

**UNIVERSIDAD SAN FRANCISCO DE QUITO USFQ**

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**The Association between Breakfast Skipping, Nutritional Status and Physical Activity among middle-aged Ecuadorian population**

**Proyecto de Investigación**

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**HOJA DE CALIFICACIÓN  
DE TRABAJO DE TITULACIÓN**

**The Association between Breakfast Skipping, Nutritional  
Status and Physical Activity among middle-aged Ecuadorian  
population**

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Quito, 11 de diciembre del 2017

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## RESUMEN

*Introducción:* La omisión del desayuno se ha asociado con la ganancia de peso, un bajo nivel de actividad física, al igual que una dieta pobre en calidad. En Ecuador no existen datos sobre este hábito alimenticio y su asociación con estado nutricional y actividad física.

*Objetivo:* Se replicó los tradicionales estudios nutricionales de corte transversal para comparar la omisión del desayuno y la calidad de dieta en cuestionarios con el nivel de actividad física en los días que no reportan el consumo de desayuno y medidas antropométricas.

*Metodología:* Se utilizó datos de 800 participantes del estudio de corte transversal, Estudio Latinoamericano de Nutrición y Salud (ELANS) – Ecuador. El estado nutricional fue evaluado mediante varias medidas antropométricas, mientras que el nivel de actividad física fue evaluado mediante el cuestionario internacional de actividad física (IPAQ – International Physical Activity Questionnaire), ajustado para sexo, grupos de edad y región del país.

*Resultados:* Aproximadamente el 73.1% de los participantes reportaron el desayuno en uno o dos recordatorios de 24 horas, y el 6.6% de participantes no reportaron el desayuno en ninguno de los recordatorios. El 26.9% de la muestra total reportaron una omisión del desayuno en uno o dos recordatorios de 24 horas. A pesar de no demostrar significancia estadística, los individuos que tienden a saltarse el desayuno presentan pobres estados nutricionales, según su índice de masa corporal (IMC), circunferencia de cintura y circunferencia de cuello. Adicionalmente, se pudo observar un nivel moderado de actividad física en los participantes que no reportan el desayuno. Dentro del grupo que reportó omisión del desayuno, su probabilidad de realizar la mínima cantidad de actividad física fue de un 31.7%. A pesar de que la mayor parte del grupo de participantes que se saltaron el desayuno reportaron un nivel moderado de actividad física, esto no fue estadísticamente significativo al comparar con el grupo que desayunan.

*Conclusión:* En Ecuador, se observó un bajo porcentaje de la población que se salta el desayuno, sin embargo, la prevalencia de sobrepeso y obesidad es elevada. A pesar de que no se demostró una diferencia significativa entre la calidad de dieta, reflejado mediante la ingesta de energía y macronutrientes, nivel de actividad física y estado nutricional entre los grupos que desayunan y los que ayunan, las consecuencias a largo plazo se podrían evitar al cambiar este hábito alimenticio.

Palabras claves: Desayuno, omisión de desayuno, ELANS, obesidad, actividad física, IPAQ, estado nutricional, hábito alimenticio.

## ABSTRACT

**Introduction:** The omission of breakfast has been known to be associated with weight gain, a lower level of physical activity and a poor diet quality. However, there is no data regarding this obesity-related eating behavior in Ecuador and its association with nutritional status level of physical activity.

**Objective:** We replicated the traditional crossover design of nutrition studies in order to compare omission of breakfast and diet quality in self-reported surveys with anthropometric measurements and level of physical activity on the days that breakfast was skipped.

**Method:** We used cross-sectional dietary data for 800 adult respondents who reported breakfast omission in one or two dietary recalls in the Latin American Survey of Nutrition and Health (LANHS) – Ecuador. Nutritional status was evaluated through anthropometric measures, while physical activity was evaluated through the International Physical Activity Questionnaire, according to gender, age groups, and country region.

**Results:** Approximately 73.1% of participants reported breakfast in both recalls, 20.3% of participants reported breakfast in one of 2 recalls, and 6.6% of participants did not mention breakfast in both recalls. Overall, 26.9% of the total sample of participants reported skipping breakfast in any one or both recalls. Individuals who were more likely to skip breakfast had an overall poor nutritional status according to their body mass index (BMI), waist circumference and neck circumference, although this association was not statistically significant. Furthermore, we were able to observe a medium level of physical activity reported by the participants, but as the breakfast skipper groups were analyzed, the likelihood of meeting the least amount of physical activity was 31.7%. Although the majority of breakfast skippers achieved physical activity at a moderate level, the difference was not statistically significant compared with breakfast eaters.

**Conclusion:** In Ecuador, there a relative low percentage of the general population that skips breakfast, however, the prevalence of overweight and obesity has increased. Although the quality of dietary selections reflected in the energy and macronutrient density of a day's intake, level of physical activity and nutritional status did not differ between the breakfast and the no-breakfast day, the long-term health consequences should be avoided by changing this eating habit.

