



## **A Strong Relationship of Physical Activity and Obesity in Adults between 60 and 70 Years from Celaya, Mexico: A Cross Sectional Study**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author NPR designed the study, wrote the protocol, performed the statistical analysis and wrote the first draft of the manuscript. Author LVP reviewed the protocol, statistical analysis and the first draft of the manuscript. Author GOV managed the literature searches and reviewed the manuscript. Author SCDS supervised the field work and reviewed the manuscript. Author NEMP supervised the consent forms, helped to write the protocol, and reviewed the manuscript. Author MGNE helped to write the protocol, supervised the field work and reviewed the manuscript. All authors read and approved the final manuscript.*

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## ABSTRACT

**Purpose:** To determine the relationship between calories intake, level of physical activity and overweight/obesity in adults over 60 years in Celaya, Mexico.

**Study Design:** It was a cross-sectional study.

**Place and Duration of Study:** Population: 754 adults between 60 and 70 years old from Day Care Centers for the elderly from Celaya, Guanajuato, México between August 2014 and July 2015.

**Methodology:** We included a sample of 100 of adults, both genders, who signed the consent form; the calories intake was measure with SNUT survey, physical activity with International Physical Activity Questionnaire and measuring of overweight/obesity with Body Mass Index. Statistical analysis was with Pearson's r, and lineal regression equation between mean daily calories intake and Body Mass Index and between physical activity (METS/min/week) and Body Mass Index. The variables were categorized and it was calculated Chi squared test, p value, Odds Ratio and it was generated in a logistic multivariable model.

**Results:** The sample was 100 adults between 60 and 70 years old. There was not a correlation between caloric intake and Body Mass Index in males nor females ( $P>0.05$ ). There was a good negative correlation between physical activity and body mass index ( $r=-0.56$ ) and a negative lineal relationship ( $P<0.05$ ). There was a relationship between physical activity and overweight/obesity ( $X^2= 47.29$ ,  $df 1 P=.00001$ ) and  $OR=102.60$ . There was not a relationship between Mean Daily Caloric Intake and overweight/obesity ( $X^2= 0.84$   $df 1 P=.36$ ).

**Conclusion:** There is a strong negative correlation and lineal relationship between physical activity and Body Mass Index. There is an relationship between physical activity and overweight/obesity in the elderly from Celaya, Mexico.

*Keywords: Overweight; obesity; physical activity; calories; elderly.*

## 1. INTRODUCTION

Overweight/obesity is a global public health problem. In 2014, 1.9 billion adults were overweight, and of them 600 million were obese [1]. In Mexico, according to the Survey of Health and Nutrition 2012 (ENSANUT), the frequency of overweight/obesity in adults was 71.3%, and the ages of 50-59 years showed 14.3% higher obesity grade II and III [2].

Those over 60 in Mexico, had a rate of 40.2% overweight, 30% obesity, and abdominal obesity of 82.3% [2].

Overweight/obesity is due to "an energy imbalance between calories consumed and expended" [1] mainly due to consumption of foods of high caloric density and decreased physical activity.

Diet is a modifiable factor in older adults and an adequate dietary intake may translate to better quality of life [3,4]. In a studying among elderly in Australia, it was found that most of them exceeded the recommended intake of most nutrients, except vitamin D and calcium, and that excessive consumption of calories could lead to obesity [5].

The high caloric intake requires people to perform more physical activity in order "to burn" the excess caloric intake; however in the elderly, overweight and obesity are even worse because they remain seated during the day.

Physical activity (PA) in older adults is limited by the deterioration of physical abilities, or barriers, that prevent the exercising, [6] with the consequence of accumulating calories in the body, and the increase of Body Mass Index (BMI).

Age decreases the number and sensitivity of taste receptors located in the tongue, which perceive the main, bitter, sour, salty and sweet flavors. The latter flavor is the most reduced, leading to a sweet-tooth, which increases the consumption of sugars in foods for people over 60, resulting in a diet rich in calories and resulting obesity [7]. Additionally, the elderly often depend on someone else for the selection and preparation of food, and can easily have an unhealthy diet.

