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### INVESTIGACIÓN – **versión *post-print***

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#### **Breakfast frequency and its association with academic performance in a university population: a cross-sectional analytical study in México.**

#### **Frecuencia del desayuno y su asociación con el rendimiento académico en población universitaria: un estudio transversal analítico en México.**

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## ABSTRACT

**Introduction.** A complete breakfast is an important mealtime that has multiple health benefits and a determining role in the supply of essential nutrients, depending on its composition. It also contributes to the physical and intellectual performance of students and promotes the correct daily energy distribution, which is related to overweight and obesity. The objective of this research was to identify the frequency of breakfast and its relationship with academic performance in university students.

**Methods:** Cross-sectional, analytical study with convenience sampling, including university students from different academic fields at the Benemérita Universidad Autónoma de Puebla, Mexico, who were administered a questionnaire on eating habits, academic habits, and anthropometric measurements.

**Results:** A total of 498 university students (255 men and 244 women) participated. School breakfast influenced academic performance. Those who always ate breakfast (21%) had higher scores (median: 9, RIC: 8-9) than those who never ate breakfast (2.4%) and almost never (11%), with lower scores between 8-7. Subjects who never eat breakfast are 6.8 times more likely to have worse academic performance (OR=6.88, 95%CI: 1.42-33.32).

**Conclusions:** Breakfast frequency is associated with academic performance.

**Keywords:** Breakfast; Academic Performance; College students.

## RESUMEN

**Introducción.** Un desayuno completo es una comida importante que tiene múltiples beneficios para la salud y un papel determinante en el aporte de nutrientes esenciales, dependiendo de su composición. También contribuye al rendimiento físico e intelectual de los estudiantes y promueve la correcta distribución energética diaria, lo que se relaciona con el sobrepeso y la obesidad. El objetivo de esta investigación fue identificar la frecuencia del desayuno y su relación con el rendimiento académico en estudiantes universitarios.

**Metodología.** Estudio analítico transversal, con muestreo por conveniencia, que incluyó a estudiantes universitarios de diferentes carreras académicas de la Benemérita Universidad Autónoma de Puebla, México, a quienes se les aplicó un cuestionario sobre hábitos alimentarios, hábitos académicos y medidas antropométricas.

**Resultados.** Participaron un total de 498 estudiantes universitarios (255 hombres y 244 mujeres). El desayuno escolar influyó en el rendimiento académico. Aquellos que siempre desayunaban (21%) tuvieron puntuaciones más altas (mediana: 9, RIC: 8-9) que aquellos que nunca desayunaban (2,4%) y casi nunca (11%), con puntuaciones más bajas entre 8-7. Los sujetos que nunca desayunan tienen 6,8 veces más probabilidades de tener peor rendimiento académico (OR=6,88, IC95%: 1,42-33,32).

**Conclusión.** La frecuencia del desayuno está asociada con el rendimiento académico.

**Palabras clave.** Desayuno; Desempeño académico; Estudiantes universitarios.

## KEY MESSAGES

- Eating breakfast is associated to higher scores in academic performance.
- Those who always ate breakfast had higher scores than those who never ate breakfast and almost never.
- Subjects who never eat breakfast are 6.8 times more likely to have worse academic performance.

## INTRODUCTION

Breakfast is the first and most important meal of the day, usually light and eaten in the morning, as the Royal Spanish Academy describes. It is crucial for the body's supply of energy and nutrients, which are essential for work and learning activities<sup>1</sup>, in addition to its effects on general well-being<sup>2</sup>. It has been found that the type of breakfast influences the brain development during childhood and adolescence<sup>3</sup>, immediate verbal memory<sup>4,5</sup>, well-being, and frame of mind<sup>6</sup>. Research has shown that breakfast consumption has been positively associated with higher academic achievement and cognitive functioning among children and adolescents<sup>7,8</sup>, also has a beneficial effect of breakfast on verbal and numerical aptitudes, visual perception and reasoning<sup>8,9</sup>; and a healthy breakfast is associated with increased learning and achievement<sup>10</sup>. Systematic reviews of intervention studies have shown that eating breakfast has a positive effect on cognition, finding that those who eat breakfast have better results on memory tests and task resolution<sup>11</sup>. More recent studies maintain this statement, since again, only that most research is focused on analyzing the relationship between skipping breakfast and cognition or short-term memory<sup>12,13</sup>.

