IOSR Journal of Nursing and Health Science (IOSR-JNHS)
e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 11, Issue 4 Ser. I (Jul. – Aug. 2022), PP 61-72
www.iosrjournals.org

How does obesity influence the mental health of men and women? A cross-sectional study of the Ecuadorian population

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Abstract:
Background: *The analysis of the empirical relationship between obesity and mental health in the Ecuadorian population contributes significantly to the literature, since obesity is an important risk factor for somatic diseases such as metabolic syndrome, cardiovascular diseases, liver damage, respiratory diseases and arthropathies. However, obesity also constitutes e one of the main "social stigmas", with a marked impact at the individual psychological level. The high prevalence of psychological pathology in obese patients makes it possible to visualize it as a psychiatric problem, which should be identified and treated simultaneously with weight control programs.*
Materials and Methods: *A nationally representative sample of men and women over 18 years of age from the National Health and Nutrition Survey 2018 (ENSANUT) was used. A binary logistic linear regression model was used where Odds Ratio (OR) with their 95% confidence intervals (95% CI) were estimated for each of the independent variables.*
Results: *Our results show that those with a Body Mass Index ≥ 30 have a higher propensity to suffer from chronic mental disorders. That is, our results reveal that obesity increases 2.5 times (OR= 2.5; CI=1.99-2.86) the probability of suffering from chronic mental illnesses. This result is statistically significant ($p<0.05$). It was also shown that women in rural areas, with lower income and low schooling are more susceptible to mental disorders compared to the rest of the population. Another interesting result is that individuals working in the informal sector presented a greater probability of presenting psychological pathologies, this result is differentiated between men (OR= 1.65; CI=1.45-1.81) and women (OR= 1.89; CI=1.62-1.99), the effect being greater in informal women.*
Conclusion: *Obesity and mental health disorders are two relevant problems in the global public health debate mainly because of their high physical and economic costs, affecting a high percentage of the population. Positive and statistically significant effects of obesity with psychological pathology were found in the general Ecuadorian population. This work was able to demonstrate the approximation of the relationship between obesity and mental health in a country where the prevalence of both problems has increased considerably over the years.*
Key Word: *Obesity, Mental health, Mental disorders*

Date of Submission: 08-07-2022 Date of Acceptance: 22-07-2022

I. Introduction

Overweight and obesity constitute one of the greatest global public health challenges. According to data from the World Health Organization, it is estimated that by 2030 half of the world's population will suffer from obesity and overweight. In Latin America, in 2016, it was recorded that approximately 29% of the adult population, among men and women, had a BMI greater than 30. In the Ecuadorian case, 19.3% of Ecuadorian adults registered obesity.[1]. This situation is alarming because currently this epidemic negatively affects several aspects of health and increases the risk of many chronic diseases in those who suffer from it, such as: pulmonary diseases, metabolic syndrome, heart disease, diabetes, cancer, liver disease, gynecological disorders, as well as venous and periodontal disease.[2]. Other associated conditions include high blood pressure (HBP), skin problems, osteoarthritis and psychological problems.[3].

Nowadays, obesity is not considered as such as a mental disorder. However, the relationship between obesity and possible concomitant psychological alterations has been studied for some decades, without reaching a consensus on the existence of a specific psychological profile Psychological pathology associated with obesity, although it has not been clearly established whether it is a cause or an effect of it, Some authors consider psychological factors to be the cause of obesity, others believe that it is a consequence of social discrimination against the obese, and consequently there is evidence of interaction between emotional symptoms and their impact on the destructuring of eating patterns and sedentary lifestyles.[4]. Several studies have pointed out the presence of physical and sexual abuse in patients with obesity, as well as a prevalence of psychiatric disorders between 30-60%, recognizing affective disorders, anxiety disorders and eating disorders (ED) as the most frequent ones.[5]. In turn, these psychosocial consequences of obesity determine behavioral patterns and personality models, which have an influence on caloric intake and energy expenditure and, consequently, on weight gain.[6]

Psychological stress may upregulate physiological stress pathways through mechanisms such as alterations in insulin signaling, positive regulation of corticosteroid production, or proinflammatory activation. Thus, they conclude that low mood in healthy children is associated with poorer metabolic health independent of adiposity.

This situation is alarming because of the great social and economic cost it entails, since currently having a high weight is one of the main "social stigmas", reducing job opportunities and education, with the consequent individual psychological cost.[7]. The obese patient is subjected to multiple psychological problems, such as social discrimination that entails serious behavioral consequences; personal, occupational and sexual limitations that lead to decreased self-esteem and isolation Friedman et al (2002), in their study of men and women with obesity, demonstrated that satisfaction with body image is directly related to depression and low self-esteem. The background they used for this research is that obese individuals who were seeking to reduce weight showed a high prevalence of distress compared to obese individuals without this interest in weight reduction.[8].