Although in Mexico the prevalence of overweight/obesity is very high, it is not sufficiently in the electronic databases addressing the issue of caloric intake, physical

activity and obesity in adults between 60 and 70 years old.

Interest in the study arises in the authors because of the controversial claims of a sweetened-drink company, which concluded that diet is not a major factor in obesity, but that physical activity has the greater impact [8].

McTiernan et al. [9] reported the benefits of a program of physical intervention in adults for weight reduction and therefore the Body Mass Index; hence the controversy about which is more important physical activity that a healthy diet to lower BMI [10].

Because of this, the aim of this study was to find the correlation between the caloric intake and physical activity with BMI in adults of 60 to 70 years old in Celaya, Mexico.

## **2. MATERIALS AND METHODS**

We went to Day Care Centers for the Elderly in Celaya, to take a sample of 754 adults aged 60 to 70 years, enrolled in these centers.

### **2.1 Selection of Participants**

Inclusion criteria were adults from 60 to 70 years old, who agreed to participate in the study, registered in day care centers for the elderly in Celaya, Guanajuato.

Exclusion criteria were that they had motor and/or cognitive deficit, or they were in a hospital, or nursing home resident (permanent homes for the elderly).

### **2.2 Variables**

#### **2.2.1 Sociodemographics**

They were age, gender, and employment status as working, non-working and retired).

#### **2.2.2 Exposure variables**

The independent variables were caloric intake, measured by the survey of frequency of foods (SNUT), which was analyzed with the software SNUT [11]. The questionnaire was validated in Mexican population [12]. It referred to the average food consumption in the past year, and the results of the analysis in software are the mean average of calories each day, the measure

is in mean daily calorie intake each day; and is presented with the mean and standard deviation.

Calorie intake was categorized as inadequate (<2000 cal/day) and high (2000 or more calories/day) [13].

Another exposure variable was physical activity as a continuous numerical variable, which is the metabolic rate by performing physical activity daily in the last seven days. We used the International Physical Activity Questionnaire (IPAQ) in its long version in Spanish, [14] validated in a Latin American population; [15] measured in METS/min per week, and presented with the mean and standard deviation.

PA was categorized as mild (<600 METS/min per week) and moderate/vigorous (600 or more METS/min per week) [14].

#### **2.2.3 Outcome variable**

BMI is a continuous numerical variable; body mass is expressed in kilograms by height in meters squared; the weight was measured with as little as possible of clothing, without shoes, sitting at- rest 15 minutes prior to measurement. A Medidata Series® digital scale was used. Height in centimeters was measured with the same arc altimeter scale. The measurement conditions were the same as the measurement of weight, and standing without shoes. It is measured in kg/m<sup>2</sup> and presented with the mean and standard deviation.

Status of obesity is a dichotomous categorical variable, being adequate with <25 kg/m<sup>2</sup> and overweight/obese of 25 kg / m<sup>2</sup> or more. The original classification of BMI is adequate <25 kg/m<sup>2</sup>, overweight between 25 and 29.9 kg/m<sup>2</sup> and obesity 30 or more kg/m<sup>2</sup> [1]. We join together overweight and obesity to do more easy the analysis of data.

### **2.3 Sample Size**

With an expected of 0.40, between physical activity and BMI, the active minimum sample size is 61 participants, with 95% accuracy and 90% power, from a population of 754 adults between 60 and 70 years old (Epidat 4.1, 2014, Xunta de Galicia, PAHO, and University CES). We increased the subject participants to 100 because of potential drop outs, and for questionnaires not fully answered.

Sampling was simple random, with a sampling frame of adults between 60 and 70 years old, registered in day care centers. Random numbers were generated, and the analysis program tabulated data with these numbers, and 100 participants were selected (Epidat 4.1, 2014, Xunta de Galicia, PAHO, University CES).

### 2.4 Statistical Analysis

Descriptive statistics were used to determine the distribution of sociodemographic variables in the study.

Correlation was performed including Pearson r and linear regression equation between the caloric intake and physical activity with BMI by gender, calculating t test to show whether if there is a linear relationship among variables and the regression line is pending, and the p-value, with confidence intervals of 95%.