Academic performance is the result of tests given by a teacher to evaluate the skills and knowledge of students. The Grade Point Average (GPA) method is generally used to summarize this performance<sup>14</sup>. This method consists of provide a number to the performance shown by the students, indicating a positive relationship of having a higher performance if a higher GPA was obtained. Most research that studies relationships of dietary activities with academic performance uses GPA. Most of the research on the effects of breakfast has been carried out on children and adolescents, the amount of research carried out on college students is small<sup>11</sup>, among the studies that have been carried out it has been observed that GPA in those who skipped breakfast from one to three times per week was below the average GPA of the participants<sup>15,16</sup>; the relationship between breakfast and specific learning and long-term achievement is hard to determine because of methodological problems such as the type of test used, lack of consensus of what is considered a quality breakfast<sup>17-19</sup> and the baseline nutritional status of the study subjects<sup>20</sup>; Moreover, most of the research has been done in children and adolescents despite it has been shown that college students are more likely to skip breakfast<sup>21-24</sup>. To our knowledge, there are no studies on the relationship between breakfast and academic performance in Mexican university students.

The objective of this research was to identify the frequency of breakfast and its relationship with academic performance in Mexican university students.

## **METHODS**

### *Study design*

An analytical cross-sectional study was conducted with a non-probabilistic and open call sampling. The participation was voluntarily after being informed of the study's subject and purpose. The study took place in the "Benemérita Universidad Autónoma de Puebla (BUAP)", in Puebla, Mexico, between November 2018 and February 2019. This research was approved by the Ethics and Research Committee of the Faculty of Chemical Sciences of the BUAP with registration number: BQ-ALIM-FCQ/15/2018.

### *Participants*

The inclusion criteria considered were being a university student, voluntarily agreeing to participate in the study. On the other hand, we exclude to those who did not presented

information requested or who lacked anthropometric measurements, or who, if applicable, after having taken anthropometric measurements, they reported for some reason that they had not been able to adhere to the instructions for taking measurements previously. The nature and purpose of the study was explained to each participant, and informed consent was obtained from all of them.

### *Study variables*

A qualitative sociodemographic and nutritional history questionnaire was applied through a face-to-face interview with one of the researchers to collect age, sex, study career, socioeconomic level, persons with whom they live, weekly food frequency, and breakfast frequency.

The socioeconomic level classification considered monthly income in euros, having 3 categories: lower-middle ( $\leq 610.71$ ), middle (610.7 to 1096.1), upper-middle (1096 to 2293.4)<sup>25</sup>. For the question about with whom they live the categories were parents, aunts, uncles or other relatives, siblings, or living alone.

To measure the food quality, we applied a weekly food frequency questionnaire, including the categories: pastries, dairy products, sausages, foods of animal origin, fruits or juices, vegetables, fats, cereals, fried foods, and sweets. Similarly, the frequency of breakfast was asked, where the frequency was classified as Always (7 days a week), Regularly (6-5 days a week), Occasionally (4-3 days a week), Almost never (2-1 days a week), Never (0 days a week). The food frequency questionnaire used for the present study was self-developed, and a content validation was done with a group of 50 students and 5 nutrition experts, in accordance with the recommendations of Cade<sup>26</sup>.

The body composition of the participants was determined by anthropometric measurements (weight, height, and body mass index [BMI]) meanwhile body fat percentage (%BF) was measured by bioelectrical impedance analysis (Tetrapolar, OMRON HBF-514C). Anthropometric measurements were done with instruments calibrated according to ISAK recommendations. Height (to the nearest 0.1 cm; Lufkin W606) and weight (to the nearest 0.1 kg; OMRON HBF-514C). The measurement of the bioelectrical impedance analysis was carried out by prior appointment and at the time of making their appointment for the anthropometric measurements, they were given instructions in which they were asked to attend their appointment on time, to have voided their bladder before the measurements,

on an empty stomach and dressed in light clothing, without having consumed coffee or diuretics or having done exhaustive physical activity the previous day.

We asked for student's school average of the current semester to determine academic performance. To validate the school average, they had to provide a copy of an official document with the GPA given by the university (Kardex). The school average is on a scale of 0 to 10, where 0 is poor academic performance and 10 is excellent academic performance. Academic performance was distributed in quartiles, and those participants in quartiles 3 and 4 (with points from 9 to 10) were categorized as high academic performance, while those in quartiles 1 and 2 (with points from 7-8) were categorized as low academic performance.