Key Words: breakfast, breakfast skipping, LANHS, obesity-related eating behavior, obesity, physical activity, IPAQ, nutritional status, eating habit.

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## 1. Introduction

Obesity has become the greatest threat to global public health in the last century, affecting approximately 1.4 billion adults in 2016 (Leidy et al, 2016). The prevalence of obesity in adults in Ecuador has reached 50.0% of the total population, and of that, 36.3% are female and 61.1% are male (Freire, 2014). Certain lifestyle factors, our diet, including both the nutritional quality and our acquired eating patterns, lead us to a major target of obesity prevention strategies (Uzhova et al., 2017).

The omission of breakfast has been an obesity-related eating behavior that has received a lot of attention recently, especially since this has been established as the most important meal of the day (St-Onge 2017). Current recommendations suggest that the consumption of breakfast will lead to healthy body weight and successful weight loss maintenance. In a U.S. study reported among adults (n=3598; baseline age, 18-30 years), the daily breakfast eaters gained 1.91 kg less than infrequent breakfast consumers (<4 days/week) over 18 years (Thomas, 2015).

Consequently, prospective studies have demonstrated that skipping breakfast is associated with dyslipidemia, hypertension, higher risk for type 2 diabetes and cardiovascular disease (Thomas, 2015).

Furthermore, through behavioral studies, it has been established that skipping breakfast is associated with additional bad nutritional choices, as well as a lower level of physical activity due to lack of energy intake in the first meal of the day. Timlin et al. found that individuals who ate breakfast daily were more likely to participate in strenuous physical activity than those who never ate breakfast (26.5% v. 19.1%,  $p < 0.01$ ) (Lyerly et al., 2013). Currently there is no existing

study in Latin America that analyzes this eating behavior and its correlation with obesity and physical activity.

The present study is the first in Latin America to analyze the omission of breakfast and the participants' nutritional status and level of physical activity that is accomplished the day this meal is skipped. In addition, this study evaluates diet quality, including macronutrients, and several micronutrients that pertain to a healthy breakfast. The objective of the current study is to establish an association within the Ecuadorian population between the breakfast skipping, adiposity and level of physical activity. This will help us establish nutritional recommendations in order to prevent a rise in obesity in Ecuador, and eventually in the rest of Latin American countries.

## **2. Methods**

### **Study overview.**

This cross sectional study is based on the data from The Latin American Survey of Nutrition and Health (LANHS) - Ecuador, whose methods have been reported elsewhere (Fisburg et al, 2016). Briefly, it is a randomized cross-sectional multicenter investigation of the nutritional and physical activity status of adolescents and adults in eight Latin American countries. This data was collected over a period of one year in the following countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru and Venezuela. The current study used data collected in Ecuador from September 2014 to March 2015.

**Study participants and design.**

The LANHS used a randomized complex, multistage sampling process, which was stratified by geographical location, gender, age and socioeconomic status in order to select a representative sample of the Ecuadorian population. The sample size was calculated with a confidence interval of 95% and a margin of error of 3.46%. A survey design effect of 1.75 was estimated based on guidance from the U.S. National Center for Health Statistics, and calculations of the minimum sample sizes required per strata (i.e. socioeconomic level, age and gender) performed for Ecuador. We analyzed data from 800 adolescent and adult participants from 15 to 65 years of age from nine cities including Guayaquil, Machala, Portoviejo, Manta, Quito, Cuenca, Ambato, Loja and Ibarra, which correspond to the costal and highland regions of Ecuador (397 males and 403 females). We excluded pregnant and lactating women, individuals with major physical or mental impairments, adolescents without a signed consent form by their parent or legal guardian, individuals living in any residential setting other than a household, and individuals unable to read. The current study is a randomized cross sectional study that analyzes the association of breakfast skipping with nutritional status and physical activity.

**Ethical Considerations.**

The LANHS protocol was approved by the Western Institutional Review Board. In Ecuador, the study protocol was approved prior to its implementation by the Universidad San Francisco de Quito International Bioethics Committee. Each individual signed a written consent form prior to their participation in the study. Participant confidentiality was maintained via the use of numeric identification codes and all data transfer was done with a secure filing sharing system.

**Data collection.**

The LAHNS data was collected via questionnaires administered in two household visits and objective anthropometric measurements. In the first visit, the socioeconomic level questionnaire (established by the Instituto Nacional de Estadística y Censo, Ecuador) and the 24-hour dietary recall was applied, as well as anthropometric measurements taken. In the second visit, which took place 4 to 30 days later, a second 24-hour recall and the International Physical Activity Questionnaire (IPAQ) was administered to each participant.

