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Relationship of Calories Intake and Physical Activity in Adolescents in Colima, Mexico: A Cross-sectional Study

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Authors' contributions

This work was carried out in collaboration among all authors. Author MACC designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author XAH collaborate in to write protocol and review the first draft. Author NPR managed the analyses of the study and reviewed the draft. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To identify the relationship between calories intake, physical activity and body mass index in adolescents in Colima Mexico.
Study Design: A cross-sectional study analytic, observational.
Place and Duration of the Study: Colima and Tecoman, Mexico.
Methodology: It was designed in adolescents, of both genders, with a BMI in 85th percentile or greater, where the average daily calorie intake was quantified with the SNUT survey and the level of physical activity with the International Physical Activity Questionnaire. Anthropometry to obtain the BMI. The stage of change of the trans-theoretical model was identified. Statistical analysis was Pearson's r between calories and BMI and between physical activity and BMI, systolic and diastolic blood pressure with BMI, and the stages of change.

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Results and Discussion: Poor correlation (r = 0.13) but significant linear relationship between calorie intake with BMI (t = 2.01 P = .05) and moderate correlation (r = - 0.41) and significant linear relationship (t =- 6.76, P = .0001) between activities physical and BMI. Between systolic and diastolic blood pressure and BMI, r= 0.28 and 0.34, respectively, with a strong linear trend in both (*P* = .0001) Of the adolescents, 39.32% were in the action stage (they plan to take actions to improve their overweight / obesity status) and 34% in the pre-contemplation phase (where the adolescent does not plan to do anything about his overweight / obesity).
Conclusion: There is a relationship between daily calorie intake and BMI and a strong negative relationship between physical activity and BMI, and a third of adolescents do not see overweight / obesity as a problem and have not thought of doing anything about modifying their lifestyle to improve their BMI.

Keywords: Adolescents; physical activity; energy intake; stages of change.

1. INTRODUCTION

Obesity is a global public health problem, since its prevalence has increased in most countries of the world and Mexico is no exception; According to the World Health Organization (WHO), it is defined as the abnormal or excessive accumulation of fat that represents a health risk [1]. It is reported that 18% of children and adolescents worldwide suffered from obesity worldwide in 2016 [2].

Obesity was considered to be a problem for high-income countries, but now its prevalence has increased in middle- and low-income countries, with alarming prevalence figures and darkening the outlook for those countries, since it is estimated that chronic-degenerative diseases will increase [1].

In Mexico, with the Mid-Way Health and Nutrition Survey, in 2016, the prevalence of overweight and obesity was reported, 36.3% for adolescents between the ages of 12 and 19, 1.4% higher than reported in the Survey of Health and Nutrition of 2012, which was 34.9%, although a real increase cannot be inferred, since the 95% confidence intervals (95% CI) of both surveys overlap, 33.7 to 36.2% in 2012 and 32.6% to 40.1%, in 2016 [3,4].

The prevalence of overweight was 22.4% and obesity 13.9%; By gender, in 2016, it was reported that in the female sex the prevalence of overweight was 26.4%, 2.7% higher than reported in 2012 (*P* <.05) [3]. Regarding obesity, a prevalence of 12.8% was reported in 2016, in the age group of 12 to 19 years, being similar to that reported in 2012, with a prevalence of 12.1% [3].

The main cause of overweight and obesity in adolescents is an imbalance between energy intake and expenditure, and is mainly due to the consumption of high-calorie foods high in fat and sugars and low in vitamins, minerals and other micronutrients ; also to the decrease of physical activity levels, since having a sedentary lifestyle, energy expenditure decreases [5]. Presumably, high calorie intake and low level of physical activity should show a relationship with the high Body Mass Index (BMI).

In schoolchildren in Celaya, Mexico, it was reported that the average daily calorie intake was between 755 and 6909 calories / day and that those schoolchildren had a BMI between 13.49 and 42.24 kg/m2 [6]; in older adults aged between 60 and 70, from the same city, [7], reported a strong negative correlation between physical activity and BMI, r = -0.50 t = 3.71 *P* = .001 for men and r = - 0.061 t = 5.73 *P* = .0001 for women, but finding no correlation between daily calorie intake and BMI, r = 0.23 t = 0.130 *P* = .13 for men and r = 0.24 t = 1.83 *P* = .07 for women.

