COMPARATIVE STUDY OF RISK FACTORS RELATED TO CARDIOVASCULAR DISEASE IN CHILDREN FROM BOGOTÁ, COLOMBIA AND TOLUCA, MEXICO

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Abstract

Introduction: Currently, cardiovascular risk factors have not been studied so extensively in young people. Objective: To compare the cardiovascular risk factor between Colombian and Mexican children. Patients and methods: This was a transversal, descriptive, comparative and clinical study. 30 children of primary school aged 6-12 from Bogotá, Colombia were matched by age with a sample of 30 children from Toluca, Mexico. Cardiovascular risk factors measured were Body Mass Index (BMI), serum lipid profile, glucose and homocystein (Hcy). Besides we applied the validated surveys formats for food (dietary history), physical activity (International Physical Activity Questionnaire, IPAQ), alcohol consumption and smoking. Results: BMI was higher in Mexican children than in Colombian (20.43 ± 3.35 vs 16.92 ± 3.46) ($p \leq 0.001$). Among Mexican children, 20% (6) of them had blood glucose concentration greater than 100 mg/dl, 6.6% (2) had triglycerides greater than 200 mg/dl, 36.6% (11) had cholesterol levels greater than 170 mg/dl, 16% (53.3) had HDL lower than the recommended limits, and 60% (18) had LDL above the normal limit. For the Colombian population these percentages were of 0, 3.3, 46.6, 13.33 and 53.3 respectively. Discussion: Mexican children had a stronger correlation between BMI and atherogenic indices and less physical activity than Colombian. Of the 30 Mexican children enrolled in the study only 13% had none of the cardiovascular risk factors, while in the Colombian this percentage was of 33. Conclusion: Latin American children are not metabolically homogeneous, Mexican children are at high risk of cardiovascular disease.

Key words: cardiovascular risk factors, children, homocysteine, obesity, overweight.

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Introduction

Cardiovascular disease is the leading cause of death and disability worldwide. Data from the World Health Organization (WHO) write down that Latin America is currently experiencing a large-scale epidemic of cardiovascular disease.[1] Among the recognized cardiovascular risk factors (CVRF) there are poor eating habits, smoking, alcoholism, hypertension, sedentarism, high cholesterol levels, diabetes, psychoactive substance use and stress.[2] New CVRF are homocysteine (Hcy), C reactive protein (CRP), interleukins (IL), etc.

Although cardiovascular diseases are manifested mainly in adults and elderly people, recent studies have shown an increased cardiovascular risk in children, related to lifestyles and bad habits acquired at school and in each family, thereby increasing the likelihood of dyslipidemia, hypertension and diabetes in adolescence and young adults.[3] For example, based on data from pathology studies, it is known that the atherosclerotic process begins in childhood and the degree of spread of lesions in children and young adults correlates with the presence of the same risk factors identified in adults.[4] Thus, CVRF start from childhood, showing no serious consequences at this stage of life, but certainly they will produce deleterious effects in adulthood.

The National Survey of the Nutritional Situation (ENSIN) in Colombia 2010, found a prevalence of 18.9% for overweight and 5.2% for obesity in children aged 5-9 years, with the highest proportion in Barranquilla, Bogotá, Cali and Medellin. Compared to the 2005 data it was observed an increase of 4%, and 6% for overweight and obesity respectively in children aged 8-9 years.[5] On the other hand, in Mexico the trends for overweight and obesity in children are really alarming.[6]

Based on the above, the aim of this study was to compare CVRF between primary school children of Bogotá, Colombia, and Toluca, Mexico, in order to design effective intervention programs against cardiovascular disease.

Methods

This clinical, prospective and comparative study was carried out in Bogotá, Colombia and Toluca, Mexico, from January 2012 to January 2013.

Population

60 children aged 6-12 from the Primary Schools “Manuel Elkin Patarroyo” (Bogotá, Colombia) and “Lic. Isidro Fabela” (Toluca, Mexico), were matched by sex and age. If there was not a girl or a boy with the exact age we proceeded to select the most proximal to the needed age.

Inclusion criteria

Students with written parental permission. We excluded all those children who did not meet the preparation requirements for sampling and those whose parents did not authorize their participation by signing the informed consent.

