Nutrition Indicators, Dyslipidemia and Arterial Pressure in the Pediatric Population Located in Low and High Marginalisation Zones in Mexico

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The objective of this investigation is to evaluate nutritional indicators, lipidic profile, and blood pressure in the pediatric population that live in low and high marginalisation zones in Mexico. In a cross-sectional analytical study, students 6 to 18 years old in low and high marginalisation areas of Mexico were selected. Participants were asked to take surveys related to anthropometrics, biochemical, arterial pressure, and evaluation of healthy nutrition index. Less than 1% of the participants had a "healthy nutrition" for both areas. The joint prevalence of overweight and obesity was 40%. The combined prevalence of elevated systolic and diastolic blood pressure was almost 40%, a huge percentage of systolic blood pressure (32%) was observed as well. Half of the population had high levels of triglycerides. Marginalisation was inversely associated with systolic and diastolic blood pressure and positively associated with HDL-C. The population has a low consumption of fruits and vegetables together with high consumption of beverages containing sugar and sweets. It is evident in all the indicators that a significant percentage of subjects exceed the clinical cut-off values related to risk regardless of marginalisation level. It is necessary to insist on educational intervention to create a conscience in observing healthy nutrition at an early age and to preserve these healthy habits during adolescence. The inclusión of the measurement of clinical indicators like arterial pressure and the evaluation of biochemical indicators that assess cardiovascular risks in the public policies of pediatric health is necessary.

Keywords: Blood Pressure; Dyslipidemia; Nutritional indicators; Marginalisation; Pediatric Population.

The United Nations Organisation, within its Sustainable Development Goals established in 2015 end to hunger and poverty and achieved food security at a global level by 2030[1].

In 2018, The World Health Organisation (WHO) reported the prevalence of overweight and obesity in children and adolescents aged 5 to 19 at 18%, a dramatic 4% increase from 1975[2]. At present, population-based health evaluations do not exist at a global level, nor do incidences or the prevalence of dyslipidemia and hypertension in the pediatric population. Nonetheless, Ji et al., reported that more than 1 out of 5 children (25%) exhibit dyslipidemia in the United States[3]. Regarding arterial pressure, numbers show that 15% of North American children have hypertension[4].

According to the National Health and Nutrition Survey (ENSANUT) 2018 in Mexico; the combined national prevalence of overweight and obesity in school children was 35.6% and 38.4% in adolescents. However, although child obesity in Mexico falls within the top places worldwide[5], within the ENSANUT, the evaluation of biochemical parameters within the pediatric population is not included, making it difficult to quantify the health damage. In the child population, very few studies have evaluated the presence of alterations in biochemical indicators.

Guerrero-Romero et al., reported that Mexican children 10 to 13 years old were not obese, 15.9% and 6.2% of elevated total cholesterol and low levels of high-density cholesterol, respectively (6,7). The ENSANUT reported an incidence of hypertension in adults at 18.4% and through studies on children, the numbers are 5% to 30%[7-9].

High-income countries report that higher socioeconomic sectors have a better diet quality[10]. On the contrary, low and mid-income countries reported that the higher socioeconomic sector could have a less healthy diet than the lower socioeconomic sector[10]. Living in urban areas is associated with hypertension due to the lack of physical activity, higher stress level and changes in eating patterns or habits[11]. The information, though is contradictory concerning lipidic profile; an unhealthy lipidic profile has always been largely associated with a low socioeconomic level, education and living conditions in rural areas. However, studies reported a high marginalisation level similar to that of being enrolled in a public school, the children are associated with a better lipidic profile[12-15].

In Mexico, the National Population Council (CONAPO) developed the marginalisation index differentiating localities by deficiencies they face. This involves deficiency indicators in education, housing, monetary income and population distribution. In Mexico, 31.1% of federal entities find themselves at a high or very high marginalisation level[16,17].

There are multiple nutrition indicators, like anthropometrics: body mass index (BMI), waist and hip circumference; biochemistry: laboratory tests like lipidic profile, blood glucose among others; clinical: arterial pressure, as well as signs of vitamin deficiency; dietary: 24-hour reminder, that gathers information of food consumed and its quantity[18]. Diet quality indexes have been proposed, which evaluate the global quality and determine risk factors (NDC)[19]. For example, the Healthy Eating Index (HEI) specifies the level of adherence to dietary guides of North Americans[20], and its importance lies in assessing diet quality[21] currently used in different countries with adaptations and validations.