Obese children and adolescents are likely to become obese adults and develop non communicable diseases such as diabetes or cardiovascular disease at earlier ages [8].

The unhealthy lifestyle, high calorie intake and sedentary life are the most important risk factors for developing obesity and changes in these factors are essential to reduce adiposity, for which the motivation for these changes must be reinforced [9].

Strasburger [10], point out that by decreasing the time the adolescent spends in front of the screen, calorie intake decreases, as well as dietary habits that should be promoted to reduce or prevent obesity, and limiting eating in restaurants, limiting consumption of sweetened

beverages, decrease the portion size of food as well as eating as a family without distractors favor healthy behavior in terms of child and adolescent feeding [11].

The 2016 Half-Way Health and Nutrition Survey (ENSANUT) reports that in Mexico, 11.8% of the population between the ages of 20 and 49 already had a previous diagnosis of diabetes and 24.1% of high blood pressure [3]. In Thailand, it was found that 6.9% of adolescents, aged between 8 and 13, had high blood pressure with the cut-off point of the American Academy of Pediatrics [12].

The detection of overweight / obesity is important, but it should be checked if the obese subject is aware of their problem and if they are willing to do something to combat it. Prochaska and Vellicer proposed the change in health behavior, where interventions can be planned and applied depending on the motivation of the participants [13]. The model considers five defined stages: precontemplation, contemplation, preparation, action and maintenance [14,15].

Prochaska et al., [16] affirmed that change is a multi-stage, cyclical process and people have different levels of motivation, of intention that make them incur in a particular way in a different scheme to adopt or abandon a behavior.

The objective of the project was to analyze the correlation between daily calorie intake and the level of physical activity with BMI and to demonstrate if that correlation is linear, in addition to identifying in which stage of the change are the overweight / obese adolescents of Colima, Mexico.

2. MATERIALS AND METHODS

2.1 Design

A cross-sectional, observational, analytical study was conducted where the universe were adolescents aged 12 to 18 years registered in an institution of higher secondary education in the state of Colima, Col., Mexico, in two cities: Colima and Tecoman.

2.2 Sampling

When identifying adolescents with BMI of 85th percentile or greater [Reference], a simple random sampling was performed, but 90% of adolescents wanted to participate.

2.3 Selection of Participants

The inclusion criteria were: men and women between the ages of 12 and 18, registered in two schools of higher secondary education in Colima and Tecomán, with BMI of 85th percentile in CDC Curves 2000 [17], whose parents agreed to participate, signing the informed consent and adolescents signed the announce to participate (in those under 18). For participants of 18 years, they signed the informed consent.

The exclusion criteria were: those who did not agree to participate or the parents did not sign the informed consent.

2.4 Variables

The sociodemographic variables were: age, gender, marital status.

The independent variables were:

- Physical activity. It is a continuous quantitative variable. It is the body movement that consumes energy. It is measured in METS/min/week by the International Physical Questionnaire (IPAQ) [18] and is presented with mean and standard deviation.
- Calorie intake. It is a continuous quantitative variable. It is the average daily calorie intake. It is measured in mean calories intake by day, measured with the Frequency of meals consumption (SNUT) [4] and is presented with mean and standard deviation.
- Change stage. It is an ordinal categorical variable. It is the stage of motivation in which the person is to perform actions to modify their status of overweight / obesity; it is measured as precontemplation, contemplation, preparation, action and maintenance [19]; It is presented with frequencies and percentages.

The dependent variables were:

- Body mass index (BMI). It is a continuous quantitative variable. It is the body mass expressed in kg/m^2. It is measured in kg/m^2 and is presented as mean and standard deviation.
- Systolic blood pressure (SBP). It is a continuous quantitative variable. It is resistance to blood circulation during

cardiac contraction; It is measured in mm Hg and is presented with mean and standard deviation [20,12].

- Diastolic blood pressure (DBP). It is a continuous quantitative variable. It is resistance to blood circulation during cardiac relaxation; It is measured in mm Hg and is presented with mean and standard deviation [20,12].