Instruments

Clinical and sociodemographic data were obtained from the clinical history. Food eating habits were evaluated with the dietary history. All the foods recorded in 24h-recalls were classified in four food groups from the Mexican food pyramid,[7] which were fruits and vegetables; a second level containing bread and cereals; the third level contains animal products and the fourth level sugar and fats. The physical activity was evaluated with the International Physical Activity Questionnaire (IPAQ); alcohol consumption and smoking were evaluated whether an active addiction in children and parents.

Anthropometric measures

Body weight was measured in an overnight fasting status without shoes in a minimal clothing state by the use of a digital scale (Inner Scan, Tanita) to the nearest 0.1 kg. Height, waist and hip circumferences were measured using a non-stretched tape measure to the nearest 0.1 cm. Body Mass Index (BMI) was calculated as weight in kg divided by height in meters squared. The cut-off points for overweight and obesity were defined under the Asociación Española de Pediatría de Atención Primaria (Table 1).[8] In order to measure skinfolds (subscapular, thigh, triceps) (mm) we used a caliper and followed the recommendations of the Sociedad Española de Nutrición Comunitaria.[9]

Table 1. Cutoff values for Body Mass Index

	Overweight		Obesity	
Age	Boys	Girls	Boys	Girls
6	17.55	17.34	19.78	19.65
6.5	17.71	17.53	20.23	20.08
7	17.92	17.75	20.63	20.51
7.5	18.16	18.03	21.09	21.01
8	18.44	18.35	21.60	21.57
8.5	18.76	18.69	22.17	22.18
9	19.10	19.07	22.77	22.81
9.5	19.46	19.45	23.39	23.46
10	19.84	19.86	24.00	24.11
11	20.55	20.74	25.10	25.42
11.5	20.89	21.20	25.58	26.05
12	21.22	21.68	26.02	26.07

Blood pressure
Blood pressure (mmHg) was measured using a pediatric sphygmomanometer and appropriately sized cuff. We followed the recommendations of the National High Blood Pressure Education Program (NHBPEP) Working Group on Hypertension Control in Children and Adolescents.[10]

Blood test
After a fasting period of 12 hours blood samples were collected (BD Vacutainer®) for the assessment of: glucose (mg/dl), lipid profile (total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), very-low density lipoprotein (VLDL), triglycerides) (mg/dl) (rx ImolaTM, Randox in Mexico and Mindray BS 200 de Annar Diagnostica in Colombia). A blood sample (EDTA tube) of each child was centrifuged at 2500 rpm and kept -20°C until processing Hcy (kit of Wiener Laboratorios S.A.I.C., Argentine, processed in Mindray BS 200, Annar Diagnostica). The cutoff value for fasting blood glucose was 5.6 mM according to recommendations by the American Diabetes Association.[11] To classify the lipid profile we observed the recommendations of the Asociación Española de Pediatría de Atención Primaria (Table 2).[8]

Atherogenic indices
Atherogenic index (AI) was calculated by the equation: AI = [(total cholesterol - HDL)/HDL]. We also calculated the triglycerides/HDL, total cholesterol/HDL and LDL/HDL ratios.

Ethics
This study was approved by the Bioethics and Research Committee of the Medical Sciences Research Center (CICMED), Autonomous University of the State of Mexico (UAEMex), date code: 09/05/13, and was subjected to the ethical and moral value judgments of Helsinki. We also followed the Bacteriologists bioethical and ethical aspects specified in the resolution No. 008430 of 1993, Title II, Chapter I (of the ethical aspects of research in humans) of the Ministry of Social Protection of Colombia and the General Health Law of Mexico. Written consent was obtained from all parents.

Statistics
The data was entered into the Microsoft Excel 97 for Windows. Statistical analysis of the data was carried out using SPSS version 17. Continuous variables were expressed as mean ± SD. As there was no normal distribution, we compared the groups using the Mann-Whitney U-test. The degree of association between variables was evaluated using Spearman's correlation. Lineal regression analysis selecting systolic blood pressure, cholesterol, triglycerides, HDL, LDL, VLDL and Hcy as independent variables and AI as the dependent variable was calculated. A two-sided p = 0.05 was considered to be statistically significant

Results
General characteristics
The clinical and biochemical data are shown in Table 3. Age, height and gender distribution did not differ significantly within the two studied groups.

