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Overweight/Obesity and Associated Factors in Healthcare and Non-Healthcare Workers in an Ecuadorian Hospital: A Cross-Sectional Study

Sobrepeso/obesidad y factores asociados en personal sanitario y no sanitario en un hospital de Ecuador: estudio transversal

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ABSTRACT
Introduction: Overweight and obesity constitute a major public health problem and are closely associated with non-communicable diseases such as diabetes, cardiovascular disease, and cancer. Factors related to the hospital work environment, age, sex, central adiposity, and vitamin D status may influence the risk of excess weight; however, evidence among healthcare and administrative personnel in oncology hospitals in middle-income countries remains limited. The objective of this study was to evaluate the prevalence of overweight and obesity and associated factors among workers in an Ecuadorian oncology hospital. **Methods:** A cross-sectional observational study was conducted in 2023 at a hospital in Guayaquil, Ecuador. The study included eligible healthcare and non-healthcare workers from SOLCA (Sociedad de Lucha Contra el Cáncer), who were invited to participate after meeting exclusion criteria, with voluntary participation and complete data for the primary variables. Anthropometric and body composition measurements were obtained, and clinical and sociodemographic data were collected using a questionnaire adapted from the World Health Organization (WHO). Bivariate and multivariate analyses were performed, including chi-square and Student's t-tests, binary logistic regression, multiple linear regression, and Poisson regression with robust variance (main analysis). The study was approved by an ethics committee and followed the STROBE guidelines. **Results:** 653 workers were included (33.7% men), with a median age of 32 (28-39) years old. The prevalence of being overweight and obesity was 74.9%. No significant differences in BMI were observed by job type; however, administrative personnel showed greater waist circumference and visceral fat level (p = 0.01). Age and sex were independently associated with overweight/obesity and level of visceral fat. Elevated glycated hemoglobin and lower vitamin D were associated with greater levels of visceral fat. **Conclusions:** Overweight and obesity are highly prevalent among hospital workers, especially among men and older workers. Targeted institutional interventions are needed to promote healthy lifestyles, as well as longitudinal studies to identify the causes of low vitamin D levels.

Keywords: Prevalence, Overweight, Obesity, Healthcare workers, Non-healthcare workers.

RESUMEN
Introducción: El sobrepeso y la obesidad constituyen un importante problema de salud pública y se asocian con enfermedades no transmisibles como diabetes, enfermedad cardiovascular y cáncer. Factores del entorno laboral hospitalario, la edad, el sexo, la adiposidad central y el estado de la vitamina D pueden influir en el riesgo de exceso de peso; sin embargo, existe escasa

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evidencia en personal sanitario y no sanitario de hospitales oncológicos en países de ingresos medios. El objetivo fue evaluar la prevalencia de sobrepeso/obesidad y los factores asociados en personal sanitario y no sanitario de un hospital oncológico ecuatoriano. **Metodología:** Estudio observacional transversal realizado en 2023 en un hospital de Guayaquil, Ecuador. Incluyó personal sanitario y no sanitario elegible del hospital de la Sociedad de Lucha Contra el Cáncer, invitados tras aplicar criterios de exclusión, con participación voluntaria y datos completos para las variables principales. Se realizaron mediciones antropométricas, composición corporal, se recolectaron datos clínicos y sociodemográficos mediante un cuestionario adaptado de la Organización Mundial de la Salud. Se realizaron análisis bivariados y multivariables, incluidas pruebas de ji al cuadrado y t de Student, regresión logística binaria, regresión lineal múltiple y regresión de Poisson con varianza robusta (análisis principal). El estudio contó con aprobación de un comité de ética y siguió las directrices STROBE. **Resultados:** 653 trabajadores fueron incluidos (33,7 % hombres), con una mediana de edad de 32 (28-39) años. La prevalencia de sobrepeso y obesidad fue del 74,9 %. No se observaron diferencias significativas en el índice de masa corporal según el tipo de trabajo; sin embargo, el personal no sanitario presentó mayor circunferencia de cintura y nivel de grasa visceral (p = 0,01). Edad y sexo se asociaron de forma independiente con sobrepeso/obesidad y nivel de grasa visceral. Hemoglobina glicosilada alta y vitamina D baja se asociaron a mayor nivel de grasa visceral. **Conclusiones:** El sobrepeso y la obesidad son altamente prevalentes en trabajadores hospitalarios, especialmente en hombres y trabajadores de mayor edad. Se requieren intervenciones institucionales dirigidas para promover estilos de vida saludable y estudios longitudinales para identificar las causas de niveles bajos de vitamina D.