2.5 Questionnaires

It is used the SNUT survey [4], where based on the food consumed during the previous year, the daily average calorie consumption is obtained. The survey is validated in the Mexican population [21] and it was used in the Health and Nutrition survey in Mexico in 2012 [4].

The International Physical Activity Questionnaire [18], a short version in Spanish, was used for the level of physical activity. It consists of 3 questions about vigorous, moderate physical activities and walking, in addition to how many days in the last 7, did those activities and on one of those days, how many minutes did he do it. For each activity there is a constant (8 for vigorous activities, 4 for moderate activities and 3.3 for walking) that are then multiplied by days and minutes. The sum of the three activities is the total physical activity expressed in METS/minutes/week. The reliability of this questionnaire is 0.88 in Latin America [22].

The algorithm recommended by Villalobos et al., was used to identify the stage of change [15].

2.6 Procedures

The objectives of the study were explained to parents and adolescents and the questions they asked were answered. They were requested to sign the informed consent and the consent to participate. Already signed, the adolescents answered the SNUT survey [4,21] and the IPAQ (International Physical Activity Questionnaire [18,22], and the questionnaire of stages of change [15,19] and anthropometry was performed. For the anthropometry, the adolescents remained at rest for 10 minutes and subsequently proceeded to use a scale with an altimeter, the adolescents being as little as possible with clothes and without shoes. For blood pressure, the Rossmax MG150f ® (Rossmax Medical, Berneck, Switzerland) digital baumanometer was used and between measurements separated by 5 minutes of time and the blood pressure recorded was the average of the three measurements [20].

2.7 Sample Size Calculation

Assuming a Pearson correlation index of - 0.5 between physical activity (METS / minute / week) and BMI (Kg/m^2), the minimum sample size is 37 adolescents, with 95% accuracy and 90% power (Epidat 4.1, Xunta de Galicia, PAHO, CES University).

2.8 Statistic Analysis

Descriptive statistics were used for all variables. To identify the correlation between calorie intake and level of physical activity with BMI, Pearson's r correlation index was calculated and to identify if the correlation is linear, the linear regression equation, 95% confidence interval, test was calculated of t and value of P. To demonstrate statistical significance of the results, the value of P was set at .05. Statistical analysis was performed in STATA 13.0 ® (Stata Corp., College Station, TX, USA).

3. RESULTS AND DISCUSSION

The sample consisted of 234 adolescents from the upper secondary schools. Table 1 shows the categorical sociodemographic characteristics, where it is reported that women predominated with 55.13% and single women with 98.72%. The distribution of the sociodemographic quantitative variables is shown in Table 1, where it is reported that the age range corresponded to high school students (15 to 19 years old), weighing 55 to 123.50 kg and height from 1.46 to 1.87 m.

Table 2 shows the distribution of the study variables of adolescents in Colima, Mexico. The average BMI is higher, and corresponded to obesity. Regarding systolic and diastolic blood pressure, although in the range there were measurements of 149 for systolic and 100 for diastolic blood pressure, none corresponded to arterial hypertension, since they did not have at least 140/90 mm Hg measured on two different occasions [12].

Fig. 1 shows the moderate negative correlation (r = - 0.41) between physical activity and BMI, this linear relationship being (t = -6.76, *P* = .0001). Confirm that the higher the physical activity, the lower the BMI, accepting the alternative hypothesis that the regression line is not horizontal.

Table 1. Distribution of sociodemographic characteristics of adolescents (n=234)

Variable	f	%
Gender		
Male	105	44.87
Female	129	55.13
Civil status		
Single	231	98.72
Married	3	2.28
Variable	Range	Mean ± S. D.
Age (years)	15 to 19	16.67 ± 1.54
Weight (kg)	55.00 to 123.50	82.91 ± 12.20
High (m)	1.46 to 1.87	1.65 ± 0.08

Table 2. Distribution of study variables in adolescents

Variable	Range	Mean ± SD
Body mass index (kg/m^2)	25.0 to 42.8	30.44 ± 3.92
Systolic blood pressure (mmHg)	80 to 149	114.71 ± 11.02
Diastolic blood pressure (mmHg)	55 to 100	72.10 ± 9.69
Physical activity (METS/min/week)	924 to 9,036	3,050.90 ± 1258.62
Mean calories intake by day	594.35 to 7,931.9	2,526.34 ± 1,469.86