### *Sample size calculation*

The sample size calculation was estimated based on the results of the study by Sampasa-Kanyinga H et al 2017<sup>16</sup>, which observed greater academic performance in frequency of regular breakfast consumption. We estimate to observe an effect of at least 70% (OR=1.70) greater probability of poor performance with low frequencies of consumption. Therefore, the sample size calculation was estimated to be 497 participants, adjusting for an estimated 10% loss due to missing data or incomplete questionnaires. The calculation was performed in G\*Power software.

### *Statistical analysis*

Quantitative variables data is presented as median and interquartile range because their distribution density had a slight positive bias, as qualitative variables are presented as frequency and percentage. Comparisons of quantitative variables between 2 groups were performed by the Mann-Whitney U test, whereas a Kruskal-Wallis H test was used for comparisons between more than 3 groups; Dunn's post hoc test was used for pairwise comparisons.

To explore the effect of consumption frequencies on the GPA, a multivariable linear regression model was carried out incorporating all consumption frequency variables using the Enter method, the model was adjusted for sex and age. The results are summarized as  $\beta$  coefficient and 95%CI.

A multivariable logistic regression model was applied to determine the association of breakfast frequency with academic performance; variables were entered into the model by

the Enter method. The covariates for the results adjustment were Age (quantitative), Sex, BMI (quantitative), Who they live with (ordinal) and socioeconomic level (ordinal). The results are summarized as Odds ratio (OR) and 95% confidence interval (95%CI). The assumptions of the models were verified by residual analysis.

A value of  $p < 0.05$  was considered a statistically significant difference. Results were performed in SPSS v.21 software and data visualization in GraphPad v.9.0.1 software.

## RESULTS

The sample studied was constituted by a total of 499 university students, of which 255 (51.10%) were men and 244 (48.90%) were women; there were no excluded or eliminated participants. The median weight for men was 70kg (64-76), while for women it was 58kg (53-64). As for BMI, the population showed a median of 24 Kg/m<sup>2</sup>. Table 1 presents the general characteristics, school average, and frequency of dietary intake for the total population and classified by sex. The median school average for the study was 8 points (8-9). The school average distribution was 65 participants with 7 points (13.0%), 232 with 8 points (46.5%), 178 with 9 points (35.7%), and 24 with 10 points (4.8%).

Table 2 shows the stratification of the sample by socioeconomic level, revealing that most of them were in middle (72.7%) and lower-middle (18.8%) levels. Nevertheless, the highest school averages (9 points) were of those students in the strata “extreme poverty” and “upper middle”, with non-statistically significant differences ( $p=0.2$ ). The comparison between data shows that the population that belongs to the “extreme poverty” socioeconomic level has a higher weight (median between 84-85 kg) than the population in the remaining levels. The body mass index presented by this group is also the highest, being 29, followed by the lower middle level with an average BMI of 24 Kg/m<sup>2</sup>.

**Table 1.** General characteristics, school average, and food frequency according to the sex of college students.

|                                | Total      | Men        | Women      | P value  |
|--------------------------------|------------|------------|------------|----------|
| n                              | 499        | 255        | 244        |          |
| <b>General characteristics</b> |            |            |            |          |
| Age, years                     | 21 (20-23) | 22 (20-23) | 21 (20-23) | 0.003*   |
| Weight, kg                     | 64 (57-72) | 70 (64-76) | 58 (53-64) | <0.0001* |

|                              |               |               |               |          |
|------------------------------|---------------|---------------|---------------|----------|
| Height, cm                   | 165 (160-170) | 170 (165-174) | 160 (155-164) | <0.0001* |
| BMI, Kg/m <sup>2</sup>       | 24 (22-26)    | 24 (22-26)    | 23 (21-24)    | <0.0001* |
| % BF                         | 23 (18-27)    | 18 (16-20)    | 27 (25-29)    | <0.0001* |
| School average               | 8 (8-9)       | 8 (8-9)       | 8 (8-9)       | 0.009*   |
| <b>Weekly meal frequency</b> |               |               |               |          |
| Pastries                     | 3 (2-4)       | 3 (2-4)       | 3 (2-4)       | 0.3      |
| Dairy products               | 4 (2-5)       | 4 (3-5)       | 3 (2-5)       | 0.2      |
| Sausages                     | 2 (2-4)       | 3 (2-4)       | 2 (1-3)       | 0.01*    |
| Animal-based foods           | 3 (2-5)       | 4 (2-5)       | 3 (2-5)       | 0.03*    |
| Fruit or Juices              | 3 (2-5)       | 3 (2-5)       | 4 (2-6)       | <0.0001* |
| Vegetables                   | 3 (2-5)       | 3 (2-4)       | 3 (2-5)       | <0.0001* |
| Fats                         | 3 (2-5)       | 2 (1-4)       | 3 (2-5)       | 0.02*    |
| Cereals                      | 4 (3-6)       | 5 (3-7)       | 4 (2-6)       | 0.003*   |
| Fried or sweet foods         | 2 (1-3)       | 2 (1-3)       | 1 (1-3)       | 0.06     |

Median (interquartile range) is shown. Data compared by Mann-Whitney U, \*: Statistical significance (p<0.05).  
BMI: body mass index, %BF: body fat percentage.