On the other hand, another study showed that 60% of obese people exposed to psychological stress suffer hyperphagia as a pathological form of defense, accompanied by immature personalities, with anxious and depressive traits. This behavioral alteration was called "emotional eating behavior" or stress hyperphagia, when food intake is not related to the sensation of hunger but to psychological discomfort (boredom, anguish or difficulty in solving problems). Obesity in this case can be considered as the symptom or the consequence of a problem of psychological and social adjustment. [9]. A study conducted by Brito et al (2000) in adolescents and young adults aged 15 to 21 years showed a higher rate of psychiatric conditions in obese patients than in the control group. These conditions include mood disorders, anxiety, eating disorders with loss of control, somatic disorders, especially in morbidly obese patients.[10]Wardle et al (2001) analyzed a sample of obese women with binge eating disorder, body dissatisfaction, and their relationship with food restriction and depression; their findings showed that these 4 elements are closely related, and by treating depression with medication, and improving body dissatisfaction with psychological therapies, the course of binge eating disorder improves, and therefore the therapeutic success rate increases.[11]

Discouraging treatment with body weight loss-recovery cycles also has an impact on psychological well-being, which is reflected in the loss of interest in losing weight, for example. Because food intake improves mood, due to increased brain serotonin concentrations, in many cases a food restriction during hypocaloric dieting is accompanied by "dietary depression" which can lead to

to treatment refusal. The development of psychotherapy for the treatment of obesity may improve the prospects of the obese patient by addressing etiopathogenic factors, as well as by preventing relapse, treatment abandonment, and increasing tolerance to the hypocaloric diet.[5].

Thus, the present research aims to clarify the psychological variables that are manifested around the growing phenomenon of obesity, its comorbidity and impact of psychopathology associated with the quality of life of obese adults. Therefore, it is necessary to address psychologically this problem with an approach that

considers both the etiology and the maintenance of obesity, cognitive variables (beliefs), affective variables (management of unpleasant emotional states) and environmental variables (customs, family habits, etc.).

II. Material And Methods

Study Design and Population: A cross-sectional study was conducted with data obtained from the 2018 National Health and Nutrition Survey of Ecuador (ENSANUT), whose data were obtained and presented by the National Institute of Statistics and Census (INEC). After cleaning the database, a total of 15546 Ecuadorians among men and women with obesity were obtained.

Inclusion and Exclusion Criteria: Data from men and women over 18 years of age with BMI ≥30% were included.

Source of Information: The ENSANUT 2018 is a survey included in the National Statistical Program that employs probability sampling applied every 5 years and whose target population is all household members in the 24 provinces of Ecuador. ENSANUT 2018 includes the HOGAR form where all the characteristics of the Ecuadorian population are evidenced in order to make representative estimates at the national level, urban-rural, by geographic domain for the 24 provinces of the country.

Study Variables. Our dependent variable was Obesity defined by BMI≥30. The information of this variable was obtained through the calculation made from the anthropometric data of weight and height provided in the form. In our independent variable that refers to information on the mental state of the person with obesity, this information could be obtained from the question: In the last 30 days have you had psychological discomfort? We were also able to control for other variables such as sex, age, schooling, number of children, type of employment and hours of work.

Statistical Analysis. The ENSANUT 2018 survey database was analyzed with the statistical package Stata v15 (Stata Corporation, College Station, Texas, USA). A value of $p<0.05$ was considered to determine statistical significance between variables. The Chi-square test was used to determine the overall correlation between the variables of interest. The association was evaluated by prevalence ratios with their respective 95% confidence intervals with an analysis for each of the variables included in the study, the independent variable of interest being obesity. For the determination of the model of mental health versus obesity in men and women, binary logistic regression was applied to calculate the OR with its 95% confidence intervals; in addition, the sociodemographic characteristics were reported by absolute frequencies, the numerical variables were reported with the arithmetic mean.

In order to statistically verify the different factors that affect the mental health of men and women, a linear regression model has been proposed to demonstrate these relationships. Forthiswehave:

$$MH_i = \beta_0 + \beta_1 X_i + \sum_{j=2}^{12} \beta_j Z_i + \varepsilon_i$$

Where MH_i represents mental health (measured through the question of whether or not an individual had psychological problems), X_i represents the obesity variable and Z_i represents a set of control variables of the linear regression model. Finally, ε_i represents the stochastic error term.

Finally, for the determination of the predictor variables, the ROC curve was applied with the probabilities estimated by applying logistic regression under the method of introducing their confidence intervals and their statistical significance $p < 0.05$.

Ethical considerations. The present study did not require the approval of an institutional ethics committee for its execution, since it is an analysis of data freely available to the public and it was not necessary to use informed consent.

III. Result

Table 1 shows the descriptive statistics of the variables. Here we analyze all the variables used in this study and see that the sample is 8325 men and 7221 women, giving a total sample of 15546 individuals. We observe that 15.69% (CI=15.02%-16.77%) of the sample reported suffering from psychological problems. This percentage is alarming, given that almost a quarter of the population has poor mental health. This fact makes it evident that mental health policies should be a priority in a developing country like Ecuador. In addition, we note that, in line with the above evidence, 28.55% of the sample suffers from obesity. That is, they have a body mass index (BMI) greater than or equal to 30. This figure is also alarming. Therefore, there seems to be an obvious positive relationship between obesity and mental health. The average age of the sample is 34 years and 53.33% are men. Also, the average number of children is 4. On the other hand, the average monthly labor income is $444.01 USD. The average years of schooling is 7 years of schooling. This shows that the level of schooling is relatively low in Ecuador. Unemployment is reported by 30.55% of respondents and the average number of working hours is 42.78. In addition, 82.52% of the sample reported that they had migrated at some

point. This fact evidences that Ecuador is a country of high internal migration. In terms of ethnicity, 75.61% of the population is mestizo, the average urban density is 157 people per square kilometer, while we observe that 55.51% of people are from the urban area.