*Physical Activity.*

The IPAQ questionnaire allowed us to categorize each participant in the following levels of physical activity according to their daily habits:

Low – Those individuals who do not meet criteria for categories 2 or 3 are considered to have a ‘low’ physical activity level

Moderate – The pattern of activity to be classified as ‘moderate’ is either of the following criteria:

- a) 3 or more days of vigorous-intensity activity of at least 20 minutes per day, or
- b) 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day, or
- c) 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum total physical activity of at least 600 MET (Metabolic Task Equivalent of Task)-minutes/week.

High – The individuals who meet either of the following criteria:

- a) Vigorous-intensity activity on at least 3 days achieving a minimum Total physical activity of at least 1500 MET-minutes/week, or
- b) 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum total physical activity of at least 3000 MET-minutes/week.

#### *Dietary Assessment.*

We used the 24-hour recalls to divide the participants in three groups according to their morning meal behaviors: 1) Breakfast skippers in any one recall, 2) Breakfast skippers in two recalls, and 3) Breakfast eaters in both recalls. Breakfast was defined as a consumption of >100 kilocalories consumed from 4 to 10 am. The 24-hour recall questionnaires were also used to analyze the total energy intake of the participants, and micronutrients including calcium, total sugar and fiber.

#### *Anthropometric measures.*

The nutritional status of the participants was established by analyzing the anthropometric measurements of body weight, height, waist and neck circumferences of each participant. These measurements were collected by certified nutritionists/dietitians. Each measurement was repeated twice to ensure accuracy, and the average used for analysis. Body weight was measured with a calibrated electronic SECA scale, model 813 with an accuracy of 0.1 kg. Height was measured with a portable SECA stadiometer, model 213 with an accuracy of 0.1 cm. The circumferences were measured with an inelastic SECA tape to the nearest 0.1 cm. The anthropometric measures analyzed in this study include body mass index (BMI), waist

circumference (WC) and neck circumference (NC). BMI was categorized according to the definitions established by the World Health Organization, which divides them in underweight, normal weight, overweight and obesity (WHO, 2015). Waist circumference of the participants was classified as an indicator of central obesity, if measurements for men and women exceeded 90 cm and 80 cm respectively (WHO, 2011).

The relationship between BMI, WC and central obesity is well known, which in turn is associated with an increased risk of developing metabolic syndrome, type 2 diabetes and hypertension. Several recent studies have examined the association between NC and cardiometabolic risk factors (Dai et al, 2016). Among these studies was the Framingham Heart Study, which demonstrated that NC is associated with cardiovascular disease risk factors even after adjustment for visceral adipose tissue and BMI, and ultimately considered NC to be a novel measurement of cardiometabolic risk (Dai et al, 2016). This study used NC as one of the anthropometric parameters in the hopes to compare it with WC, which is an established criterion for metabolic syndrome. The cut-off values used for NC in this study were  $\geq 37$  cm in men and  $\geq 35$  cm in women (Dai et al, 2016).

### **Statistical analysis**

All data was analyzed by using SPSS 20.0 software. Chi-square tests were used to examine differences between categorical data between the three groups. All continuous variables, which include the total energy intake, macronutrients, total sugar, fiber and calcium were analyzed with ANOVA. In order to use ANOVA, the following criteria were met: 1) all observations were independent, 2) equal variance is observed in each group, or homoscedasticity, and 3) the

underlying populations are normally distributed. The last condition was confirmed by the Kolmogorov Smirnov test, in which the Kurtosis and asymmetry coefficients calculated were 1.813 and 0.743, respectively. A normal distribution is established due to these values not exceeding 0.05. In addition, in order to find a correlation between neck circumference and the rest of anthropometric measurements, a Pearson's correlation test was used. All tests of significance were two tailed. Statistical significance was based on a p value of  $<0.05$ . Finally, in order to compare the utility of neck circumference with waist circumference, regression analysis was used.

### **3. Results**

Approximately 73.1% of participants (n=800) reported breakfast in both recalls, 20.3% of participants reported breakfast in one of 2 recalls, and 6.6% of participants did not mention breakfast in both recalls (Table 1). Overall, 26.9% of the total sample of participants reported skipping breakfast in any one or both recalls. There was almost an even distribution of participants who omitted breakfast between men and women. The majority of the participants who skipped breakfast in one or both recalls were young adults 20 to 34 years of age and those whom reside in the coastal regions of the country ( $p<0.01$ ). Roughly 73.4% of the participants with a low socioeconomic level reported eating breakfast on both recalls ( $p = 0.9$ ). Although the individuals with low income who reported skipping breakfast in one or two recalls was a smaller group compared to the BE (n=106 and 293 respectively), the majority of the breakfast skippers were categorized as being low income.