Evaluating nutritional health and its indicators in the pediatric population that live in localities where low and high marginalisation groups coexist will help generate a more accurate panorama to design specific strategies. This investigation aims to evaluate nutrition indicators, lipidic profile, and arterial pressure in the pediatric population that live in low and high marginalisation zones in Mexico.

MATERIALS AND METHODS

Analytic and transversal studies in children and adolescents 6 to 18 years of age who go to school in low and high marginalisation areas of Mexico from November 2015 to May 2017 have been carried out.

Context

Municipalities with low marginalisation indexes that have been evaluated are: San Luis Potosi and Matehuala, more than 85% live in urban areas where the poverty rate is 24% and 37.8%, respectively. Municipalities with high marginalisation index are Ahualulco, Moctezuma and Villa de Guadalupe. More than 76% of the population live in rural areas and Villa de Guadalupe a 100%[22].

Sample

By layering the National Institute of Statistics and Geography (INEGI) official date, municipalities with the lowest and highest marginalisation in the central and high plains of the state were selected. Participating schools with high marginalisation: 3 elementary schools, 2 secondary schools and 2 high schools; with low marginalisation: 2 elementary schools, 2 secondary schools and 3 high schools. A total of 14 educational centres were sampled (figure 1).

The calculated sample size was 800 participants, with a trusted range of 97% and an acceptable margin of error at 5%. The final exhibit was 845 participants.

Inclusion criteria: Attend one of the sampled schools, letter of consent signed by the student's parents or legal guardian and subject's consent.

Exclusion criteria: diagnosed with illness, under medication which alters the biochemical values and in the case of females, state of gestation or lactation. The elimination criteria were not completing the evaluations.

Data collection

First phase. Interview with authorities of each educational centre to inform them about the project and obtain authorisation. After that, meetings were set with the parents.

Second phase. Participants were asked to take surveys related to anthropometrics, biochemical, arterial pressure and evaluation of healthy nutrition index.

Variables

Anthropometrics

Sizes were measured with a SECA® 213, 205 (Seca 213, Seca, Hanover, MD, 2009) stadiometer on a flat surface with a 90° angle, rounded off to the nearest 0.1 cm. Considering the Frankfort plane, by placing the head in the middle, right between the bottom edge of the eyes and upper edge of the ears, forming a 90°[23]. Weight was taken using a calibrated electronic scale TANITA® UM-081 (Tanita UM-081, Tokyo, Japan) on a flat 90° surface, rounded off to the nearest 0.1 kg.

The Body Mass Index (BMI) was calculated with the Quetelet (kg/m^2) formula through Z ratings of the Body Mass Index based on age (BMI/A), derived from the date of birth and gender. The classification proposed by the OMS was used, and three categories were established: 1 malnourished (<-2 Z points), 2 normal weight (<-1 a 0.99 Z points)and 3 overweight/obese (>1 Z points)[24].

HEI

The HEI questionnaire from Spain that was validated in 2011 was used to analyse the quality and diet consumption[21]. This was based on the North American HEI, which consists of 10 variables. This index's score varies from 0 to 100, under three categories: healthy, change required and unhealthy[20].

The score total sums to 100 points theoretical maximum, with the following final cut: 1 – "healthy diet": >80 points, 2 – "change required": >50-80 points and 3 – "unhealthy diet": <50 points.

Lipidic profile

Blood samples (6 ml) were drawn with the BD Vacutainer system, 12 hours fast. The serum was separated to determine: total cholesterol (TC), high-density lipoproteins (HDL-C), low-density lipoproteins (LDL-C) and triglycerides (TG). The samples were processed in a BS 300 Mindray® autoanalyser, and the findings were done in a laboratory with certified clinical analysis.

The cut-off points established for biochemical parameters were: dyslipidemia cholesterol total >170 mg/dl, LDL-C >110mg/dl, HDL-C <45 mg/dl, triglycerides >75 mg/dl (0-9 años) y > 90 mg/dl (10-19 años)[25].