Table N°1: Descriptive statistics of the variables used in this study

Variable	Mean-Percent	SD	Min	Max	95% CI
Did you have psychological problems?					
Yes	25..89%	0.44	0	1	25.02% - 26.77%
No	74.11%	0.89	0	1	73.17% - 75.43%
Obesity					
No	71.45%	0.12	0	1	68,45% - 73,45%
Yes	28.55%	0.43	0	1	25,55% - 30,55%
Age					
Age	33.8	0.12			33.13 - 34.22
Sex					
Woman	46.67%	0.14	0	1	43,67% - 48,67%
Man	53.33%	0.33	0	1	50,33% - 55,33%
Number of children					
Number of children at home	4.12	0.25	0		4.01 - 4.98
Monthly labor income					
Income in dollars	444.01		0	2033	441.68 - 448.49
Years of schooling					
Years of schooling	7.08	1.77	0		2.97 - 3.96
Workmethod					
Employee	69.45%	0.66	0	1	66,45% - 71,45%
Unemployed	30.55%	0.26	0	1	27,55% - 32,55%
Out of theworkforce	3.55%	0.26	0	1	2,67% - 3,77%
Workinghours					
Number of workinghours	42.78	0.55			41.54 - 46.86
Are you a migrant?					
No	17.48	0.89	0	1	14,48% - 19,48%
Yes	82.52%	0.67	0	1	79,52% - 84,52%
Ethnicity					
Indigenous	14.73%	0.35	0	1	14.26% - 15.20%
Afro-Ecuadorian	4.03%	0.20	0	1	3.77% - 4.29%
Mongrel	75.61%	0.43	0	1	75.04% - 76.18%
White	1.32%	0.11	0	1	1.17% - 1.47%
Montubio	4.31%	0.20	0	1	4.04% - 4.58%
Urban density					
Inhabitants per squarekilometer	157.01	1152.5	321	2653.12	146.32 - 160.33
Area					
Urbana	55.51%	0.54	0	1	52,51% - 57,51%
Rural	44.49%	0.36	0	1	41,49% - 46,49%

Next, in order to see if there are statistically significant differences between the group of men and women, in Table 2 we performed a test of mean differences for groups with different variances. In this table we observe that all the variables (dependent and independent) used in our study have a significant statistical difference, since the p-value rejects the null hypothesis of an equality of means between the groups. Specifically, we observed that the p-value is less than 0.05. Therefore, we can say that the observed characteristics of the individuals in our sample are statistically different. This warrants performing our linear

regression analyses below for the group of men and women since obesity impacts men and women in different ways (and magnitudes).

Table 2. Mean difference test for groups with different variances

Variable	Men	Women	P-value
Did you have psychological problems?	7.72	6.80	0.000
Obesity	9.21	10.88	0.000
Age	33.57	31.44	0.000
Sex	51.70	42.73	0.000
Number of children	2.85	1.80	0.000
Monthly labor income	444.68	349.75	0.000
Years of schooling	7.06	5.11	0.000
Workmethod	9.76	6.69	0.000
Workinghours	35.75	42.94	0.000
Are you a migrant?	11.26	6.73	0.000
Ethnicity	34.92	30.12	0.000
Urban density	46.35	39.28	0.000
Urban area	34.77	33.76	0.137

Subsequently, we performed a correlation matrix to perform a detailed analysis of correlation between the variables and to highlight possible multicollinearity problems. **Table 2** shows significant correlations between our variables of interest, i.e. between mental health and obesity, showing a negative coefficient of -0.4505. In addition, we observed some other variables with significant correlations such as income, schooling, hours of work, number of children and urban density. All these variables have an expected sign which is correct. In addition, we observe that some correlations between the independent variables are not greater than 50%. This shows that there are probably no multicollinearity problems among the variables. Below we perform a formal test to test for multicollinearity among the variables.

Table N°3: Correlation matrix of the variables

	Var 1	Var 2	Var 3	Var 4	Var 5	Var 6	Var 7	Var 8	Var 9	Var 10	Var 11	Var 12	Var 13
Var 1	1												
Var 2	0.4505*	1											
Var 3	0.0045	0.0054	1										
Var 4	-0.0826*	0.0739*	-0.0023	1									
Var 5	0.1501*	0.0498*	-0.0045	-0.0116	1								
Var 6	-0.4340*	0.0307*	0.0046	-0.0119	0.6216*	1							
Var 7	-0.0113	0.0394*	-0.0054	0.0014	0.0220*	0.0251*	1						
Var 8	-0.0276*	0.3312*	0.0061	0.0217*	0.0689*	0.0787*	0.0489*	1					
Var 9	0.0568*	0.0058	0.0073	0.0000	0.0114	0.0148*	0.0547*	-0.0697*	1				
Var 10	0.0716*	0.4734*	0.0021	0.0529*	-0.0685*	-0.0404*	-0.0471*	0.1700*	-0.1847*	1			
Var 11	-0.0393	-0.0979*	0.0080	0.0074	-0.0207*	-0.0267*	-0.0781*	-0.0228*	-0.2026*	0.1239*	1		
Var 12	0.0098*	0.0531*	0.0099	-0.0440*	0.0219*	0.0187*	0.1295*	0.1134*	0.1410*	-0.3042*	-0.1964*	1	
Var 13	-0.0087	0.0548*	-0.0007	0.0015	-0.0123	-0.0021	0.0529*	0.0065	0.2222*	-0.1598*	-0.1992*	0.3081*	1