**Table 2.** General Characteristics, School Average, and Food Frequency according to the socio-economic status of college students.

|                                | <b>Socioeconomic status</b> |               |                     | <b>P value</b> |
|--------------------------------|-----------------------------|---------------|---------------------|----------------|
|                                | <b>Lower middle</b>         | <b>Middle</b> | <b>Upper middle</b> |                |
| <b>n</b>                       | <b>94</b>                   | <b>363</b>    | <b>42</b>           |                |
| <b>General characteristics</b> |                             |               |                     |                |
| Age, years                     | 21.5 (20-23)                | 22 (20-23)    | 21 (20-23)          | 0.3            |
| Weight, kg                     | 64 (57-72)                  | 64 (57-72)    | 61 (54-70)          | 0.7            |
| Height, cm                     | 163 (159-170)               | 165 (160-170) | 165 (160-172)       | 0.4            |
| BMI, Kg/m <sup>2</sup>         | 24 (22-26)                  | 23 (22-25)    | 23 (21-26)          | 0.06           |
| % BF                           | 22 (18-26)                  | 23 (18-27)    | 24 (20-27)          | 0.5            |
| School average                 | 8 (8-9)                     | 8 (8-9)       | 9 (8-9)             | 0.07           |
| <b>Weekly meal frequency</b>   |                             |               |                     |                |
| Pastries                       | 3 (2-4)                     | 3 (2-4)       | 3 (1-4)             | 0.7            |
| Dairy products                 | 4 (3-6)                     | 3 (2-4)       | 3 (1-4)             | <0.0001*       |
| Sausages                       | 2 (2-4)                     | 2 (2-3)       | 2 (1-4)             | 0.9            |
| Animal-based foods             | 4 (2-5)                     | 3 (2-5)       | 5 (3-6)             | 0.004*         |
| Fruit or Juices                | 3 (2-5)                     | 3 (2-5)       | 3 (5-7)             | <0.0001*       |
| Vegetables                     | 3 (2-4)                     | 3 (2-5)       | 3 (2-5)             | 0.05           |
| Fats                           | 3 (2-5)                     | 3 (2-5)       | 3 (1-5)             | 0.9            |
| Cereals                        | 5 (3-7)                     | 4 (2-6)       | 5 (3-7)             | 0.02*          |
| Fried or sweet foods           | 2 (1-3)                     | 2 (1-3)       | 1 (0-3)             | 0.2            |

Median (interquartile range) is shown. Data compared by Kruskal-Wallis H, \*: Statistical significance (p<0.05).  
BMI: body mass index, %BF: body fat percentage.

Regarding the influence of the person with whom they have breakfast (Table 3), there was no difference between having breakfast with a family member (parents, aunts, uncles, siblings) or alone on the school average, being 8 the median value in all cases.



**Table 3.** General Characteristics, School Average, and Food Frequency according to the family member with whom college students live.