SD= Standard deviation

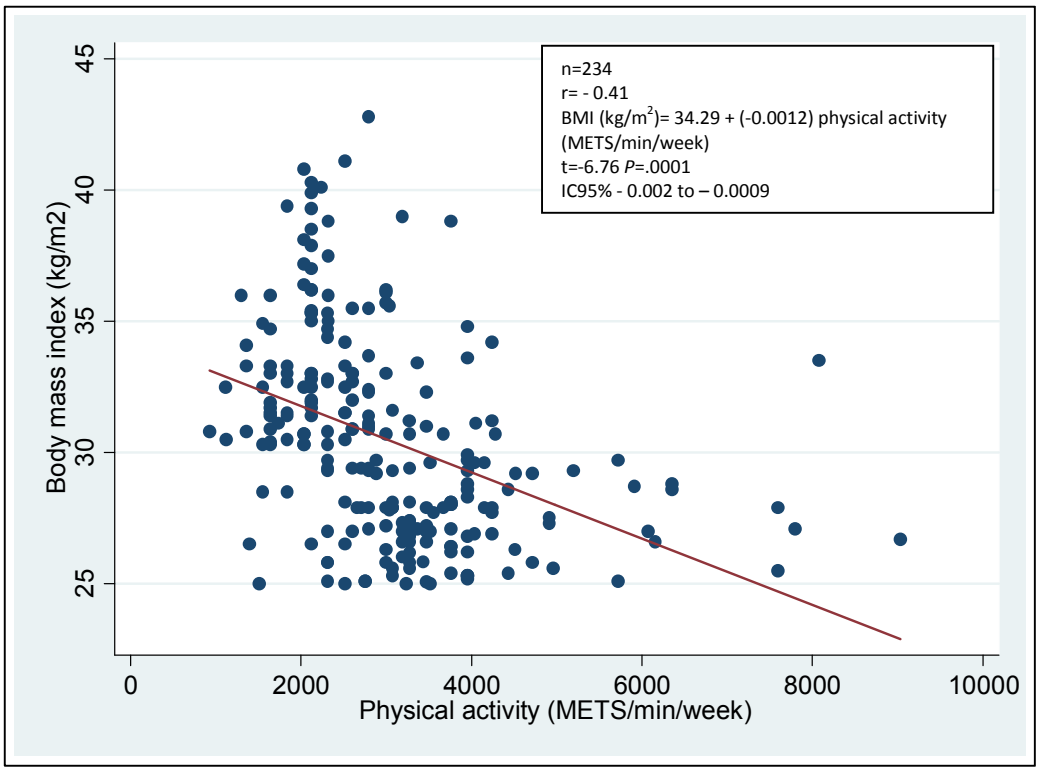

Fig. 1 Lineal regression among physical activity and body mass index in adolescents

Between average daily calorie consumption and BMI, a weak correlation was found (r = 0.13) and a significant linear relationship was found (t = 2.01 P = .05) (Fig. 2). Because the value of *P* is .05, the 95% confidence interval of the value of the slope (β) of the regression line is reviewed

and since it does not include the "0", the null hypothesis is not accepted Regression is not horizontal and has a statistically significant slope, although the correlation was poor.

A weak correlation (r = 0.23) between BMI and systolic blood pressure is shown in Fig. 3, this relationship being linear (t = 4.47 *P* = .0001).

A slight correlation (r = 0.34) and strong linear relationship between BMI and systolic blood pressure (t = 0.54 and *P* = .0001) are shown in Fig. 4. With this it can be predicted that if adolescents do not change their condition of overweight or obesity, they may in the immediate future be with high blood pressure.

Table 3 shows the third part of adolescents were not aware of their status of overweight and obesity and did not plan to do anything to solve it in the next 6 months. Another third of them were aware of their problems and that it was essential to initiate actions so that they did not move forward, perhaps to initiate control in the selection of food and increase physical activity in the following month and only 22% already had more than 6 months taking actions regarding diet and physical activity to try to control overweight and obesity.