Caloric intake, level of physical activity and status of obesity were categorized, and Chi

square, p value, Odds Ratio (OR) and confidence intervals at 95% were calculated and logistic regression model was generated with all variables.

To demonstrate statistical significance of the results, the p value was set at 0.05 at two tails.

The statistical analysis was performed on the 13.0® STATA (Stata Corp., College Station, TX, USA).

### 3. RESULTS AND DISCUSSION

The sample consisted of 100 adults between 60 and 70 years old. All participants were Hispanic race

Table 1 shows the distributions of sociodemographic characteristics, finding that the average BMI of the sample corresponds to overweight, average physical activity falls under the category of moderate, and caloric intake was slightly greater than 2,000 kcal/day.

**Table 1. Distribution of quantitative sociodemographic variables in the sample of participants, Celaya, (n = 100)**

Variable	Male	Female
<b>Age (years)</b>		
Range	60 to 70	60 to 70
Mean	65.30	65.39
Standard deviation	3.18	3.09
<b>Weight (kg)</b>		
Range	49.1 to 116	44 to 90
Mean	73.10	68.96
Standard deviation	13.05	10.55
<b>High (m)</b>		
Range	1.49 to 1.80	1.40 to 1.70
Mean	1.65	1.56
Standard deviation	0.07	0.08
<b>BMI (kg/m<sup>2</sup>)</b>		
Range	19.03 to 40.14	17.2 to 39.17
Mean	26.67	28.77
Standard deviation	4.55	4.79
<b>Physical activity (METS/min/week)</b>		
Range	100 to 3645	120 to 3200
Mean	1099.98	948.75
Standard deviation	1029.45	881.55
<b>Daily mean of caloric intake (calories/day)</b>		
Range	697.5 to 7405.99	556.43 to 3950.76
Mean	2155.11	1965.30
Standard deviation	1314.77	898.19

BMI= Body mass index

Table 2 shows the sociodemographic categorical characteristics of the sample, slightly predominating 53% female, married 42%, not working 44%, living with partner 35%; 43% consumed on average more than 2000 cal/day, 58% had PA mild (<600 METS/min per week) and 72% were overweight/obese with a BMI  $\geq 25$  kg/m<sup>2</sup>.

In British adults, an association between job loss and weight gain was reported, and in this study it was not evident among those who kept their jobs or retired [16]. In the sample of Celaya, it was found that only 17% were retired, 39% are still working and 44% do not work and depend on others, as they had no pension (Table 2) and it is possible by the fact that continue working they have to move, walking or cycling to their workplaces.

**Table 2. Distribution of qualitative sociodemographic variables in sample of participants, Celaya, (n = 100)**

Variable	n	%
<b>Gender</b>		
Male	43	43.00
Female	57	57.00
<b>Civil status</b>		
Single	13	13.00
Married	42	42.00
Widow	36	36.00
Divorced	8	8.00
Separate	1	1.00
<b>Working situation</b>		
Work	39	39.00
Non-work	44	44.00
Retired	17	17.00
<b>Who lives</b>		
Alone	18	18.00
With couple	35	35.00
Son/daughter	20	20.00
Family	9	9.00
Other	18	18.00
<b>Calories intake</b>		
<2000 cal/day	57	57.00
$\geq 2000$ cal/day	43	43.00
<b>Level of physical activity</b>		
Slight	58	58.00
Moderate/vigorous	42	42.00
<b>Obesity status</b>		
No	28	28.00
Overweight/obesity	72	72.00

In Fig. 1, the scatter plots are shown between the caloric intake and BMI by gender, showing a non-correlation and non-significative linear relationship in men and women ( $P < .05$ ).

Fig. 2 shows the scatter plots between PA and BMI, by gender, finding a statistically significant negative correlation and good slope ( $P < .05$ ), in both men and women, but the correlation is greater in women than men.