Table 1. Characteristics of Study Participants

	Total N (%) (n=800)	Breakfast skippers in any 1 recall N (%) (n=162)	Breakfast skippers in 2 recalls N (%) (n=53)	Breakfast eaters N (%) (n=585)	P
<b>Sex</b>					
<b>Male</b>	397 (49.6)	87 (53.7)	27 (50.9)	283 (48.4)	0.5
<b>Female</b>	403 (50.4)	75 (46.3)	26 (49.1)	302 (51.6)	
<b>Age</b>					
<b>15-19</b>	128 (16.0)	38 (23.5)	12 (22.6)	78 (13.3)	<0.0001
<b>20-34</b>	316 (39.5)	69 (42.6)	28 (52.8)	219 (37.4)	
<b>35-49</b>	222 (27.8)	42 (25.9)	7 (13.2)	173 (29.6)	
<b>50-65</b>	134 (16.8)	13 (8.0)	6 (11.3)	115 (19.7)	
<b>Region</b>					
<b>Costa</b>	440 (55.0)	99 (61.1)	38 (71.7)	303 (51.8%)	0.004
<b>Sierra</b>	360 (45.0)	63 (38.9)	15 (28.3)	282 (48.2)	
<b>SEL*</b>					
<b>High</b>	104 (13.0)	22 (13.6)	9 (17.0)	73 (12.5)	0.9
<b>Medium</b>	297 (37.1)	59 (36.4)	19 (35.8)	219 (37.4)	
<b>Low</b>	399 (49.9)	81 (50.0)	25 (47.2)	293 (50.1)	
<b>Anthropometric†</b>					
<b>Weight (kg)</b>	68.2 ± 14.5	69.8 ± 15.9	66.9 ± 14.5	67.9 ± 13.9	0.2
<b>Height (m)</b>	1.59 ± 9.2	1.60 ± 9.2	1.62 ± 9.5	1.59 ± 9.1	0.01
<b>WC(cm)</b>	87.4 ± 12.3	87.9 ± 11.9	84.6 ± 12.9	87.5 ± 12.4	0.2
<b>NC (cm)</b>	35.1 ± 3.7	35.3 ± 3.6	34.9 ± 3.4	35.0 ± 3.7	0.6

\*SEL: Socioeconomic level according to Instituto Ecuatoriano de Estadística y Censos (INEC)

† Expressed in mean values ± SD

WC: Waist circumference; NC: neck circumference

Individuals who were more likely to skip breakfast, had an overall poor nutritional status according to their BMI, WC and NC, although it was not statistically significant (p=0.6) (Table 2). Approximately 59% (n= 127) of breakfast skippers are overweight or obese according to their BMI, while 60.6% (n=355) of the breakfast eaters were found to be overweight or obese using the same anthropometric measurement. Approximately 57.1% of the total sample have a positive indicator of central obesity through their waist circumference measurements, and 26.7% of them are breakfast skippers. A little over half (56.7%) of the breakfast skippers had indication of being overweight or obese due to their waist circumference. Neck circumference did not demonstrate a

statistical association between being overweight and not reporting breakfast, with only 39% of the BS showing upper trunk adiposity ( $p = 0.8$ ). Furthermore, NC was significantly ( $p < 0.0001$ ) correlated with the traditional assessment of body composition, including BMI ( $r = 0.48$ ), and waist circumference ( $r = 0.62$ ). When comparing NC with WC and its correlation with BMI ( $r = 0.87$ ), WC remains the leading anthropometric parameter to demonstrate metabolic syndrome risk (Table 3).

Table 2. Association between breakfast patterns, anthropometric measures and level of physical activity

	Total N (%) (n=800)	Breakfast skippers in any 1 recall N (%) (n=162)	Breakfast skippers in 2 recalls N (%) (n=53)	Breakfast eaters N (%) (n=585)	P
<b>BMI (kg/m<sup>2</sup>)</b>					
<b>Underweight (<math>&lt;18.5</math>)</b>	28 (3.5)	6 (3.7)	4 (7.5)	18 (3.1)	0.6
<b>Normal (18.5-24.9)</b>	290 (36.2)	56 (34.6)	22 (41.5)	212 (36.2)	
<b>Overweight (25-29.9)</b>	286 (35.8)	57 (35.2)	18 (34.0)	211 (36.1)	
<b>Obesity (<math>&gt;30</math>)</b>	196 (24.5)	43 (26.5)	9 (17.0)	144 (24.6)	
<b>Waist Circumference</b>					
<b>Normal</b>	343 (42.9)	68 (42.0)	25 (47.2)	250 (42.7)	0.8
<b>Overweight</b>	457 (57.1)	94 (58.0)	28 (52.8)	335 (57.3)	
<b>Neck Circumference</b>					
<b>Normal</b>	473 (59.1)	98 (60.5)	33 (62.3)	342 (58.5)	0.8
<b>Overweight</b>	327 (40.9)	64 (39.5)	20 (37.7)	243 (41.5)	
<b>Physical Activity<sup>†</sup></b>					
<b>Low</b>	233 (30.3)	44 (28.6)	21 (41.2)	168 (29.8)	0.06
<b>Medium</b>	349 (45.4)	76 (49.4)	13 (25.5)	260 (46.1)	
<b>High</b>	187 (24.3)	34 (22.1)	17 (33.3)	136 (24.1)	

<sup>†</sup> Physical activity was analyzed based on 769 completed International Physical Activity Questionnaires (IPAQ).