Note: Var 1: Did you have psychological problems. Var 2: Obesity. Var 3: Age. Var 4: Sex. Var 5: Number of children. Var 6: Monthly labor income. Var 7: Years of schooling. Var 8: Type of work. Var 9: Hours of work. Var 10: Migrant. Var 11: Ethnicity. Var 12: Urban density. Var 13: Urban area. Asterisks mean: *p < 0.05.

Next, we performed a formal test to rule out the presence of multicollinearity among our independent variables. In **Table 4** we present a multicollinearity analysis. We use the Variance Inflator Factor (VIF) to perform this test. Previous literature indicates that a VIF greater than 5 can demonstrate that multicollinearity exists in our data. As we can see, no variable has a VIF greater than 5 and therefore we rule out multicollinearity problems in our independent variables. This analysis is important since multicollinearity problems cause instability of the parameters of a regression, incorrect signs and higher standard errors, which translates into statistical insignificance of the parameters.

Table N° 4: Multicollinearity test of the variables

Variable	**VIF**	**SQRT VIF**	**Tolerance**	**R-Squared**
Obesity	1.55	1.33	0.9966	0.0004
Age	2.14	1.98	0.9918	0.0082
Sex	2.89	1.09	0.6101	0.3899
Number of children	1.88	1.76	0.6145	0.3855
Monthly labor income	1.97	1.65	0.9764	0.0236
Years of schooling	1.45	1.88	0.8821	0.1179
Workmethod	1.66	1.43	0.8812	0.1188
Workinghours	1.44	1.75	0.6310	0.3690

Are you a migrant?	1.12	1.86	0.9146	0.0854
Ethnicity	1.88	1.67	0.7746	0.2254
Urban density	1.67	1.09	0.8583	0.1417
Urban area	1.05	1.32	0.9537	0.0463
Mean VIF	1.90			

Subsequently, in **Table 5** we observe the grouped age and the number of people with psychological problems and obesity. Here we observe that as age increases, so do the cases of psychological problems and obesity. In this table we can observe an interesting pattern: individuals suffering from obesity are almost equal to those suffering from psychological problems within all age ranges. This fact leads us to strongly suspect that there is a strong positive relationship between obesity and psychological problems.

Table N°5: Age grouped and number of cases of psychological problems and obesity

	Psychologicalproblems		**Obesity**	
Age	**Yes**	**No**	**Yes**	**No**
19-25	39	256	59	302
26-30	67	238	89	295
31-35	134	299	98	399
36-40	143	304	199	418
41-45	149	499	119	418
46-50	263	456	169	597
51-55	335	521	278	532

A multivariate logistic regression analysis to analyze factors influencing mental health in the sample of men is shown below in **Table 6.** Our logistic regression involves 8325 men. Here we note that the dependent variable is a dichotomous variable that takes the value of 1 if a man reported having had psychological problems. We find that, as expected, the odd ratio (OR) of having suffered from obesity is significant and greater than 1. Our results show that those men who suffer from obesity have a higher risk of suffering from psychological problems. That is, our results specifically show that suffering from obesity increases the probability of suffering from psychological problems by 2.32 times (OR= 2.32; CI=1.91-2.17). This result is statistically significant. It was also shown that other variables that influence mental health are the number of children, which positively affects the probability of suffering psychological problems. Likewise, labor income reduces the probability of suffering from psychological problems by 2.03 times. A similar result is observed in the variable of years of schooling. Being unemployed and out of the labor force also positively predicts the probability of suffering from psychological problems. An interesting variable is migration, as we find that migrants are more likely to suffer from mental illness. Finally, we also observed that living in a more densely populated city increases the risk of psychological problems.

In **Table 6** we observe that the chi-square (X^2) and log-likelihood statistics are stable and statistically correct. The chi-square statistic is significant suggesting that, taken together, the independent variables jointly explain the variability of the dependent variable. On the other hand, the log-likelihood statistic is negative and is observed to collect as much information as possible.

Table N° 6: Logistic regression analysis between mental health and obesity in men

Variable	**OR**	**Std. Err.**	**P>z**	**95% CI**
Obesity				
No	Ref.			
Yes	2.32**	0.982	0.002	1.986 - 2.621
Age				
Age	1.001	0.863	0.057	0.872 - 1.321
Number of children				
Number of children at home	1.032**	0.054	0.004	1.012 - 1.453
Monthly labor income				
Income in dollars	-2.981**	0.687	0.872	-2.001 - -1.321
Years of schooling				