In the rural population of Mexico, it is reported that women had a higher BMI than men, with BMIs of 27.7 and 25.2 respectively, and the men did more physical activity than women; plus there is a negative correlation between PA and BMI [17]. This is similar to the result in adults between 60 and 70 years from Celaya (Fig. 2). This data suggest that to higher PA less BMI; also, the strong correlation and negative lineal relationship among PA and BMI were found in males and females.

In this study, there was correlation and linear relationship between caloric intake and BMI, but when categorizing both variables, we could not detect a statistically significant association, possibly because of the sample size of only 100 seniors.

In the sample from Celaya, caloric intake had less impact than physical activity in the increased BMI (Figs. 1 and 2).

After categorizing physical activity and the status of obesity, they was tabulated and a statistically significant association was found ( $p < 0.05$ ) and OR showing a large effect of AF on the status of obesity. In tabulating the calorie intake with obesity status no statistical association was found ( $P > 0.05$ ) (Table 3).

This confirms the strong relationship between physical activity and overweight/obesity, and no relationship between caloric intake with overweight/obesity in the sample of adults between 60 and 70 years from Celaya, shown in Figs. 1 and 2.

It is important to note that 72% of participating subjects had a BMI of 25 kg/m<sup>2</sup> or greater, being overweight or obese, similar to the proportion of overweight/obese reported in ENSANUT 2012, with 40.2% of overweight, obesity 25.0%, and 82.3% of visceral obesity [2].

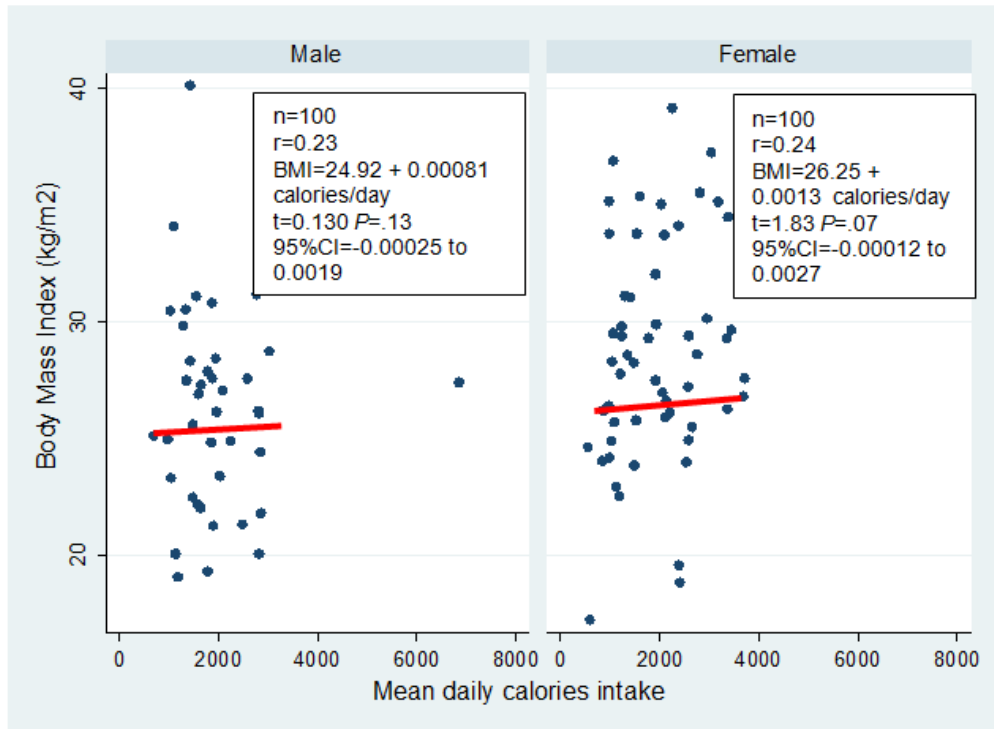


Fig. 1. Correlation and linear regression between average daily calorie intake and body mass index, by gender in adults over 60 years, Celaya