The results obtained from the adolescents of Colima, a predominance of women was 53.14%, single 98.72%, (Table 1) and showed a moderate negative correlation and strong linear relationship between physical activity and BMI (Fig. 1); There was also a poor correlation and linear relationship between daily average calorie intake and BMI (Fig. 2). For the BMI and the TAS and TAD, moderate correlations were found but strong linear relationships (Fig. 3 and Fig. 4). These data are similar to study of schoolchildren and older adults in Celaya, reported by Padilla et al [6,7]; in school children the energy intaje were until 6000 calories by day, measured by SNUT survey; in older adults, it was more important the correlation among physical activity than energy intake for BMI high.

In this sample of Mexican adolescents from the state of Colima show what Padilla et al. [7] had reported in older adults with a poor correlation between caloric intake and BMI and strong negative correlation between physical activity and BMI.

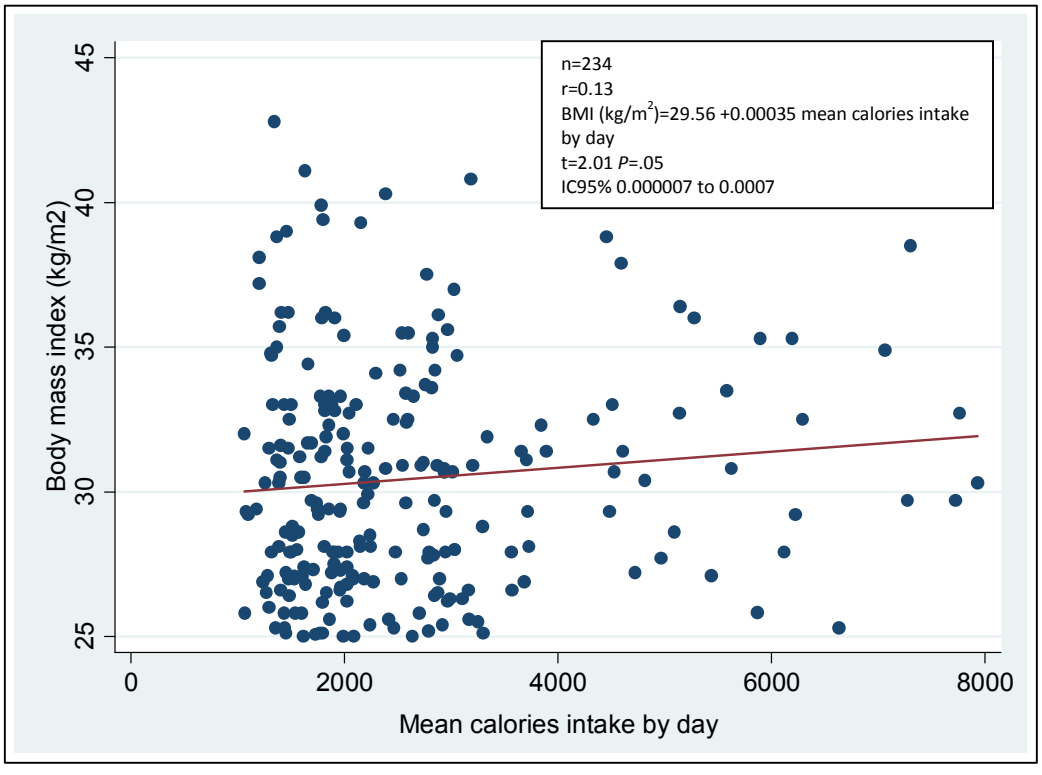

Fig. 2 Lineal regression among mean calories intake by day and body mass index in adolescents