Table 3. Pearson's partial correlations between anthropometric measurements\*

	<b>Neck circumference</b>	<b>Waist circumference</b>
<b>Waist circumference</b>	0.67†	—
<b>BMI</b>	0.61†	0.86†

\*Adjusted for age and sex

† p&lt; 0.0001

In the general population we were able to observe a medium level of physical activity reported by the participants, but as the breakfast skipper groups were analyzed, approximately 31.7% achieved the least amount of physical activity. Although the majority of the breakfast skippers achieved physical activity at a medium level, the difference was not statistically significant compared with the breakfast eaters. In contrast, the breakfast eaters, 46% self-reported a medium level physical activity in their majority (p = 0.06). Overall, no association was found between skipping breakfast and a lower level of physical activity.

In terms of nutritional quality, BS were most likely to consume less total calories, protein, carbohydrates, fat, sugar, fiber and calcium compared to BE (Table 4). On average, BE self-reported a 10.3% increase in total energy intake compared to the breakfast skippers daily consumption. Male breakfast skippers on average consumed 2255 kcal and female breakfast skippers reported a consumption of 1852 kcal on the days they omitted the first meal of the day, neither sex reaching their total energy intake recommendation (2500 kcal and 2000 kcal for men and women, respectively) (Table 5). Breakfast eaters consumed a much higher amount of protein, exceeding the daily recommendation (46-56 grams/day) by an average of 34 grams (p<0.01). The amount of carbohydrates and total fat consumed were within acceptable ranges across all groups. Furthermore, breakfast skippers on average consume approximately 61% of

the adequate intake of fiber (25-38 grams for men and women), compared to a 79% of fiber consumed by breakfast eaters ( $p < 0.0001$ ). Additionally, although neither group consumed the estimated average requirement (EAR) of calcium (1000-1500 mg), both male and female breakfast skippers consumed 50.9% of the EAR. When comparing breakfast skippers from the costal and highland regions of Ecuador, there was a statistical difference observed in the daily consumption of total energy intake, total fat, total sugar, fiber and calcium, with a higher consumption made by participants that reside in the highland region (Table 6).

Table 4. Mean Daily Energy Intake of breakfast skippers compared to breakfast eaters

	<b>Breakfast Skippers in any 1 recall (n= 162)</b>	<b>Breakfast Skippers in 2 recalls (n= 53)</b>	<b>Breakfast Eaters (n= 585)</b>	<i>p-value</i>
<b>Total Energy (Kcal)</b> Mean, (SD)	2178 (1498)	1949 (1006)	2301 (957)	0.05
<b>Protein (g)</b> Mean, (SD)	83.2 (42)	73 (34)	90.4 (38)	<0.01
<b>Protein (%)</b> Mean, (SD)	16.2 (4)	16.1 (5)	16 (4)	0.9
<b>Carbohydrate (g)</b> Mean, (SD)	283 (156)	267.8 (152)	310 (128)	0.01
<b>Carbohydrate (%)</b> Mean, (SD)	53.7 (9)	54.3 (9)	54.6 (9)	0.5
<b>Total Fat (g)</b> Mean, (SD)	75.0 (65)	64.2 (42)	77.9 (41)	0.1
<b>Total Fat (%)</b> Mean, (SD)	30.0 (9)	29.5 (8)	29.9 (8)	0.9
<b>Total Sugars (g)</b> Mean, (SD)	54.8 (44)	46.1 (35)	58.9 (38)	0.05
<b>Fiber (g)</b> Mean, (SD)	15.8 (9)	14.7 (9)	19.8 (11)	<0.0001
<b>Calcium (mg)</b> Mean, (SD)	537 (352)	485 (287)	724 (400)	<0.0001

Table 5. Mean Daily Energy Intake of breakfast skippers vs breakfast eaters according to sex

	Male			<i>p-value*</i>	Female			<i>p-value*</i>
	BE (n=283)	BS1 (n=87)	BS2 (n=27)		BE (n=302)	BS1 (n=75)	BS2 (n=26)	
<b>Total Energy (Kcal) Mean, (SD)</b>	2589 (936)	2403 (1864)	2107 (1202)	0.09	2031(898)	1918 (846)	1786 (741)	0.3
<b>Protein (g) Mean, (SD)</b>	101.8 (38)	91.6 (47)	76.9 (41)	<0.01	79.7 (35)	73.4 (33)	68.9 (26)	0.1
<b>Carbohydrate (g) Mean, (SD)</b>	346 (127)	314 (184)	290.5 (182)	0.05	276.1 (119)	246.9 (104)	244.2 (112)	0.08
<b>Total Fat (g) Mean, (SD)</b>	88 (41)	80.1 (80)	68.4 (51)	0.1	68.5 (37)	69.2 (41)	59.9 (31)	0.5
<b>Total Sugar (g) Mean, (SD)</b>	63.3 (37)	61.4 (52)	53.2 (43)	0.4	54.7 (38)	47.1 (31)	38.7 (24)	0.04
<b>Fiber (g) Mean, (SD)</b>	21.1 (11)	16.8 (10)	15.5 (11)	0.001	18.5 (10)	14.6 (7)	13.7 (8)	<0.01
<b>Calcium (mg) Mean, (SD)</b>	764.3 (419)	581 (396)	440.7 (260)	<0.0001	686.6 (378)	485 (287)	530 (311)	<0.0001