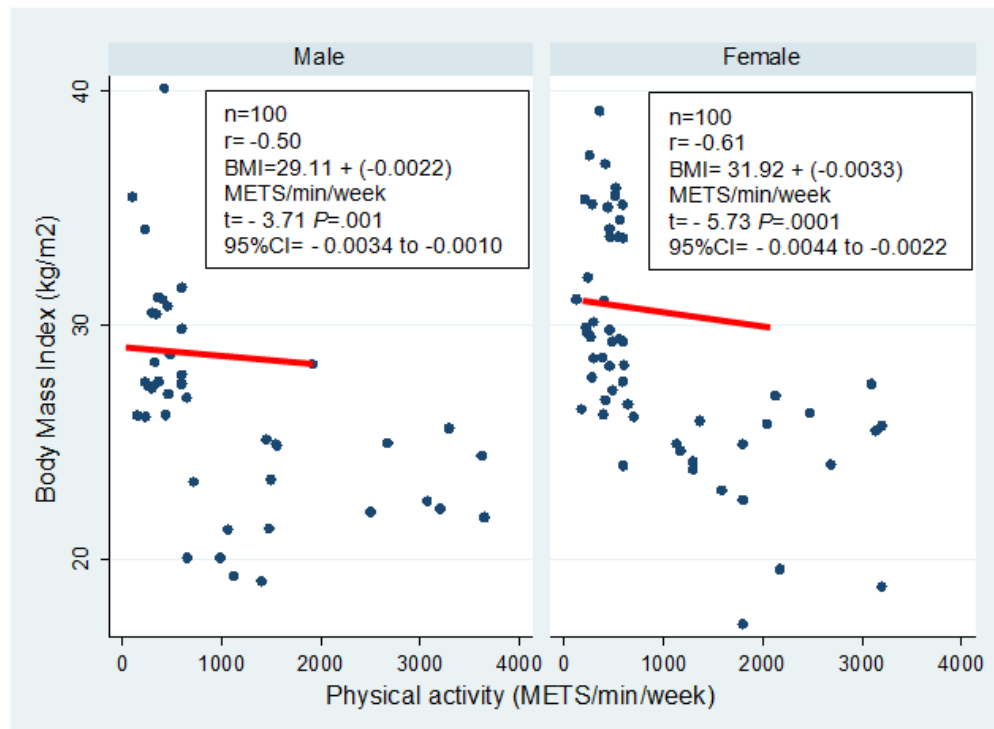


Fig. 2. Correlation and linear regression between physical activity and body mass index, by gender in the adults over 60 years, Celaya

**Table 3. Level of physical activity and caloric intake and obesity status in adults from 60 to 70 years, Celaya, 2015 (n = 100)**

	Obesity status				X <sup>2</sup> (df)	P-value	OR (95%IC)
	Overweight/obesity		No				
	n	%	n	%			
Level of physical activity					47.29(1)	.00001	102.60
<600 METS/min/week	57	79.17	1	3.57			(12.88 to 817.47)
≥600 METS/min/week	15	20.83	27	96.43			
Caloric intake /day					0.84(1)	.36	1.52
≥2000	33	45.83	10	35.71			(0.62 to 3.75)
<2000	39	54.17	18	64.29			

df= degree of freedom, OR= Odds Ratio, 95%IC= 95% confidence intervals

These results were expected, as it is well-known that physical activity, moderate or vigorous, helps maintain body weight, and moderate calorie intake is not a factor to increase weight and therefore BMI. Moderate physical activity is the best predictor of weight maintenance in the long term, as it has effect on energy balance, body composition, mood, quality of life and the risk of disease [17].

Dabrowska et al. [18] found an inverse relationship between physical activity (different domains) and BMI in Polish women, with Pearson r from -0.2 to -0.57, depending on the domain of physical activity. In Celaya Pearson's r between physical activity and BMI was -0.61 (Fig. 2).

Smith et al. [19] studying English seniors reported that moderate physical activity has a Risk Ratio (RR) of 0.50 and vigorous physical activity has a RR of 0.43 with obesity, showing that moderate or vigorous physical activity prevents the development of obesity; and they also reported that moderate and vigorous physical activity has a RR of 0.69 and 0.43, respectively in relation to central obesity. In Celaya, older adults have an inverse linear relationship between physical activity and BMI; and categorizing the level of physical activity and the presence of overweight and obesity, a strong association between overweight/obesity and mild physical activity level (Table 3) are reported.