Years of schooling	-1.686***	0.542	0.001	-1.543	-	-1.754
Workmethod						
Employee	Ref.					
Unemployed	1.455*	0.216	0.032	1.321	-	1.765
Out of theworkforce	1.032*	0.321	0.021	1.321	-	1.765
Workinghours						
Number of workinghours	1.653	0.654	0.035	1.345	-	1.897
Are you a migrant?						
No	Ref.					
Yes	1.567*	0.535	0.045	1.354	-	1.853
Ethnicity						
Indigenous	Ref.					
Afro-Ecuadorian	-1.043	0.312	0.067	-1.012	-	-1.231
Mongrel	-1.065	0.432	0.655	1.001	-	1.198
White	-1.986	0.563	0.192	-1.452	-	-2.004
Montubio	1.654	0.643	0.431	1.594	-	1.865
Urban density						
Inhabitants per squarekilometer	1.654**	0.543	0.031	1.493	-	1.985
Area						
Urbana	Ref.					
Rural	1.456	0.753	0.912	1.321	-	1.764
Observations	8325					
AIC	23975.03					
BIC	23138.09					
R^2	0.025					
X^2	3.956***					
Log-likehood	-31461.51					

Notes: Asterisks mean: *p <0.10,**p < 0.05, ***p < 0.01. In the table, the dependent variable is the dichotomous variable of psychological problems which takes a value of 1=Yes and 0=No.

Subsequently, **Table 7** shows a multivariate logistic regression analysis to analyze the factors influencing mental health in the sample of women. Our logistic regression involves 7221 men. Here we note that the dependent variable is a dichotomous variable that takes the value of 1 if a woman reported having had psychological problems. We find that, as expected, the odd ratio (OR) of having suffered from obesity is significant and greater than 1. Our results show that those women who suffer from obesity have a higher risk of suffering from psychological problems. That is, our results specifically show that suffering from obesity increases the probability of suffering from psychological problems by 3.12 times (OR=3.12; CI=3.046-3.321). This result is statistically significant. This fact shows that the psychological impact of obesity is greater in women than in men. As in the regression for the group of men, it was shown that other variables that influence mental health are the number of children, positively affecting the probability of suffering psychological problems, although we observed a greater impact on women. Likewise, labor income reduces the probability of suffering from psychological problems by 2.48 times. A similar result is observed for the years of schooling variable. Being unemployed and out of the labor force also positively predicts the probability of suffering psychological problems. An interesting variable is migration, as we find that migrants are more likely to suffer from mental illness. Finally, we also observed that living in a more densely populated city increases the risk of suffering from psychological problems.

As in the previously described table, in **Table 7** we observe that the chi-square (X^2) and log-likelihood statistics are stable and statistically correct. The chi-square statistic is significant suggesting that, as a whole, the independent variables together explain the variability of the dependent variable. On the other hand, the log-likelihood statistic is negative and is observed to collect as much information as possible.

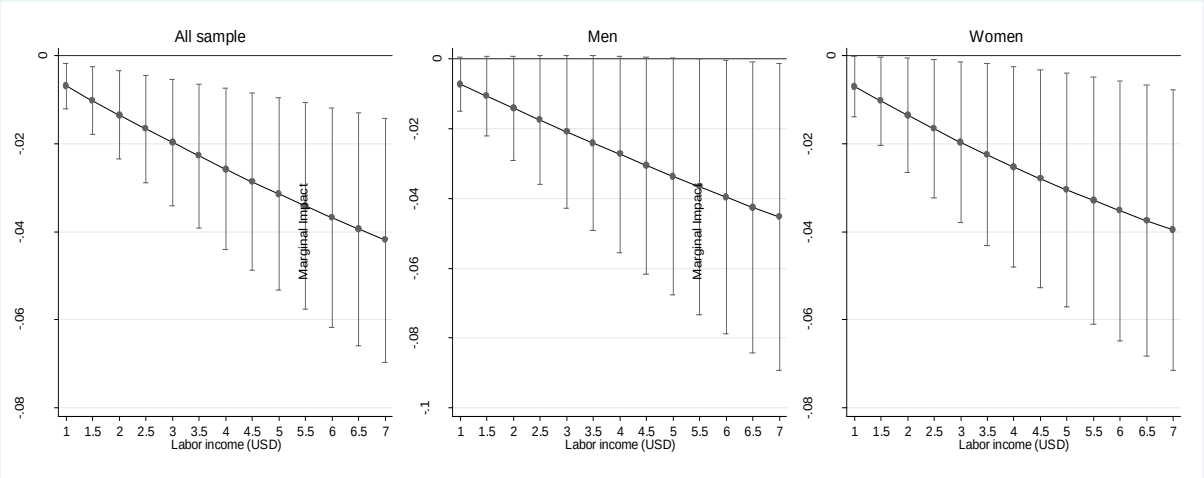
Table N° 7: Logistic regression analysis between mental health and obesity in women