\*p-value is comparing breakfast groups and nutrient intake, stratified by sex.

Table 6. Mean Daily Energy Intake of breakfast skippers vs breakfast eaters according to region

	Coast			<i>p-value*</i>	Highland			<i>p-value*</i>
	BE (n=303)	BS1 (n=99)	BS2 (n=38)		BE (n=282)	BS1 (n=63)	BS2 (n=15)	
<b>Total Energy (Kcal) Mean, (SD)</b>	2313 (978)	1997 (762)	1884 (729)	<0.01	2288 (936)	2464 (2185)	2115 (1521)	0.5
<b>Protein (g) Mean, (SD)</b>	92.0 (37)	83.1 (33)	73.0 (28)	<0.01	88.6 (39)	83.3 (53)	72.9 (47)	0.3
<b>Carbohydrate (g) Mean, (SD)</b>	309.8 (128)	267.5 (105)	255.6 (112)	<0.01	310.1 (128)	307.4 (211)	298.6 (227)	0.9
<b>Total Fat (g) Mean, (SD)</b>	77.2 (38)	68.3 (36)	62.0 (28)	0.01	78.7 (43)	85.6 (94)	69.9 (67)	0.5
<b>Total Sugar (g) Mean, (SD)</b>	56.6 (36)	52.4 (34)	41.8 (25)	0.04	61.4 (40)	58.5 (57)	56.9 (53)	0.8
<b>Fiber (g) Mean, (SD)</b>	18.7 (9)	15.2 (7)	14.5 (9)	<0.0001	20.9 (12)	16.8 (11)	15.1 (12)	0.01
<b>Calcium (mg) Mean, (SD)</b>	701.8 (342)	531.3 (346)	500.3 (274)	<0.0001	748.3 (453)	544.8 (364)	444.8 (323)	<0.0001

\*p-value is comparing breakfast groups and nutrient intake, stratified by region.

#### 4. Discussion

The present study of a nationally representative sample of the Ecuadorian population found that there is no association with skipping breakfast and being overweight/obese, nor achieving a low level of physical activity. There is a higher prevalence of overweight and obesity among the population across all breakfast groups in this study. In addition, individuals who live in the coastal region, despite their tendency of skipping breakfast, were characterized by making healthy eating choices when it comes to energy and nutrient intake.

*Breakfast consumption. -*

It has been established that obesity-related eating habits, including omission of breakfast, greatly contribute to weight gain. Despite breakfast being the most skipped of all meals, in our study, the prevalence of breakfast skipping was low. This is consistent with several studies worldwide. In Australia, breakfast skipping ranges from 4 to 30% with a predominance in the younger population (Fayet-Moore et al, 2016). In the United States, approximately 20 to 30% of adults do not eat breakfast, with the greatest increase being over the last 40 years (St-Onge et al, 2017). Although this study did not identify a predominant sex that skips breakfast, various studies have found that the female sex is associated with breakfast omission (Fayet-Moore et al, 2016). Furthermore, the young adult age group (ages 20 to 34) that has been identified as those who frequently skip breakfast, have a normal body adiposity distribution, which can be explained through numerous factors. First of all, this study does not analyze the timing or number of remaining meals of the day, which may have a compensating influence on the nutritional status (St-Onge et al, 2017). Secondly, the younger adult group is consistent with other studies and other obesity-related eating habits, as well as being part of a “social business eating pattern”, which is characterized by busy schedules, unhealthy food choices and frequent eating out (Uzhova et al, 2017). Finally, the normal body adiposity distribution may reflect the efficiency of the metabolic rate that this younger group has in comparison to the older age groups (Witbracht et al, 2014).