|                                | Family members they live with |                                   |               |               | P value  |
|--------------------------------|-------------------------------|-----------------------------------|---------------|---------------|----------|
|                                | Parents                       | Aunts, uncles, or other relatives | Siblings      | Alone         |          |
| <b>n</b>                       | <b>287</b>                    | <b>53</b>                         | <b>70</b>     | <b>89</b>     |          |
| <b>General characteristics</b> |                               |                                   |               |               |          |
| Age, years                     | 21 (20-23)                    | 22 (20-23)                        | 22 (20-23)    | 22 (20-23)    | 0.3      |
| Weight, kg                     | 64 (56-70)                    | 63 (55-73)                        | 63 (58-71)    | 65 (57-76)    | 0.6      |
| Height, cm                     | 165 (160-170)                 | 164 (160-167)                     | 165 (160-170) | 165 (159-173) | 0.4      |
| BMI, Kg/m <sup>2</sup>         | 24 (22-25)                    | 24 (22-26)                        | 23 (22-25)    | 24 (22-26)    | 0.2      |
| % BF                           | 23 (18-27)                    | 23 (19-26)                        | 22 (17-27)    | 22 (18-26)    | 0.8      |
| School average                 | 8 (8-9)                       | 8 (8-9)                           | 8 (8-9)       | 8 (8-9)       | 0.2      |
| <b>Weekly meal frequency</b>   |                               |                                   |               |               |          |
| Pastries                       | 3 (2-4)                       | 3 (2-4)                           | 3 (2-4)       | 3 (2-4)       | 0.9      |
| Dairy products                 | 4 (2-5)                       | 4 (2-5.5)                         | 4 (3-6)       | 3 (2-5)       | 0.7      |
| Sausages                       | 2 (2-4)                       | 3 (2-4)                           | 2 (1-3)       | 2 (2-4)       | 0.2      |
| Animal-based foods             | 3 (2-5)                       | 4 (2-5)                           | 4 (3-5)       | 3 (2-5)       | 0.03*    |
| Fruit or Juices                | 3 (2-5)                       | 4 (2-5)                           | 4 (2-5)       | 2 (1-4)       | 0.6      |
| Vegetables                     | 2 (1-5)                       | 4 (3-5)                           | 3 (2-5)       | 3 (2-5)       | 0.2      |
| Fats                           | 3 (2-5)                       | 4 (3-5)                           | 3 (2-5)       | 3 (2-5)       | 0.006*   |
| Cereals                        | 4 (2-6)                       | 6 (4-7)                           | 5 (3-6)       | 3 (2-5)       | <0.0001* |
| Fried or sweet foods           | 2 (1-3)                       | 2 (1-4)                           | 2 (1-3)       | 2 (1-3)       | 0.9      |

Median (interquartile range) is shown. Data compared by Kruskal-Wallis H, \*: Statistical significance (p<0.05).  
BMI: body mass index, %BF: body fat percentage.

Breakfast frequency habits are shown in Table 4, proving that those who always eat breakfast (21%) have a higher school average of 9, than those who never (2.4%) and almost never (11%) eat breakfast, with the lowest school average between 8 and 7. Students who eat breakfast regularly (25%) and occasionally (39%) have a school average of 8 regardless of the breakfast quality. The simple act of having breakfast daily reflects an improvement in academic performance (p<0.0001). Although there were no differences in nutritional status by BMI in the comparisons by breakfast frequency, there was a difference in %BF (being higher in those who eat breakfast).

It was also found that those students with more breakfast frequencies (always and almost always) showed higher consumption of dairy products, animal-based foods, fruit or juices, and cereals, but a lower frequency of consumption of pastries, fried foods, and sweets. From the results of the linear regression model, it was found that the consumption of dairy products ( $\beta=0.07$ , 95%CI: 0.03 to 0.11) and animal-based food ( $\beta=0.06$ , 95%CI: 0.01 to 0.09), was associated with a higher GPA, while the consumption of sausages ( $\beta=-0.06$ , 95%CI: -0.07 to -0.02) and Fried or sweet foods ( $\beta=-0.05$ , 95%CI: -0.09 to -0.01) were associated with a

decrease in GPA; pastries, fruits or juices, vegetables, fats and cereals were not associated with GPA.

**Table 4.** General Characteristics, School Average, and Food Frequency according to the breakfast frequency of participants in the study population.