Dietary habits
The dietary intake was described in Table 4. In Mexico, the most frequent foods were milk (80%), fruit (59.9%), juice (53.2%), vegetables (52.9%), junk food (30%), sugar beverages (26.6%) and legumes (26.6%). The intake of meat was only 2.6 days/week, fish was eaten 1.3 days/week and eggs were eaten 4 days/week. In the Colombian children the most frequent foods (ingested at least once per day) were juice (66.05%), fruit (56.25%), cakes and candies (49.85%), milk (46.15%), yogurt (45.7%), junk food (30.1%) and vegetables (29.8%). Meat was eaten 2.78 times per week, fish 0.98 times per week, and eggs 4 times per week.

Physical activity
Daily physical activity was less than an hour for Mexican children, while the time dedicated to watch TV was of 1.6 hour per day. The days/week that Mexican children dedicated to computer ga

Table 2. Cutoff values for lipid profile

	Optimal value	Limit value	Outrange value
Total cholesterol (mg/dl)	≤ 170	170-199	≥ 200
LDL cholesterol (mg/dl)	≤ 100	100-129	≥ 130
HDL cholesterol (mg/dl)			≤ 40
Triglycerides (mg/dl)			≥ 200

HDL: high-density lipoprotein, LDL: low-density lipoprotein.

	Colombia	Mexico	p
Age	9 ± 1.9	8.8 ± 2.1	
Females	21 (70%)	22 (73.33%)	
Males	9 (30%)	8 (26.66%)	
Weight (Kg)	30.3 ± 10.1	36.5 ± 12.1	0.03
BMI	16.9 ± 3.4	20.4 ± 3.3	≤ 0.001
Waist/hip ratio	0.89 ± 0.05	0.88 ± 0.08	
Glucose (mg/dl)	85.7 ± 6	93.6 ± 7.8	≤ 0.001
Slaughter Fat (%)	23.3 ± 5.4	33.5 ± 13.2	≤ 0.001
Lean mass (%)	22.8 ± 5.9	23.9 ± 8	≤ 0.001
Total cholesterol (mg/dl)	173 ± 23	162 ± 23	
HDL (mg/dl)	50 ± 8	51 ± 22	≤ 0.001
LDL (mg/dl)	103 ± 20	107 ± 25	
Triglycerides (mg/dl)	95 ± 36	113 ± 69	
Homocysteine	4.7 ± 1.1	5.04 ± 3.7	
Atherogenic index	2.4 ± 0.5	2.1	≤ 0.001
Triceps skinfold	11.2 ± 4.5	22.5 ± 16.5	≤ 0.001
Subscapular skinfold	8.4 ± 4.1	20.8 ± 10.7	≤ 0.001

BMI: body mass index, HDL: high density lipoproteins, LDL: low density lipoproteins.

Table 3. Clinical and biochemical data

	Colombia	Mexico
More than once per day (%)	Juice (38)	Milk (40)
	Junk food (30.1)	Fruit (23.3)
	Fruits (26.15)	Vegetables (16.6)
	Sugar beverages (24.2)	Juice (16.6)
	Cakes and candies (24.05)	Cakes (13.3)
	Yogurt (19.9)	Sugar beverages (10)
	Milk (18.25)	Coffee (6.6)
Once per day (%)	Fruits (30.1)	Milk (40)
	Vegetables (29.8)	Juice (36.6)
	Juice (28.05)	Vegetables (36.6)
	Milk (27.9)	Fruit (36.6)
	Cakes and candies (25.8)	Junk food (30)
	Yogurt (25.8)	Legumes (26.6)
	Coffe (23.55)	Sugar beverages (16.6)

Table 4. Dietary intake

mes was of 1.2 and the time this activity demanded was less than an hour. By contrast, the Colombian children dedicated an average of 1.5 hours for daily physical activity and only 1 for TV.

Alcohol and smoking

8 (26.66%) Mexican children had already tasted alcohol at the time of the study, beginning about at 7.25 years old. By contrast, only two children in this same population had smoke (average age 9). 14 fathers and 12 mothers were active alcohol consumers. 7 fathers and 3 mothers were active smokers. What we observed in the Colombian children was that 80% has already drunk alcohol and 2.2% of them have tried smoking.