In the Philippines, older adults generally have 35% lower caloric intake requirements according to their energy expenditure [20]. In the USA, between 1977-1978, people of age 55-64 years old consumed approx. 1800 calories/day, but in 2005-2010 increased consumption to 1950 calories/day. Also, consumption reduces with the advancement of age [21].

A logistic regression model was generated where the raw OR was between category PA and

obesity status and including: caloric intake category, gender, age, marital status, employment status, with whom they live. None of the variables improved the original logistic model (P values greater than .05) (Table 4).

Physical activity is essential for maintaining good overall health. In Spain, it was found that women do more physical activity than men, mainly due to domestic activities, [22] but also physical activity in a group in older adults, which counteracts social isolation, improving the state of mind of people [23]. In the sample from Celaya it was found that women have more strong correlation and linear regression between physical activity and BMI than men (Fig. 2), but categorizing the physical activity and overweight/obesity did not find that gender modified the association between physical activity and overweight/obesity (Table 4).

In Chile, it was generally found that the adult population consumes fewer fruits and vegetables than recommended, and that the more physically-active consume them in larger quantities [24]. Liu et al. [25] reported that the risk of atherosclerotic disease in women was 30% lower than in those who consumed 5 to 10 servings of fruits and vegetables per day, compared with those who consumed less than 5 servings.

The selected sample was representative of adults over 60 years from Celaya, Mexico and being obtained at random, the possibility of bias is decreased.

Perhaps there is no relationship between caloric intake and BMI because the SNUT survey measure the caloric intake in the last year and not more time in the life of subjects.

The ethnic origin from elderly participating in the study did not affect the results, because all were Hispanic race.

**Table 4. Logistic regression model among physical activity and obesity status, with sociodemographic variables and caloric intake Celaya, 2015**

	Category of PA + obesity status (1)	1+ caloric intake	1 + gender	1+ age	1 + civil status	1 +work situation	1+ With whom they live
OR	102.60	101.40	102.96	103.10	102.61	98.47	106.68
95%IC	12.88 a 817.14	12.72 a 808.50	12.76 a 830.80	12.82 a 829.13	12.88 a 817.68	12.33 a 786.06	13.23 a 860.12
LRT	53.74	0.22	1.71	1.19	0.02	0.37	0.48
P-value	.00001	.64	.19	.28	.89	.54	.49

PA = Physical activity, OR= Odds Ratio, 95%IC= 95% confidence intervals LRT= Likelihood Ratio Test

The weakness of the study, are the memory bias, as the SNUT survey is based on consumption in the last year and the answers could be not correct; another weakness is that the elderly to feel displaced by younger people in their work, and they answer as be more vigorous in the IPAQ survey and unable to perform the level of physical activity reported. The random sampling is a strength of the study as controls for known and unknown confounders; all participants also completed the study procedures.

#### 4. CONCLUSION

A correlation and linear relationship between physical activity level and status of overweight/obesity in adults between 60 and 70 years of both genders, in Celaya, Mexico was demonstrated, but caloric intake did not show this correlation nor linear relationship with BMI.

There are a strong association between physical activity and overweight/obesity; this association was not found among caloric intake and overweight/obesity.

The strong association between light physical activity and overweight/obesity, was not modified by consuming more than 2000 cal/day, age, gender, marital status, employment status or with whom he lives, in the sample of adults between 60 and 70 years old from Celaya, Mexico.

This gives guidelines to try to design programs to increase the physical activity, not only to improve health in general, but to influence better control of overweight or obese adults over 60 years old.

#### CONSENT

All authors declare that written informed consent was obtained from the patients.

#### ETHICAL APPROVAL

The protocol was reviewed and approved by the Bioethics Committee of the Division of Health Sciences and Engineering, Campus Celaya Salvatierra University of Guanajuato with registry number CIDSC-1331306.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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