|                                | Breakfast frequency |               |               |               |               | P value  |
|--------------------------------|---------------------|---------------|---------------|---------------|---------------|----------|
|                                | Always              | Regularly     | Occasionally  | Almost never  | Never         |          |
| <b>n</b>                       | 108                 | 128           | 195           | 55            | 12            |          |
| <b>General characteristics</b> |                     |               |               |               |               |          |
| Age, years                     | 21 (20-22)          | 22 (20-23)    | 22 (20-23)    | 21 (19-23)    | 22 (20-24)    | 0.6      |
| Weight, kg                     | 63 (55-72)          | 62 (55-72)    | 65 (58-72)    | 64 (57-69)    | 61 (55-71)    | 0.4      |
| Height, cm                     | 164 (158-172)       | 165 (160-170) | 165 (160-170) | 165 (160-170) | 160 (155-175) | 0.9      |
| BMI, Kg/m <sup>2</sup>         | 23 (22-25)          | 23 (22-25)    | 24 (22-26)    | 23 (22-25)    | 23 (22-24)    | 0.06     |
| % BF                           | 25 (20-27)          | 22 (18-26)    | 21 (18-26)    | 22 (17-26)    | 23 (16-28)    | 0.04*    |
| School average                 | 9 (8-9)             | 8 (8-9)       | 8 (8-9)       | 8 (7-8)       | 7 (7-8)       | <0.0001* |
| <b>Weekly meal frequency</b>   |                     |               |               |               |               |          |
| Pastries                       | 2 (1-4)             | 3 (2-4)       | 3 (2-3)       | 3 (2-4)       | 4 (2-6)       | 0.1      |
| Dairy products                 | 5 (3-7)             | 4 (3-6)       | 3 (2-5)       | 3 (2-4)       | 2 (1-5)       | <0.0001* |
| Sausages                       | 2 (1-4)             | 3 (1-4)       | 2 (2-3)       | 2 (2-4)       | 3 (1-5)       | 0.7      |
| Animal-based foods             | 5 (3-7)             | 4 (2-5)       | 2 (2-4)       | 3 (2-5)       | 2 (1-4)       | <0.0001* |
| Fruit or Juices                | 5 (3-7)             | 4 (2-5)       | 2 (2-4)       | 3 (2-5)       | 4 (3-5)       | <0.0001* |
| Vegetables                     | 4 (2-6)             | 3 (1-4)       | 2 (1-4)       | 2 (1-5)       | 4 (2-5)       | <0.0001* |
| Fats                           | 4 (2-5)             | 3 (2-4)       | 3 (2-4)       | 3 (2-5)       | 4 (3-6)       | 0.3      |
| Cereals                        | 5 (3-7)             | 5 (3-7)       | 3 (2-6)       | 3 (2-5)       | 4 (2-6)       | <0.0001* |
| Fried or sweet foods           | 1 (0-3)             | 2 (1-3)       | 2 (1-3)       | 2 (1-4)       | 4 (3-5)       | <0.0001* |

Median (interquartile range) is shown. Data compared by Kruskal-Wallis H, \*: Statistical significance (p<0.05). BMI: body mass index, %BF: body fat percentage.

The multivariate and univariate results of the logistic regression model to explore the association between breakfast frequency and low academic performance are included in Table 5. It was noted that academic performance is not related to age, sex, BMI, family members living with, or socioeconomic level, only the frequency of breakfast was associated with academic performance, It was observed that as the frequency of breakfast decreases, the probability of having a low academic performance increase.

**Table 5.** Logistic regression model results to determine the association of breakfast frequency with low academic performance of college students.

|                       | Univariate model |            |         | Multivariate model |            |         |
|-----------------------|------------------|------------|---------|--------------------|------------|---------|
|                       | $\beta$          | OR (CI95%) | P value | $\beta$            | OR (CI95%) | P value |
| <b>Meal frequency</b> |                  |            |         |                    |            |         |
| Always                | Reference        |            |         | Reference          |            |         |

|   |            |                   |         |            |                   |          |
|---|------------|-------------------|---------|------------|-------------------|----------|
| Regularly                                     | 0.39       | 1.47 (0.88-2.47)  | 0.1     | 0.29       | 1.34 (0.79-2.30)  | 0.3      |
| Occasionally                                  | 1.18       | 3.27 (2.00-5.34)  | <0.0001 | 1.05       | 2.85 (1.70-4.78)  | <0.0001* |
| Almost never                                  | 1.65       | 5.21 (2.47-10.99) | <0.0001 | 1.58       | 4.84 (2.25-10.41) | <0.0001* |
| Never   | 1.98       | 7.27 (1.51-34.81) | 0.01    | 1.93       | 6.89 (1.43-33.40) | 0.02*    |
| <b>Covariables of the multivariable model</b> |            |                   |         |            |                   |          |
| Age   | 0.01       | 1.01 (0.93-1.09)  | 0.77    | -0.02      | 0.99 (0.90-1.08)  | 0.7      |
| Sex (men)                                     | 0.44       | 1.56 (1.09-2.23)  | 0.02    | 0.29       | 1.33 (0.89-1.98)  | 0.2      |
| BMI   | 0.06       | 1.06 (0.99-1.13)  | 0.1     | 0.04       | 1.04 (0.96-1.12)  | 0.4      |
| <b>Family members they live with</b>          |            |                   |         |            |                   |          |
| Parents                                       | Reference  |                   |         | Reference  |                   |          |
| Aunts, uncles, or other relatives             | 0.61       | 1.84 (0.97-3.45)  | 0.06    | 0.57       | 1.76 (0.91-3.39)  | 0.09     |
| Siblings                                      | 0.55       | 1.73 (0.99-3.01)  | 0.05    | 0.55       | 1.74 (0.96-3.12)  | 0.07     |
| Alone   | 0.11       | 1.12 (0.69-1.80)  | 0.7     | 0.16       | 1.18 (0.71-1.96)  | 0.5      |
| <b>Socioeconomic level</b>                    |            |                   |         |            |                   |          |
| Lower middle                                  | 0.45       | 1.57 (0.75-3.25)  | 0.23    | -0.12      | 0.88 (0.40-1.94)  | 0.8      |
| Middle  | 0.68       | 1.97 (1.04-3.76)  | 0.04    | 0.20       | 1.22 (0.62-2.43)  | 0.6      |
| Upper middle                                  | Referencia |                   |         | Referencia |                   |          |