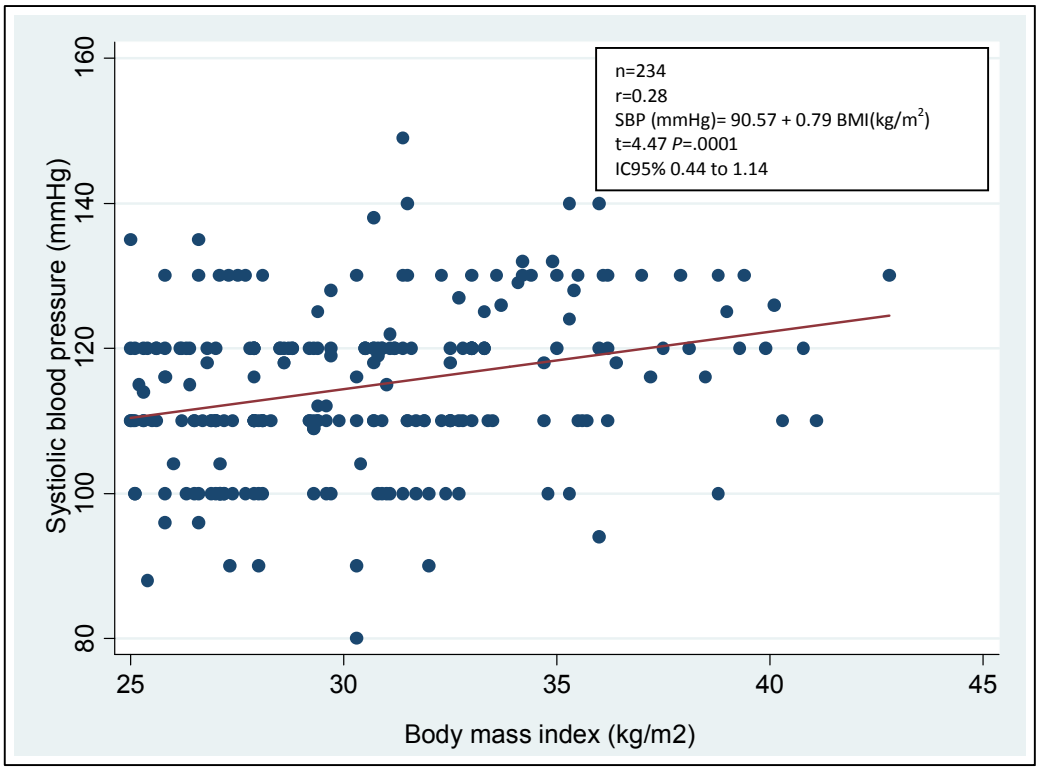

Fig. 3 Lineal regression among body mass index and systolic blood pressure in adolescents

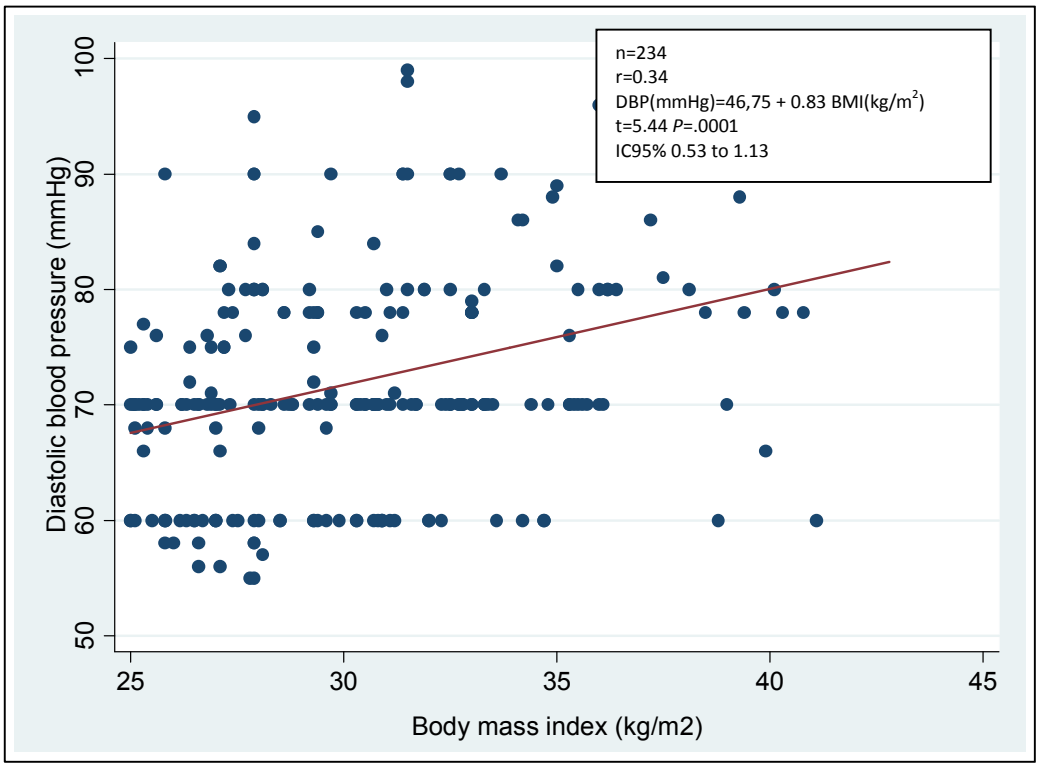

Fig. 4 Lineal regression among body mass index and diastolic blood pressure in adolescents