Arterial pressure

The HBP-1300 OMRON portable gauge was used. Three bracelet sizes were used according to the participant's brachial circumference, placed at the midpoint between the olecranon and the acromion, ensuring the subject was relaxed. The measurement was taken on the right arm while the participant remained seated for 5 minutes before the measurement was taken[26].

The interpretation of the blood pressure (BP) measurements were based on the National High Blood Pressure Education Program Working Group on High Blood Pressure, taking into account gender, age and size. For analysis and the diagnosis of elevated arterial pressure was performed with a >90 percentile for both the systolic arterial pressure (SBP) as well as the diastolic arterial pressure (DBP)[27].

Ethical considerations

The parents or guardians were present during the collection of all variables. The data was managed confidentially, and the studies were endorsed by the Ethics and Investigation Committee of the Health Department of the State of San Luis Potosi.

Statistical analysis

Descriptive statistics were used. Categories were considered discreet variables starting with Z points of BMI/A (Z BMI/A), HEI classification and margination. The Kolmogórov-Smirnov test (K-S) was utilised for continuous variables to evaluate the normality of the data; the means between the two groups were compared using the T student test. ANOVA single factor test was used to compare the means between 3 or more groups. And lastly, to determine the association or independence between two variables, X^2 test was used. A $p<0.05$ was considered statistically significant, using the IBM SPSS Statistics version 22 program.

RESULTS

Eight hundred forty-five participants between 6 and 18 years old were evaluated, wherein 47.3% were boys and 52.7% were girls. The anthropometric variables cast weights between 14.4 kgs and 117 kgs. The Z points of BMI for the age group with a -5.94 to 5.38 showed severe thinness and obesity. Regarding the lipidic profile, it was observed that the maximum value of total cholesterol, LDL-C, and triglycerides found themselves with superior numbers to adequate values of this population; besides this, the average of triglyceride concentration was also above the cut-off point acceptable for the population. For the SBP, the maximum value found was 162 mmHg and for the DBP 108 mmHg, which exceeded normal values (Table 1).

The average of the HEI was 57.4 points, which corresponds to the "change required in nutrition" category; only 0.8% obtained "healthy nutrition", 80.2% "change required in nutrition" and 18.9% "unhealthy diet" (data not shown). Low consumption of fruits and vegetables was identified, with high consumption of beverages containing sugar. From the food for daily consumption (cereals, vegetables, fruits and dairy products), it was observed that only 25.5% consume vegetables every day, less than 50% eat fruits and 79% dairy products (Table 2).

Four out of ten children showed signs of overweight and obesity. Almost half of the population showed altered TG levels for the lipidic profile, while 2 out of 10 had altered TC and HDL-C values. The combined prevalence of elevated SBP and DBP was almost 40%, a huge percentage of SBP (32%) rather than DBP (7%) was observed.

Fifty-two percent of the population was found at a low marginalisation level, while 47.3% was high. Statistically significant differences of HEI were also found by age group; children had better nutrition compared to the other two groups. Furthermore, significant differences with the HEI

Table 1. Anthropometric and clinic indicators of the study population

	Range	Mean	SD
Age (Years)	6 to 18	12	3.6
Weight (Kg)	14.4 to 117.0	45.6	17.5
Height (cm)	103 to 183	1.48	0.16
Z BMI/A	-5.9 to 5.3	0.4	1.4
SBP (mmHg)	72 to 162	113.4	13.2
DBP (mmHg)	40 to 108	64.1	9.3
TC (mg/dL)	68 to 276	149.99	29.36
HDL-C (mg/dL)	28 to 110	54.01	11.38
LDL-C (mg/dL)	15 to 199	76.52	25.22
TAG (mg/dL)	24 to 333	97.26	51.14

Z BMI/A: Z rating of the Body Mass Index based on age, SBP: systolic blood pressure, DBP: diastolic blood pressure, TC: total cholesterol, HDL-C: high-density lipoprotein, LDL-C: low-density lipoprotein, TAG: triglycerides and marginalisation level were found, indicating that groups with high marginalisation receive better nutrition (Table 3).