*Energy and Nutrient intake. -*

Despite breakfast omission being known to be associated with lower 24-hour energy intake, our study found that energy intake was not significantly different across breakfast categories. Greater

breakfast consumption was usually associated with greater reported energy intakes compared to breakfast skipping. Total sugar, fiber and calcium were evaluated in this study, due to its nutritional importance in the breakfast meal. Protein was consumed more on breakfast day by men than the days that breakfast was omitted, as well as fiber and calcium, although the recommended requirements for calcium were not met in any of the breakfast groups. Females consumed a statistically significant amount of total sugar, fiber and calcium on the days that breakfast was consumed compared to the females who chose to skip breakfast. This shows the importance of protein for men and the tendency for women to consume a higher amount of sugar in their diet. However, a larger amount of fiber and calcium is consumed on the days that individuals have breakfast, which reflects its importance in the first meal of the day (Witebracht et al, 2014). There were notable differences in nutrient intakes when comparing participants from the coastal and highland regions of Ecuador. There was a significant difference across all nutrient categories and total energy intake on breakfast days than on the no-breakfast day in the coastal region, which shows the concrete difference in diet quality within the same country. This can be due to the different staple food items that each region has as part of their traditional meals. Furthermore, the amount of fiber consumed daily in the coastal region is significantly less, which should be adjusted in order to maintain bowel health, lower cholesterol levels, help control blood sugar levels and aid in achieving a healthy weight (Witbracht et al, 2014). In a 4-week randomized trial in the U.S., between men and women who either had a higher-fiber breakfast, a non-fiber breakfast, or skipped breakfast, the no-breakfast group had a greater weight loss (-1.18 kg) compared with the breakfast groups. Conversely, the breakfast skippers had an increase in serum total cholesterol (St-Onge et al, 2017). If the participants that were classified as breakfast skippers maintain this eating habit, it is important to emphasize on studies

linking breakfast consumption with overall diet quality and regulation of appetite. They have reported that micronutrient-rich breakfasts and morning meals were potentially satiating and had a beneficial effect on appetite regulation, which would help to balance the energy intake throughout the day and prevent overeating and subsequently obesity (Uzhova et al, 2017).

*Anthropometry.* -

Inconsistent with scientific literature, our results did not demonstrate that breakfast skipping was consistently associated with weight gain, which is consistent with several studies that suggest that the impact of breakfast skipping may differ by weight status (Witbracht et al, 2014). Being as this is a cross-sectional study that analyzed only two 24-hour recalls, it does not reflect the daily eating habits of an individual. Eating breakfast may also reflect better lifestyle and food choices across the day, explaining some of the limited association we observed with anthropometric measures. Although it was not statistically significant, over half of the breakfast skippers being overweight or obese, may be a reflection of this obesity-related behavior and/or several more, but this study does not establish causation. In addition, the majority of the breakfast eaters were also classified as overweight or obese, which may be due to the nutritional quality of their diet, lack of physical activity or a combination of eating habits that should be analyzed in future studies.

The novelty analysis for Latin America in this study is the inclusion of neck circumference to the rest of the anthropometric measures evaluated. This anthropometric measure is a positive marker for glucose homeostasis parameters and metabolic conditions, such as nonalcoholic fatty liver disease, type 2 diabetes mellitus (Joshiyura et al, 2016). It has been suggested that fat in the neck

may be more similar to visceral fat, which is more strongly related with cardio metabolic risks compared to subcutaneous fat (Joshi et al, 2016). Our data shows that neck circumference was significantly associated with measures of overall and central adiposity, with a modest magnitude of correlation. While in agreement with a study by Joshi et al., this study shows that neck circumference has a smaller correlation with BMI compared to waist circumference, implying that the incremental value of adding neck circumference would be higher, as neck circumference would be more independent of BMI compared to waist circumference. For this reason, we recommend that this anthropometric measure should be included in guidelines for the assessment of obesity, especially in situations when the traditional anthropometric measures are not available nor convenient.

#### *Physical Activity.-*

In a study conducted by Eumann et al., who sought an association between obesity-related eating behaviors (OREB) and physical activity, compared individuals with only  $\leq 1$  OREB and those with  $\geq 5$  OREB, and found that the latter spent 2.6 metabolic equivalent hours/week less in physical activity and ingested an additional 163 kcal/day. This is explained through the fatigue that is experienced due to the lack of energy intake consumed during breakfast, a meal that triggers metabolic functionality. Our study demonstrated a self-reported medium level amount of physical activity amongst the participants who skipped breakfast in one or two recalls. This can be explained by the following reasons: the participants reported a socially-acceptable amount of physical activity, the participant consumed a compensatory meal or meals following the lack of breakfast, or their dinner time and/or amount of energy intake led to the omission of the first meal of the day. In a study conducted by Leyerly et al. that analyzed a sample of US adolescents

and young adults, they reported similar results, in that there was no association found between skipping breakfast and meeting physical activity guidelines for age among US adolescents and young

Additional studies are necessary to account for type and quality of breakfast consumed and how the omission of it effects the following meals. We know that this eating habit can lead to multiple health consequences that, although it is not evident in a cross-sectional study, it will have long term implications. Recently, it has been proved that skipping breakfast has a direct correlation with heart disease (Uzhova et al, 2017). In a current study by *Uzhova et al.*, reported evidence of the association between different breakfast patterns with the risk of atherosclerosis. In this study, regular skipping breakfast was associated with a 1.55- and 2.57- fold higher odds for noncoronary and generalized atherosclerosis, respectively, and independently of the presence of conventional cardiovascular disease (CVD) risk factors and considering overall diet quality. We recommend that future studies should analyze breakfast skipping in long-term trials, in addition to timing and amount of energy intake throughout the entire day.