Table 3. Distribution by change stages in adolescents

Change stage	f	%
Precontemplation	80	34.19
Contemplation	9	3.85
Preparation for the action	92	39.32
Action	0	0.00
Maintenance	53	22.65

The sample of adolescents whose parents agreed to participate was 234, predominantly the female gender 53.15% and the unmarried with 98.72% (Table 1), which was expected since they are students of the upper middle level. Salazar et al., studying Mexican adolescents from the state of Hidalgo, in their physical activity, BMI and meal times, reported 58% of women, similar to what was reported in the sample of adolescents from Celaya [23].

All the members of the sample had a BMI of 25 kg / m2 or greater (Table 2).

The correlation between physical activity and BMI was moderate and negative in our sample (r = -0.41) with a statistically significant negative linear relationship (*P* = .0001) (Fig. 1) unlike that reported by Saucedo et al. [24], where they found no correlation between physical activity and BMI, in adolescents in the state of Hidalgo. In both studies, the International Physical Activity Questionnaire [18], in its short version, was used to measure physical activity. Salazar et al. [23], when studying adolescents from the University of Colima, found an important effect between being physically inactive with obesity (OR = 5.5), which reinforces the results in this study.

Regarding the correlation between average daily calorie intake and BMI, it was poor (r = 0.13) although the linear relationship is at the limit of being statistically significant (*P* = .05), and reviewing the 95% confidence interval does not include 0, therefore the alternative hypothesis that the regression line is not horizontal is accepted.

In Colombia, a significant correlation between BMI and blood pressure values was reported in adolescents in Manizales [25]. This is similar to those reported among adolescents in Colima, Mexico, since there is a significant correlation between BMI and SBP (r = 0.28 linear relationship (*P* = .0001) (Fig. 3) and between BMI and DBP (r = 0.34) and significant linear relationship (*P* = .0001) (Fig. 4) In Brazil, in medical students, a significant relationship between BMI and SBP (*P* <.05) was reported and no relationship between BMI and DBP was found (*P* =. 45) [26]. In 360 Ecuadorian adolescents up to 15 years of age, an association was found between overweight / obesity with arterial hypertension, reporting that no overweight adolescent / obesity was normotensive [27].

In order to effectively treat the problem of overweight or obesity, the adolescent must be aware that he has a health problem and that he must take actions to control it. García [19], studying young university students in Celaya, Mexico, reported that 6% were in pre-contemplation, 5% in contemplation, 10% in preparation, 50% in action and 28% in maintenance. In the sample of adolescents in Colima, the percentages were: 34.2%, 3.9%, 39.3%, 0% and 22.7%, respectively (Table 3). This indicates that a third of Colima's adolescents have no idea of the problem of overweight or obesity and if they have it they do not plan to do anything to remedy it and open an area of opportunity to work with educational interventions to raise awareness about the consequences of Overweight or obesity on health and motivate to make changes in the lifestyle of adolescents, to try to improve their BMI.

4. CONCLUSION

The results from the sample of adolescents show the correlation and lineal regression, between calories intake and physical activity with BMI: also shows the correlation and lineal regression between BMI with SBP and DBP.

These data are important because the policy makers can design interventions in individual or community level to promote the physical activity and regulate the energy intake.

Another important data is the fact that adolescents in Colima are not motivates to change, although they have problems by BMI high.

For the future, the design interventions for management overweight or obesity, should take into account these findings.

CONSENT

All authors declare that written informed consent was obtained from the parents of the adolescents and announce to participate from the adolescent.

ETHICAL APPROVAL

The protocol was approved by the Investigation and Ethics Committee from Regional University Hospital in Colima, Mexico, with the registry: CI-2017/01/SR/ENF/015.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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