Variable	OR	Std. Err.	P>z	95% CI
Obesity				
No	Ref.			
Yes	3.12**	0.982	0.002	3.046 - 3.321
Age				
Age	1.001	0.863	0.057	0.872 - 1.321
Number of children				
Number of children at home	2.112**	0.054	0.004	2.096 - 2.197
Monthly labor income				
Income in dollars	-2.489**	0.987	0.872	-2.001 - -2.321
Years of schooling				
Years of schooling	-1.686***	0.542	0.001	-1.543 - -1.754
Workmethod				
Employee	Ref.			
Unemployed	1.55*	0.216	0.032	1.321 - 1.765
Out of theworkforce	1.026*	0.321	0.021	1.0321 - 1.0765
Workinghours				
Number of workinghours	1.653	0.654	0.035	1.345 - 1.897
Are you a migrant?				
No	Ref.			
Yes	1.567*	0.535	0.045	1.354 - 1.853
Ethnicity				
Indigenous	Ref.			
Afro-Ecuadorian	-1.043	0.312	0.067	-1.012 - -1.231
Mongrel	-1.065	0.432	0.655	1.001 - 1.198
White	-1.986	0.563	0.192	-1.452 - -2.004
Montubio	1.654	0.643	0.431	1.594 - 1.865
Urban density				
Inhabitants per squarekilometer	1.654**	0.543	0.031	1.493 - 1.985
Area				
Urbana	Ref.			
Rural	1.456	0.753	0.912	1.321 - 1.764
Observations	7221			
AIC	24232.03			
BIC	23520.09			
R^2	0.025			
X^2	3.956***			
Log-likehood	-31221.51			

Notes: Asterisks mean: *p <0.10,**p < 0.05, ***p < 0.01. In the table, the dependent variable is the dichotomous variable of psychological problems that takes a value of 1=Yes and 0=No.

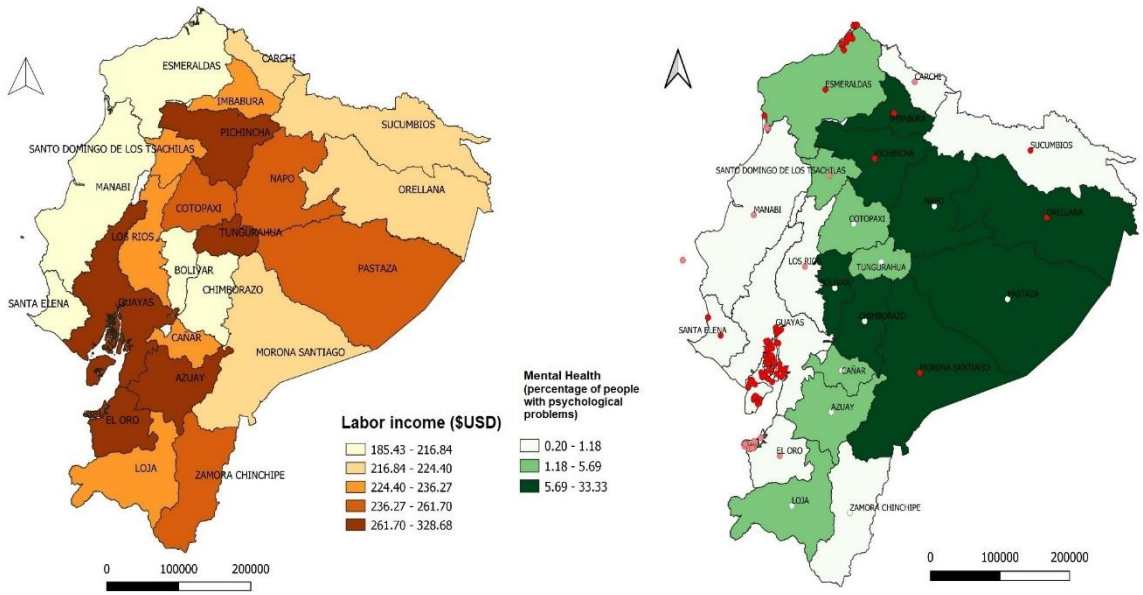
In **Table 6** and **Table 7** we observe an interesting pattern, and that is the fact that income negatively impacts mental health. That is, as salary increases, the impact of reducing psychological problems are greater. Therefore, we plot the marginal impacts of the income variable. Here we observe the marginal impacts for three sample groups: the general sample, the sample of men and the sample of women. We observe that as predicted by the regressions, the marginal impact is negative, i.e., the higher the income the lower the probability of suffering from psychological problems. In addition, we observe that the marginal impact of income is greater in men than in women.

Figure 1: Marginal impacts of labor income on men's and women's mental health.



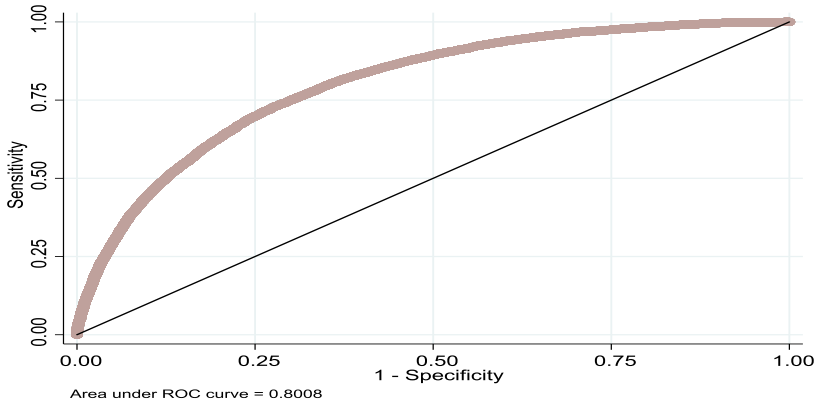
Finally, to complement the idea that income mitigates the impact of mental health, **Figure 2** shows the spatial distribution of income and mental health in Ecuador across provinces. In the figures we observe that there is a significant pattern. In general, provinces with lower labor income are those that report more psychological problems in Ecuador. This fact is evidence that there is an effectively inverse relationship between mental health and wages as shown in our results. Other variables that affect mental health are family size (number of children) and migration; the distribution of this variable can be seen in **Figure A1** in Appendix A. Likewise, variables such as schooling and age significantly predicted the mental health of the individuals in this study. Therefore, **Figure A2** in Appendix A shows the spatial distribution of these variables. To give robustness to the model in Appendix A are also presented.