Analysing the average differences of the variables by marginalisation level, it was observed that children with high marginalisation levels scored better in the HEI and better numbers of SBP and DBP compared with participants who live in areas with very low marginalisation ($p<0.05$). Regarding HDL-C, it was determined that groups

Table 2. Frequency of consumption based on the Healthy Eating Index of the study population

Recommendation of consumption frequency	Daily (7 days)		Weekly (6-2 days)		Occasional (1-0 days)	
Daily consumption foods						
	n	%	n	%	n	%
Cereals	715	84.3	129	15.3	3	0.3
Vegetables	215	25.5	563	66.6	65	7.7
Fruits	420	49.7	369	43.7	54	6.4
Dairy	668	79	149	17.6	28	3.3
Weekly consumption foods						
Meat	221	26.2	566	67	57	6.7
Legumes	529	62.6	265	31.4	50	5.9
Occasional consumption foods						
Sausages and cold cuts	121.68	14.4	601	71.1	122	14.4
Sweets	441.935	52.3	355	42	46	5.4
Sweet beverages	527	62.4	261	30.9	55	6.5

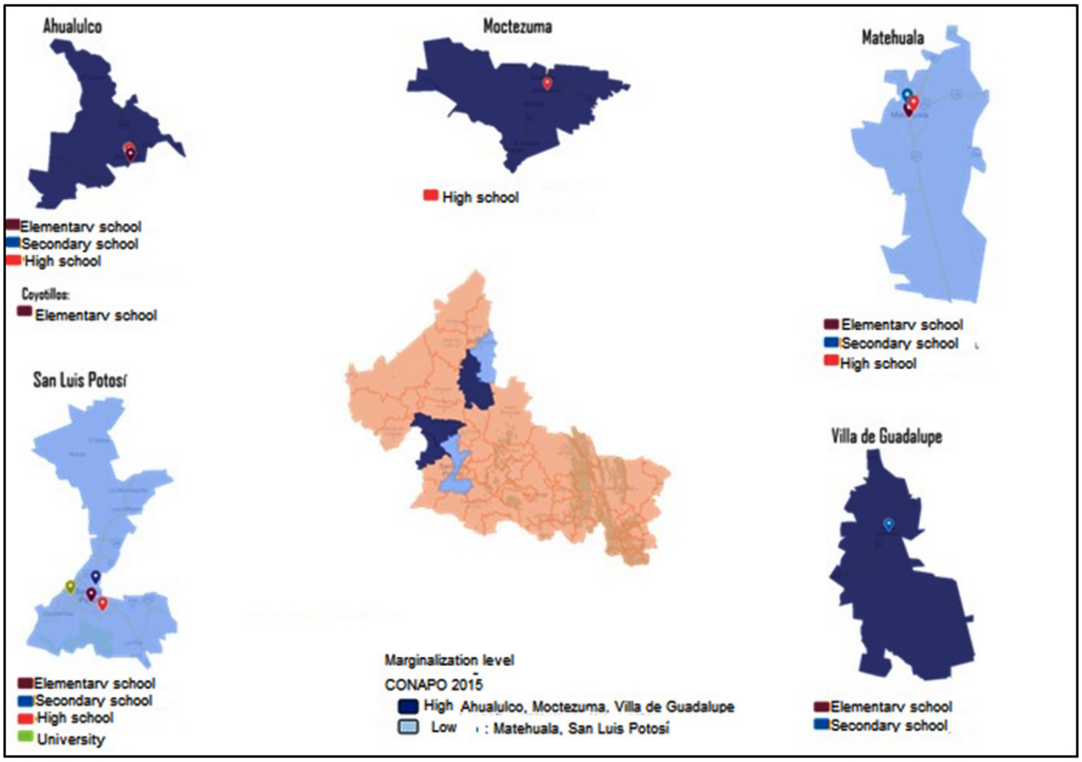

Fig. 1. Localization of study sites

with high marginalisation have better levels of this indicator than those with very low marginalisation (p=0.052) (Table 4).

DISCUSSION

This project's objective was to evaluate the nutrition indicators, the lipidic profile, and the BP in the pediatric population that live in areas of very high and low marginalisation in Mexico. It was determined that the pediatric population does not have healthy nutrition through the HEI where less than 1% have "healthy nutrition" for both areas. This is also reflected in other nutrition indicators like the BMI, where four of every ten children are overweight and obese.

It was observed that half of the population had elevated TG and that 2 of every 10 showed levels that were out of range in TC and HDL-C. Almost every 4 out of 10 persons who were evaluated showed high numbers of SBP and DBP. Participants who live in high marginalisation areas obtained better scores in the nutrition index, arterial pressure, and HDL-C than those who live in low marginalisation areas.

