323.
20. Tanaka H, Monahan K, Seals D. Age-predicted maximal heart rate revisited. J Am Coll Cardiol 2001;37(1):153-156.

21. Perichart-Perera O, Balas-Nakash M, Schiffman-Selechnik E, Barbato-Dosal A, Vadillo-Ortega F. Obesity increases metabolic syndrome risk factors in school-aged children from an urban school in Mexico city. J Am Diet Assoc 2007;107(1):81-91.
22. Centers for Disease Control and Prevention, National Center for Health Statistics.
CDC growth charts. Georgia, United States: CDC [Available at http://www.cdc.gov/growthcharts/.][Accessed 2009 July 11].
23. Fernandez JR, Redden F, Pietrobelli A, Allison DB. Waist circumference percentiles in nationally representative sample of African-American, European-American and Mexican-American children and adolescents. J Pediatr 2004;145(4):439-444.
24. Williams D, Going S, Lohman T, Harsha D, Srinivasan S, Webber L *et al*. Body fatness and risk for elevated blood pressure, total cholesterol, and serum lipoprotein ratios in children and adolescents. Am J Public Health 1992;82(3):358-63.
25. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics 2004;114:555-76.
26. International Diabetes Federation Task Force on Epidemiology and Prevention of Diabetes. The metabolic syndrome in children and adolescents: the IDF consensus. Diabetes Voice 2007;52(4):1-24.
27. Conwell L, Trost S, Brown W, Batch J. Indexes of insulin resistance and secretion in obese children and adolescents: a validation study. Diabetes Care 2004;27(2):314-319.
28. Keskin M, Kurtoglu S, Kendirci M, Atabek M, Yazici C. Homeostasis model assessment is more reliable than the fasting glucose/insulin ratio and quantitative insulin sensitivity check index for assessing insulin resistance among obese children and adolescents. Pediatrics 2005;115(4):500-503.
29. Tresaco B, Bueno G, Pineda I, Moreno LA, Garagorri JM, Bueno M. Homeostatic model assessment (HOMA) index cut-off values to identify the metabolic syndrome in children. J Physiol Biochem 2005;61(2):381-388.
30. Gidding S, Dennison B, Birch L, Daniels S, Gillman M, Gilman M *et al*. Dietary recommendations for children and adolescents: a guide for practitioners: consensus statement from the American Heart Association. Circulation 2005;112(13):2061-2075.
31. Ewart CK, Young DR, Hagberg JM. Effects of school-based aerobic exercise on blood pressure in adolescent girls at risk for hypertension. Am J Public Health 1998;88(6):949-51.
32. Lazaar N, Aucouturier J, Ratel S, Rance M, Meyer M, Duché P. Effect of physical activity intervention on body composition in young children: influence of body mass index status and gender. Acta Paediatr 2007;96(9):1315-1320.
33. Atlantis E, Barnes E, Singh M. Efficacy of exercise for treating overweight in children and adolescents: a systematic review. Int J Obes (Lond) 2006;30(7):1027-1040.
34. Strong W, Malina R, Blimkie C, Daniels S, Dishman R, Gutin B *et al.* Evidence based physical activity for school-age youth. J Pediatr 2005;146(6):732-737.
35. Carrel AL, Clark RR, Peterson SE, Nemeth BA, Sullivan J, Allen D. Improvement of fitness, body composition, and insulin sensitivity in overweight children in a school-based exercise program: a randomized, controlled study. Arch Pediatr Adolesc Med 2005;159:963-968.
36. Martínez Vizcaíno V, Salcedo Aguilar F, Franquelo Gutiérrez R, Solera Martínez M, Sánchez López M, Serrano Martínez S *et al*. Assessment of an after-school physical activity program to prevent obesity among 9- to 10-year-old children: a cluster randomized trial. Int J Obes (Lond) 2008;32(1):12-22.
37. Webber L, Osganian S, Feldman H, Wu M, McKenzie T, Nichaman M *et al*. Cardiovascular risk factors among children after a 21/2 year Intervention-the CATCH Study. Prev Med 1996;25(4):432-41.
38. Woo K, Chook P, Yu C, Sung R, Qiao M, Leung S *et a*l. Effects of diet and exercise on obesity-related vascular dysfunction in children. Circulation 2004;109(16):1981-1986.
39. Andersen L, Harro M, Sardinha L, Froberg K, Ekelund U, Brage S *et al*. Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). Lancet 2006;368(9532):299-304.
40. Rankinen T, Bouchard C. Genetis and blood pressure response to exercise, and its interactions with adiposity. Prev Cardiol 2002;5(3):138-44.
41. Webber LS, Harsha DW, Phillips GT, Srinivasan SR, Simpson JW, Berenson GS. Cardiovascular risk factors in Hispanic, white, and black children: the Brooks County and Bogalusa Heart studies. Am J Epidemiol 1991;133(7):704-14.