β: Regression coefficient, OR (95%CI): Odds Ratio and 95% confidence interval, \*, \*: Statistical significance (p<0.05).

## DISCUSSIONS

The objective of this research was to identify the frequency of breakfast and its relationship with academic performance in college students. It was found that breakfast frequency is a determinant of academic performance, with less breakfast frequency being associated with lower academic performance.

The school average is not influenced by socioeconomic level or family members they live with, but it does change according to breakfast frequency. The school average is higher in students who always eat breakfast compared to those who never eat breakfast, meaning that regular breakfast is a dietary practice that leads to better academic performance.

Our findings coincide with those reported in the published literature since it has been found that breakfast has a positive predictive effect on academic performance<sup>27</sup>. Research in Turkey shows that academic success is related to breakfast, finding that success improved in those who regularly ate breakfast compared to those who did not<sup>28</sup>. This is also supported by the research of Chen et al, where it was found that the number of times breakfast is eaten per week matters, because the more times students ate breakfast, the better their academic performance<sup>29</sup>. Martin AJ et al, found that breakfast consumption was associated with higher breakfast quality, and both variables, breakfast consumption and breakfast quality were

associated with higher adaptative motivations and achievement later that day, as well as they were associated with a lower maladaptive motivation<sup>30</sup>.

The improvement in academic performance that is attributed to breakfast could be related to blood glucose levels. Since skipping breakfast results in a gradual decrease in insulin and glucose that can lead to a fatigue that interferes with cognitive function<sup>31</sup>, it has even been observed that those subjects who have a breakfast with a lower glycemic load and glycemic index show higher cognitive performance scores<sup>31</sup>. However, the relationship between academic performance and blood glucose levels is not always consistent, but despite that, the results of a systematic review suggest that a lower postprandial glycemic response is beneficial to cognitive performance<sup>32</sup>.

Another theory states that a good quality diet provides not only the energy but also correct the nutritional deficiencies that are involved in cognitive functioning, such as iron and iodine deficiencies<sup>33</sup>. A balanced, nutrient-rich breakfast may intervene in students' mood, motivation and anxiety by targeting serotonin receptors<sup>34</sup>; which may relate to why quality breakfasts, as well as fruit and vegetable consumption have been found to be related to motivation and achievement<sup>35,36</sup>. It is important that public policies consider integration with local food systems to promote healthier and more sustainable eating through an intercultural approach that empowers the community and contributes to long-term sustainability, this has been a recommendation that has been made by diverse sources, mainly in school feeding contexts, where it is recommended to promote gastronomic innovation to improve food acceptance and reduce waste<sup>37</sup>. Olarte et al focused their research on school breakfast programs, which were found to increase attendance of older students, finding that chronic absenteeism decreased by seven percentage points in high school students. In addition, students who ate a daily, substantial breakfast were found to be more focused during the school day and to have decreased misbehavior. This could represent another theory on how breakfast has a positive impact on academic performance<sup>38</sup>.

On the other hand, Moller et al. proposed the hypothesis that it could be due to the short-term energy supply and its long-term impact, as they found that skipping breakfast is associated with less cognitive and emotional engagement. In addition, most of the breakfast skippers in their research had lower socioeconomic levels<sup>39</sup>. Socioeconomic level has been shown to influence the effect of breakfast consumption and achievement motivation, being

the effect stronger in those with higher levels<sup>27</sup>. Our results revealed that socioeconomic level also has an impact on student's health, as those who reported being in extreme poverty had a BMI over 29 Kg/m<sup>2</sup> (overweight), which indicates that students in this group do not have an adequate diet and consume fatty products more frequently. As has been shown by numerous studies the diet of people of lower socioeconomic status is less healthy<sup>40</sup>. This could be because, as they have a reduced purchasing power, they acquire less healthy foods because they are cheaper.