Table 3. General characteristics of the study population and comparison with the HEI

General characteristics	N	%	Mean	SD	t	p
SEX					0.153	0.879
Masculine	400	47.4	57.4	8.5		
Feminine	445	52.7	57.3	9.3		
AGES						<0.001
6 a 9*	260	30.8	59.4	8.1		
10 a 14	307	36.3	56.1	8.8		
15-18	278	32.9	56.9	9.5		
Z BMI						0.205
Underweight	24	2.8	54.3	9.5		
Normal weight	512	60.6	57.3	8.9		
Overweight/obesity	309	36.6	57.7	8.9		
SBP					0.973	0.331
Acceptable	575	68	57.4	9.1		
Elevated	270	32	57.3	8.5		
DBP					0.973	0.331
Acceptable	786	93	57.4	8.9		
Elevated	59	7	56.3	9.5		
TC					-1.25	0.213
Acceptable	489	76.6	57.07	8.78		
Elevated	149	23.4	58.10	9.31		
HDL-C					-1.31	0.190
Acceptable	504	79	57.07	8.80		
Low	134	21	58.21	9.30		
LDL-C					-0.59	0.556
Acceptable	580	90.9	57.24	8.99		
Elevated	58	9.1	57.97	8.07		
TAG					0.35	0.730
Acceptable	334	52.4	57.42	8.56		
Elevated	304	47.6	57.18	9.30		
MARGINALISATION					-3.01	0.003
Very low	445	52.7	56.53	8.81		
High	400	47.3	58.37	9.02		

HEI: Healthy Eating Index, SD: standard deviation, Z BMI/A: Z rating of the Body Mass Index based on age, SBP: systolic blood pressure, DBP: diastolic blood pressure, TC: total cholesterol, HDL-C: high-density lipoprotein, LDL-C: low-density lipoprotein, TAG: triglycerides

Table 4. Comparison between high and very low marginalisation population with nutritional and clinic indicators

	Variable Marginalisation level	Mean	SD	t	p
Z BMI	Very low	0.36	1.49	-1.53	0.126
	High	0.52	1.44		
HEI	Very low	56.53	8.81	-3.01	0.003
	High	58.38	9.02		
SBP	Very low	116.76	12.04	7.79	<0.001
	High	109.83	13.63		
DBP	Very low	66.66	8.73	0.18	<0.001
	High	61.45	9.21		
TC	Very low	149.36	31.14	-0.48	0.634
	High	150.50	26.81		
HDL-C	Very low	53.33	11.13	-1.95	0.052
	High	55.22	12.24		
LDL-C	Very low	76.44	27.71	0.10	0.919
	High	76.25	19.68		
TAG	Very low	97.95	50.18	0.65	0.514
	High	95.13	53.40		

SD: standard deviation, Z BMI/A: Z rating of the Body Mass Index based on age, HEI: Healthy Eating Index SBP: systolic blood pressure, DBP: diastolic blood pressure, TC: total cholesterol, HDL-C: high-density lipoprotein, LDL-C: low-density lipoprotein, TAG: triglycerides

Very few published studies exist where HEI is used to evaluate the quality of nutrition. A recent study in Northern Mexico used this index in 29 families wherein no participant obtained a "healthy nutrition" rating, and 75.5% required changes to improve their diet[28]. Another study carried out in Southern Mexico by Muñoz Cano et al.,[29], evaluated the nutrition quality of 3,550 university students' diet, only 0.1% of the sample rated as healthy nutrition. Said results coincide with ours, where only 0.80% showed healthy nutrition.

Pinheiro et al.,[30], evaluated the diet of 203 school children aged 12 to 13 in Chile, wherein only 1.5% possessed healthy nutrition. In yet another study, 9,000 children 2 to 18 years old were evaluated and scored 54.9 on nutrition quality, similar to our study (57.41%)[31].

Our findings also showed a low consumption of fruits and vegetables and high consumption of beverages containing sugar, coinciding with other studies done on school children in Mexico[32]. Upon evaluating the nutritional state, a prevalence of 36.6% of overweight and obesity was determined. These values coincided with what was reported by the ENSANUT 2018[7].