Anthropometric data

Weight was higher in Mexican children (36.59 ± 12.18 kg) than in Colombian (30.37 ± 10.1 kg) ($p = 0.03$) as well as the BMI (20.43 ± 3.35 vs 16.92 ± 3.46) ($p \leq 0.001$). In relation to the skinfolds, the triceps was larger in Mexicans (22.5 ± 16.5 mm) than in Colombians (11.28 ± 4.54 mm) ($p \leq 0.001$), this was similar to the subscapular skinfold (20.8 ± 8.45 vs 10.77 ± 4.19 mm ($p \leq 0.001$). Slaughter fat percentage was higher in Mexican population than in Colombians (33.57 ± 13.27 vs 23.39 ± 5.44) ($p \leq 0.001$). The lean mass percent was higher in Mexican population than in Colombia (23.94 ± 8.03 vs 22.87 ± 5.97) ($p \leq 0.001$). Fat mass kg was greater in the Mexican population (12.65 ± 7.16 vs 7.5 ± 4.55) ($p \leq 0.001$).

Going inside of the data it showed an astonishing difference in overweight and obesity prevalence. While in Mexico there were 11 (36.66%) children with overweight and seven (23.33%) with obesity, in Colombia there was only one child with overweight and two with obesity.

Blood pressure

While in the Colombian sample, nine children (30%) had systolic blood pressure (SBP) higher than the percentile 95th by age and height, in the Mexican children, unexpectedly there was no any case of hypertension.

Biochemical data

Among Mexican children, 20% [6] of them had blood glucose concentration greater than 100 mg/dl, 6.6% [2] had triglycerides greater than 200 mg/dl, 36.6% [11] had cholesterol levels greater than 170 mg/dl, 16% (53.3) had HDL lower than the recommended limits, and 60% [18] had LDL above the normal limit. For the Colombian population these percentages were of 0, 3.3, 46.6, 13.33 and 53.3 respectively.

When comparing both countries we got that glucose was higher in Mexican children than in Colombians (93.6 ± 7.89 vs 85.73 ± 6.08 mg/dl) ($p \leq 0.001$), HDL was lower in Colombians than in the Mexican population (50.58 ± 8.21 vs. 51.5 ± 22.78 mg/dl) ($p \leq 0.001$). Hcy showed no statistical significant differences neither between countries nor gender (5.15 ± 4 in Mexican boys, 4.7 ± 2.8 Mexican girls, 4.7 ± 1.1 Colombian boys and girls) although there was a more extreme distribution in Mexican children (range 1.7-21) than Colombian [2.9-6.3].

Atherogenic indices

AI was higher in Colombian students than in Mexicans (2.48 ± 0.54 vs 2.15 ± 0.05) ($p \leq 0.001$). Analyzing the Pearson correlation results between BMI and four atherogenic indices (Table 5), there was a significant positive correlation among three them in the Mexican children. The lineal regression analysis selecting SBP, cholesterol, triglycerides, HDL, LDL, VLDL and Hcy as independent variables and AI as the dependent variable, showed that HDL cholesterol represented a protective factor ($p \leq 0.001$), while the significant risk was for LDL (0.02) and VLDL (0.011).

Atherogenic index	Children		
	Both countries	Colombia	Mexico
BMI vs AI	-0.0964	-0.0591	0.3584*
BMI vs TG/HDL	0.0273	0.1233	0.4043*
BMI vs Chol/HDL	-0.0964	-0.0591	0.3584*
BMI vs LDL/HDL	-0.1416	-0.1512	0.3363

BMI: Body Mass Index, Chol: cholesterol, TG: triglycerides, HDL: high-density lipoproteins, LDL: low-density lipoproteins. *: ≤ 0.05

Table 5. Pearson correlation between BMI and atherogenic indices

Discussion

The atherogenic potential of carbohydrates in the diet is associated with hyperinsulinemia, generating a proatherogenic state in endothelium, as a result of metabolic disorders, and that insulin stimulates the proliferation of smooth muscle cells in the blood vessels, activation of the renin-angiotensin system, growth factors, increased CRP, and the generation of altered lipid profile.[12]

Derived from the above written paragraphs, our results verify that the everyday diet in Mexican children was based on milk and milk derivatives; eggs and tortillas and with a less frequency meat, sugar beverages, fruits and juices. The dietary intake of carbohydrates was higher in Mexican children than

the recommendations. The intake of fruits, vegetables and cereals was very low. In comparison with these data, the Colombian children showed an unexpected higher intake of junk food.