Figure 2. Provincial spatial distribution of wages and mental health in Ecuador.



Finally, to determine the fit and explanation of the independent variables, the ROC curve was applied with the probabilities estimated by applying logistic regression. The ROC curve in **Figure 3** coincides with the probability of correctly distinguishing a case of psychological problems from one that is not, through the significant predictor variables, the worst scenario being when the area is equal to 0.50. In our case, suffering from obesity together with other significant variables, such as labor income, schooling, number of children, having been a migrant, age, being unemployed or out of the labor force and urban density, represented an area under the curve of 0.80880 (95% CI: 0.752-0.854), considering that they adequately predict (positively or negatively) cases of psychological problems ($p < 0.001$). On the other hand, to give rigor to our analysis, **Figure A3** in Appendix A shows the confusion matrix of the model, indicating that the independent variables explain a large proportion of the variability of our independent variable, specifically we observe that the independent variables explain 73.47% of the variability in the dependent variable, this percentage being relatively high.

Figure 3. ROC curve of the estimated model.



IV. Discussion

Obesity is a disease that has been on the rise in recent decades and has multifactorial causes (genetic, metabolic, social psychological, cultural, etc.), which raises the need to address this problem psychologically as well. In this context, obesity should be considered as one of the main "social stigmas" with a marked impact at the individual psychological level, without becoming a psychiatric disorder.[12]. Obesity and mental health are two issues that have been gaining importance in the current public health debate due to the large number of people suffering from either of these conditions.[13]. This is relevant if we consider that both problems are associated with lost labor productivity and lower wages, in addition to being costly for governments.[14].

The present work allows us to describe that obesity and sedentary lifestyle are factors that are associated to a great extent with a worse mental health status in the population studied. This research revealed that 15.69% (CI=15.02%-16.77%) of the sample reported suffering from psychological problems. This percentage is alarming, given that almost a quarter of the population has poor mental health. This fact makes it evident that mental health policies should be a priority in a developing country like Ecuador.

In addition, we observed that men who suffer from obesity have a higher risk of suffering from psychological problems. In other words, our results specifically show that suffering from obesity increases the probability of suffering from psychological problems by 2.32 times (OR= 2.32; CI=1.91-2.17). This result is statistically significant. It was also shown that other variables that influence mental health are the number of children, positively affecting the probability of suffering psychological problems. On the other hand, it was shown that women who suffer from obesity have a higher risk of suffering from psychological problems. In other words, our results specifically show that suffering from obesity increases the probability of suffering from psychological problems by 3.12 times (OR=3.12; CI=3.046-3.321).

All our results are consistent with the World Psychiatric Association studies in adults from general populations in 13 countries found in 2007 that, after adjusting for age, sex and educational level, obesity was only associated with statistical significance in two DSM-IV categories among all those included in the CIDI 3.0 interview: depressive disorders and anxiety disorders, especially in women, and more strongly so at higher BMIs.[15].

The results of this cross-sectional study are consistent with other studies with a very different design and in different contexts: on a smaller scale, the physical exercise-mental health relationship has been evaluated through the implementation of directed physical activity programs in small groups, finding that there is an association between both factors, and also causal (something that we cannot infer from the present study).[7]. The results of the present study can be attributed in part to the adaptations derived from an active lifestyle, which reduce the incidence of mental health problems, depression or anxiety.[16].

This study is one of the first of its kind in our country, carried out in a broad population base and with the objective of defining the association between mental health, physical activity and obesity.[17]. From a public health perspective, it allows to describe that the consequences in terms of mental health and obesity are observed in the early stages of life, and in the general population, a healthy weight is associated with different dimensions of psychological well-being, while the practice of physical activity during leisure time is a good indicator of the state of children's health in the broadest sense of the term.[18].

V. Conclusion

Obesity is a problem with a great negative impact on mental health. In our country it is necessary to carry out studies on the subject, taking into account the differences in the population between men and women as well as the socioeconomic strata, in order to have a better management of the entity from a multidisciplinary point of view. In other words, the explanation and approach to one case of obesity is never exactly the same as

the explanation and approach to another. From this, it follows the need for interdisciplinary work to address each of the details that affect this problem.

The approach and treatment of the psychological characteristics is of fundamental importance, otherwise the patient is not able to commit adequately to the treatment and in general has greater difficulty in losing weight and/or maintaining it. It should not be forgotten that the human being is a bio-psycho-social being, and as such, all therapies must be approached from this perspective, and the treatment of obesity is not excluded.