Different investigations have associated dietary patterns with socioeconomic and demographical factors. Living in an urban area or having a higher socioeconomic level is closely related to higher consumption of fruits and vegetables and better diet quality[33]. The contrary thought is observed in other cases. A study with which the data was acquired from the ENSANUT 2012 showed that from the early years of age in urban areas, lower consumption of fibre, higher consumption of added sugar and saturated fats were detected. Same as with the socioeconomic level, wherein the population with a lower socioeconomic level had better dietary patterns, but sugar consumption was still elevated[34]. Lopez-Olmedo et al., also observed that the quality of diet in the Mexican adult population is inversely related to the level of education and socioeconomic status[34]. The discrepancy in these results with other countries is due to multiple causes. One of which could be the transformation in diet and the dietary system of the Mexicans, where there was an increase in non-essential food containing excess sugar, salt, and refined carbohydrates. In addition, Mexico was the first mid-income country that approved taxes on beverages containing sugar and junk food, causing important effects in reducing the consumption of said products by the population considered at a lower socioeconomic level[35].

It was shown that the HEI score diminishes with the increase in age. This phenomenon was also observed in other related studies[31]. Their parents predominantly control children at a younger age when it comes to nutrition, more importantly, the restriction of certain food types and their pressure in consuming healthier food[36].

In this particular study, the lipidic profile of the participants showed an elevated incidence in altered values: 23.4% in CT, 21% in HDL-C, 9.1% in LDL-C and 47.6% for TG, Guerrero-Romero et al., reported the altered prevalence of TC, HDL-C, LDL-C and TG in Mexican children at 15.9%, 6.2%, 14.6% y 9.3% respectively; predominances a lot lower than our results, except for the LDL-C[6].

The group with high marginalisation showed a better concentration of HDL-C than those with lower marginalisation. Despite being a risk factor, the economic and social disadvantage appears to have triggered a protection mechanism in nutritional, clinical, and biochemical indicators. Different studies have evaluated the lipidic profile with socioeconomic, educational, and marginalisation levels associated with HDL-C. Results of which are conflicting – while some associate a better educational and socioeconomic status with increased HDL-C concentration, others link lower marginalisation with elevated concentration of HDL-C, similar to the results we found[12-15].

The prevalence of altered BP was high in this study (39%) compared to other investigations where the prevalence was reported at 5%, 11% and 30%[4, 8, 9]. In both the SBP and DBP, we observed that lower marginalisation obtained elevated values of BP while higher marginalisation obtained a higher score in the HEI. Another study showed a higher score in the HEI, cardiovascular risk is lesser[37].

The nutritional evaluation is insufficient with just the weight and size of these age groups. Nowadays, child obesity is an epidemic; therefore, it is necessary to take rigorous and precise measures regarding nutritional evaluation. Mexico counts on norms regarding the control of children's health. Still, its policies do not include the continuous assessment of arterial pressure o biochemical indicators that make it possible to know the prevalence of hypertension and dyslipidemia in this age group, allowing timely interventions.

Study limitations

One of the limitations is that the evaluated sample is focused on the population of children who go to school; hence it's unknown whether these pathologies' behaviour is the same for the population of out-of-school children. Another limitation is the quality of diet which was measured with a screening instrument (HEI), leaving the question whether the extent of harm of having inadequate nutrition through the evaluation of other indicators like the identification of micronutrients.

CONCLUSION

A high predominance of alterations in nutritional indicators was found in the study population. All the indicators show that a significant percentage of subjects exceed the clinical cut-off values related to risk regardless of marginalisation level. Therefore, it is necessary to insist on educational intervention to create a conscience in observing healthy nutrition at an early age and to preserve these healthy habits during adolescence, especially since it is found that the quality of diet diminishes with age. Lastly, with these findings on hand, it is necessary to include the measurement of clinical indicators like arterial pressure and the evaluation of biochemical indicators that assess cardiovascular risks in pediatric health's public policies.

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Declaration of interest

The authors declare no conflict of interest as well as no economic, personal or political relationship that may influence our judgment or exist of any financial interest that may constitute a conflict real, potential or apparent.

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Compliance with Ethical Standards

All procedures performed in this study involved human participants, and they were in accordance with the ethical standards of the Ethics and Investigation Committee of the Health Department of the State of San Luis Potosi and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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