### *Strengths and Limitations*

There are several strengths that this study possesses, including the large representative sample of the Ecuadorian population. This is the first study that analyzes the association between breakfast skipping and nutritional status, including physical activity in an adult population in a Latin American countries. In addition, this study utilizes a novelty anthropometric measure, neck circumference, as one of the parameters to evaluate adiposity. Numerous limitations have been identified in this study, as well. The exposure, breakfast skipping, was measured based on two 24

hour dietary recalls. It is possible that participants may have given socially desirable responses by reporting eating breakfast when they actually did not consume any food during breakfast or that they reported an incorrect amount of physical activity. Furthermore, the two recalls may not have appropriately captured participants' typical dietary behaviors. For example, it may not be accurate to classify someone who skipped breakfast on one or two days, as a breakfast skipper, even though this method has been used in previous studies, thus exposure misclassification may be possible. And lastly, it does not describe the long-term effects of this eating habit and have no follow-up data on our participants due to its cross-sectional design. For this reason, we recommend future studies to include long-term evaluations of the participants' nutritional status and level of physical activity, in order to determine causality.

## **5. Conclusions**

This study examined the omission of breakfast in a representative Ecuadorian population and showed that adults who skipped breakfast were not associated with being overweight/obese nor did it affect their level of physical activity. Individuals who skipped breakfast reported lower energy intake, as well as macronutrient and certain micronutrients such as calcium, fiber and total sugar. Further studies investigating specific foods and beverages consumed at breakfast, timing of meals and how those choices impact on weight status is recommended.

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## Appendix.

Appendix table 1. Mean Daily Energy Intake of breakfast skippers vs breakfast eaters according to age groups

	Age: 15-19				Age: 20-34				Age: 35-49				Age: 50-65			
	BE (n=78)	BS1 (n=38)	BS2 (n=12)	<i>p-value*</i>	BE (n=219)	BS1 (n=69)	BS2 (n=28)	<i>p-value*</i>	BE (n=173)	BS1 (n=42)	BS2 (n=7)	<i>p-value*</i>	BE (n=115)	BS1 (n=13)	BS2 (n=6)	<i>p-value*</i>
<b>Total Energy (Kcal)</b> Mean, (SD)	2466 (1070)	2251 (1077)	1750 (640)	0.08	2470 (864)	2409 (2002)	2221 (1166)	0.6	2229 (958)	1886 (774)	1524 (290)	0.02	1976 (960)	1690 (948)	1573 (1121)	0.4
<b>Protein (g)</b> Mean, (SD)	92.5 (35)	79.5 (31)	56.6 (13)	< 0.01	96.4 (38)	92.7 (51)	87.3 (39)	0.5	87.2 (40)	74.6 (28)	60.6 (20)	0.04	82.3 (38)	70.9 (45)	53.1 (27)	0.1
<b>Carbohydrate (g)</b> Mean, (SD)	336 (133)	300 (114)	240.5 (96)	0.04	326 (122)	304 (193)	303 (180)	0.5	305.2 (126)	250.4 (120)	211.7 (65)	<0.01	269 (128)	229 (118)	225 (159)	0.4
<b>Total Fat (g)</b> Mean, (SD)	80 (34)	73.4 (45)	62.9 (28)	0.2	87.4 (40)	84.4 (88)	73.8 (52)	0.5	73.4 (39)	67.6 (33)	48.1 (15)	0.2	65.3 (45)	54.1 (42)	41.1 (20)	0.3
<b>Total Sugar (g)</b> Mean, (SD)	61.6 (30)	57.1 (52)	31.2 (12)	0.04	61.6 (37)	59.4 (48)	51.8 (41)	0.5	58.7 (37)	46.7 (26)	49.0 (36)	0.1	52.1 (43)	49.4 (46)	45.9 (39)	0.9
<b>Fiber (g)</b> Mean, (SD)	18.9 (9)	16.6 (8)	10.4 (5)	<0.01	20.2 (10)	15.8 (10)	17.7 (11)	<0.01	20.1 (12)	15.6 (7)	10.0 (4)	0.01	19.1(11)	13.9 (8)	14.5 (10)	0.2
<b>Calcium (mg)</b> Mean, (SD)	771.8 (380)	547.5 (336)	573 (295)	<0.01	767.5 (441)	557.1 (370)	510.1 (298)	<0.0001	675.9 (349)	516.5 (362)	281.8 (133)	<0.01	682.2 (394)	460.2 (284)	425.3 (283)	0.05

\*p-value is comparing breakfast groups and nutrient intake, stratified by age group.