The application of nutritional treatments and lifestyle changes do not seem sufficient for the control of overweight/obesity, because obesity is a multifactorial pathology in which the emotional state is a determining component and often the most complex to treat. The criteria for therapeutic success should contemplate not only weight reduction as the final product, but a whole continuous process with positive results in the quality and less sedentary lifestyle, actively integrating exercise, a greater acceptance of body image and a change in eating habits, together with an awareness of the disease that avoids relapses that are so frequent in this process, but which do not necessarily mean an absolute failure of the treatment.

Therefore, it is necessary to open new lines of research and intervention to address the issue and promote exclusive breastfeeding for its health, social and economic benefits. The promotion of breastfeeding should be an objective of health policies to significantly reduce maternal and infant morbidity and mortality.

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Appendix A

Figure A1. Spatial distribution of family size and informal migrants in the provinces of Ecuador.

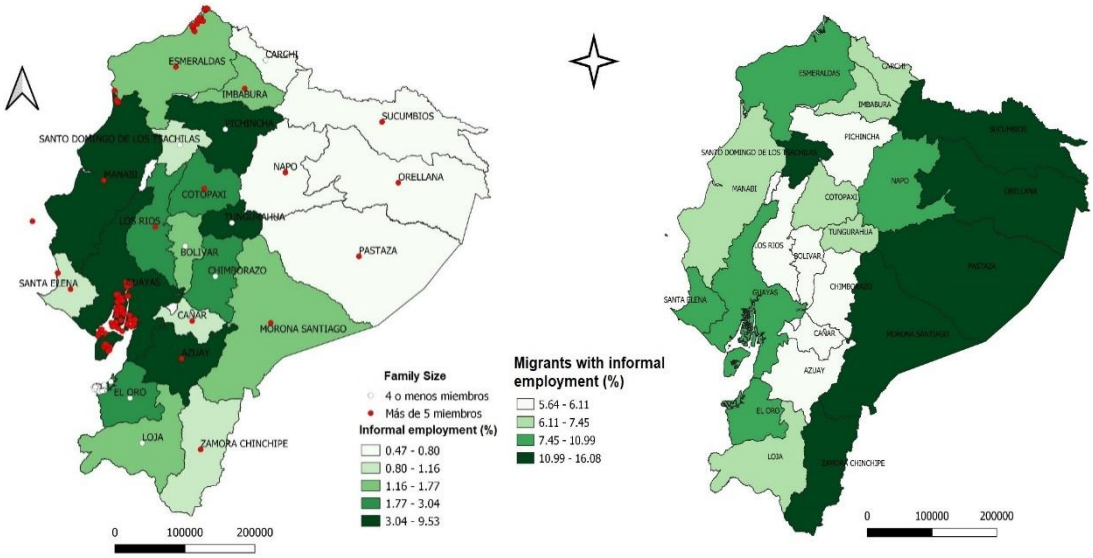

Figure A2. Spatial distribution of schooling and age in the provinces of Ecuador.

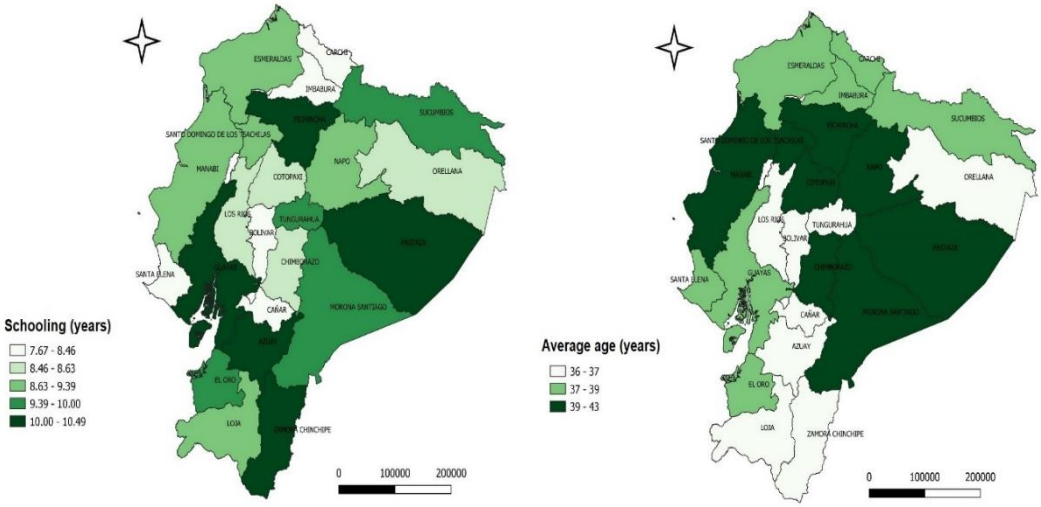

Figure A3. Confusion matrix of the estimated model of the model

	True		
Classified	D	~D	Total
+	5516	2444	7960
-	3596	11210	14806
Total	9112	13654	22766

Classified + if predicted Pr(D) >= .5
True D defined as sectores != 0

Sensitivity	Pr(+| D)	60.54%
Specificity	Pr(-|~D)	82.10%
Positive predictive value	Pr(D| +)	69.30%
Negative predictive value	Pr(~D| -)	75.71%
False + rate for true ~D	Pr(+|~D)	17.90%
False - rate for true D	Pr(-| D)	39.46%
False + rate for classified +	Pr(~D| +)	30.70%
False - rate for classified -	Pr(D| -)	24.29%
Correctly classified		73.47%