Physical inactivity has serious health consequences. On the contrary, in children, the beneficial effects associated with physical activity include weight control, effects on cholesterol levels and insulin resistance, low blood pressure, psychological well-being, and an increased predisposition for physical activity in young adulthood.[13] Additionally, sports and T.V. watching are both related to a greater amount of food intake.[14] From our results we can deduce that in order to prevent obesity, and other cardiovascular risk factors, we must improve food intake quality as well as physical activity. It is clear from our data, a self overestimation of the physical activity by the Mexican children as the selected activities and time inverted to practice them did not match. This study further corroborates a role for physical activity against obesity as the Colombian children were normal-weight despite eating more junk food than Mexicans.

Of particular concern is the fact that children, through marketing are stimulated to cigarette smoking and alcoholism, despite the knowledge of the damage produced by these addictions.[15] Going further, it is really alarming the cases of first alcohol consumption among Colombian children. Children of parents with alcohol addiction, for example, show higher rates of alcoholism than children who do not have parents with this addiction.

Association of lipid profile and waist circumference as CVRF for overweight and obesity among school children has already been evaluated in Qatar.[16] In our population there was no a clear effect of the waist/hip ratio and metabolic parameters.

Obesity deserves particular attention because it is usually accompanied by two notorious and significant risk factors: diabetes and arterial hypertension. Therefore, controlling obesity during childhood is important because the obesity acquired during this period of life tends to persist into adulthood.[4] Reading about other nations, we have that the most recent studies conducted in Brazil reveal that the prevalence of overweight in children and adolescents ranges from 8.4% to 19%, while that of obesity ranges from 3.1% to 18%.[17] In the USA, the National Health and Nutrition Examination Survey (NHANES) estimated a prevalence of 30% for overweight and obesity ≥ P85 and a prevalence of 15% for obesity ≥ P95 for the age-group between 6 and 19 years of age.[18]

It is estimated that 30% of children and adolescents with overweight/obesity have hypertension [19]. Thus, the presence of overweight/obesity appears to be one of the most important factors related to hypertension in children and adolescents worldwide. In our study it was surprising that even in normal weight children of Colombia there were some with hypertension.

Due to the variety of criteria used to define ideal lipid levels in adolescents, it is difficult to compare results from across the world. However, studies have shown, for example, the presence of atheromatosis in aortic intima with cholesterol levels between 140 and 170 mg/dL.[20] In a previous study developed in Toluca it was found that a higher BMI was associated with higher blood pressure, and higher total cholesterol, triglycerides, and insulin concentrations, and with lower HDL-cholesterol. Surprisingly, in this survey, Colombian children had higher AI and although there were less boys and girls with hypertriglyceridemia, in that country there were more cases with hypercholesterolemia but none with hyperglycemia.

Hcy, sulfurated amino acid formed from methionine, which is metabolized by a cysteine or transsulfidation is recycled through remethylation to methionine. There are contradictory studies about the association of homocisteinura and early atherosclerosis and thrombosis.[21]

In our bi-national study no significant difference was detected for Hcy levels.

In agreement with our findings only for Mexican children, another study performed in Venezuela in a sample of 370 second grade students aged 7.82 ± 0.62 years found a significant positive correlation between BMI, and the atherogenic indices: triglycerides/HDL and total cholesterol/HDL.[22] In line with data reported in literature, HDL values represent a protective factor.

The key for an effective primary prevention is the promotion of a balanced diet and healthy way of life. The aim of a secondary prevention (screening) is to identify children who have risk factors for developing obesity. Because obesity is difficult to treat once established, any effort at prevention is important.

This study has some limitations worth noting. First, sampling bias may be an issue. However, the mean body height and weight of the children who participated in the health examination conducted in the city were similar to those in a national survey.[23] Future research is certainly warranted to unravel the mechanistic influences of social pressure that push the child behavior towards some life style election. Caution is warranted when trying to generalize these findings to other ages and race/ethnic groups. Indeed, it is possible that unique biological, behavioral, and familial risk factors may exist for different races and ethnicities, and this should be a

focus for subsequent investigations.
Primary prevention is the basis for the fight against childhood obesity, as it is more effective than treating the disease once established. Improving community food and physical activity should be part of the national public health policy to reduce chronic disease at elderly age.[24] The strategy is based on advice for all people with a family focus and from different social environments surrounding the child: health care, day care, schools, community and media.

Conclusion
Of the 30 Mexican children enrolled in the study only 13% had none of the cardiovascular risk factors, while in the Colombian this percentage was of 33. This is the point of the iceberg of the immediate health disaster in Mexico in the up-coming years. Thus, an extremely powerful social, governmental, familiar and individual action is mandatory to set up, if not, the viability of the nation will be seriously compromised.

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