It is also important to mention that although no differences were observed in weight and BMI between breakfast frequencies, there were differences in the percentage of fat, which was higher in those subjects who ate breakfast daily. These findings draw attention since it has been observed in longitudinal studies that the consumption of a daily breakfast is a protective factor (PR=0.93, 95%CI: 0.89-0.97) for weight gain in Mexican women after 3 years of follow-up<sup>41</sup>, however, the reason why that in young adults such as university students, the percentage of fat may be increased due to the quality of breakfast, since the time available to consume food or the type of food may lead to lower nutritional quality, although this is only an assumption, something similar has been observed in other studies<sup>42</sup>, where Mexican children with greater overweight and obesity have dietary patterns of unhealthy foods based on sweet cereal and corn dishes, which are foods that are frequently consumed for breakfast. In our study, we were only able to observe that students who ate breakfast more frequently (always and almost always) had a greater consumption of dairy products, foods of animal origin, fruits or juices and cereals; It could be that processed foods are consumed from the foods in these groups, which contributes to the limitation of not knowing exactly what type of quality of diet the students had. In a recent study, where the quality of the diet in Mexican university students was evaluated, it was observed that the vast majority reported a Westernized diet with high consumption of ultra-processed foods<sup>43</sup>.

There are some other factors related to nutritional education and important differences in associations according to sex, age, type of socioeconomic indicator analyzed, diet measurement methodology, etc., which cause heterogeneity between populations. For example, unlike previously mentioned, in the research by Santos da Silva et. al. with a population of adolescents, skipping breakfast was associated with a higher socioeconomic level, bad habits such as regular consumption of alcoholic beverages, and irregular

consumption of school meals. In addition, living alone with the mother, father, or neither, and meals with parents also were associated with a high socioeconomic level<sup>44</sup>, disagreeing with our study, where no association was found between breakfast and the family member with whom one lives.

Since breakfast is the first meal of the day it can influence an adequate diet, because a correct nutrient intake is accomplished during the day. Arshad and Ahmed found an association between breakfast and academic performance, but also that most students who skip breakfast eat less fruit, fish, lettuce, and soup, plus they feel lazy and unactive during study time. And they mostly skip a meal per day<sup>23</sup>. This was similar to our findings where we reported that students who eat unhealthy meals more frequently also skip breakfast more often.

The first limitation of the study is the type of sampling, since it could be unrepresentative of the population, assuming that students with better school averages were the ones that volunteered to participate because of the mean school grade (8-9 points). However, to avoid bias, all members of the University were invited to participate without distinction by university career, obtaining a wide and diverse sample, equitable in terms of gender distribution. In addition, since this was a cross-sectional study, the findings should be verified by longitudinal studies. Another important limitation in our study is that we did not have specific dietary data on the type of breakfast consumed by the participants, so we are unable to judge whether the breakfast consumed was healthy or not. The frequency of breakfast consumption was arbitrary by the authors, since only a separation of two days was considered between frequencies, but this is something usual in the research that has been developed considering breakfast as an independent variable for various health and academic performance outcomes<sup>45-47</sup>.

Although this information is accurate in terms of university students in the Mexican population, its interpretation may vary when considering other countries where the diet, customs, and socioeconomic level are different. Most of the studies in Mexico have been

developed on elementary basic education levels, meaning this is one of the most recent types of research in college studies of our country.

## CONCLUSIONS

Despite many more studies are needed on the effect of breakfast on school performance, a lower frequency of breakfast was associated with lower academic performance. The school average is not influenced by the socioeconomic level or the family members with whom one lives, but it is higher in students who always eat breakfast compared to those who never eat breakfast. However, the socioeconomic level was correlated with the nutritional status of the students, since those who reported being in extreme poverty had overweight. Although the role of breakfast in metabolism is not very well known, it could be suggested that the improvement in academic performance attributed to breakfast is related to blood glucose levels, since skipping breakfast produces a gradual decrease in insulin and glucose that can lead to fatigue that interferes with cognitive function. With breakfast being the first meal of the day, it can influence proper diet, as students who eat unhealthy foods more often also skip breakfast more often.

## COMPETING OF INTEREST

No potential conflict of interest relevant to this article was reported.

## AUTHORS' CONTRIBUTION

All authors reviewed the results and approved the final version of the manuscript.

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