Palabras clave: prevalencia, sobrepeso, obesidad, personal sanitario, personal no sanitario.

1. Introduction

The World Health Organization (WHO) defines overweight and obesity as an abnormal or excessive accumulation of fat that may impair health. In 2022, 2.5 billion adults were classified as overweight, including 890 million who were obese [1]. Overweight and obesity arise from the interaction of genetic and environmental factors and represent complex, multifactorial chronic conditions. These conditions are strongly associated with multiple noncommunicable diseases (NCDs), such as type 2 diabetes, cardiovascular diseases, and certain types of cancer [2-4].

In the workplace, risk factors such as working more than 50 hours per week, night shifts, high stress levels, disrupted sleep patterns, unhealthy eating habits, and limited opportunities for physical activity contribute significantly to the development of obesity [5–9]. Furthermore, low vitamin D levels have been linked to an increased inflammatory response in individuals with obesity [10], while obesity itself increases the likelihood of vitamin D deficiency [11].

Evidence from meta-analyses of randomized clinical trials, including the large-scale Vitamin D and Omega-3 Trial (VITAL), suggests limited benefits of vitamin D supplementation on primary outcomes such as cancer and major cardiovascular events. However, secondary analyses of the VITAL study revealed a significant interaction with baseline body weight. Among participants with normal weight (body mass index (BMI) < 25.0, calculated as weight in kilograms divided by height in meters squared), vitamin D supplementation was associated with a 24% reduction in cancer incidence, a 42% reduction in cancer mortality, and a 22% reduction in the incidence of autoimmune diseases. These benefits were not observed in overweight or obese individuals [12].

Other critical factors in the assessment of obesity include waist circumference (WC), a key anthropometric measure of abdominal obesity, which is strongly linked to the risk of cardiovascular and metabolic diseases [13–15]. Visceral fat, in particular, is significantly associated with arterial stiffness, underscoring its importance in cardiovascular health [16].

In addition, alcohol consumption has become widespread worldwide, contributing to both health and social challenges. Alcohol, which provides 7.1 kcal (29 kJ) per gram, can promote a positive energy balance, thereby increasing the risk of weight gain when consumed in excess [17]. Collectively, these factors drive the rising prevalence of NCDs, contributing to absenteeism and reduced labor productivity [18].

Despite the known risks, few studies have explored the prevalence of overweight, obesity, and their associated factors among healthcare and non-healthcare workers in hospital settings. This study aimed to estimate the prevalence of overweight and obesity and to assess associated sociodemographic, clinical, and occupational factors among healthcare and non-healthcare workers at an Ecuadorian oncology hospital.

2. Methodology

A cross-sectional observational study was conducted in 2023; data were collected from September through December at the Sociedad de Lucha Contra el Cáncer (SOLCA), a cancer hospital located in Guayaquil, Ecuador. The source population consisted of all healthcare and non-healthcare workers registered at SOLCA at the start of the study period; in this study, non-healthcare workers were defined as administrative workers. After applying the exclusion criteria, eligible workers were invited to participate. Final inclusion depended on voluntary acceptance through the signing of an informed consent form and the availability of complete information for the study's primary variables.

Pregnant women and workers with medical conditions known to significantly affect body weight—such as thyroid disorders, Cushing's syndrome, polycystic ovary syndrome, or psychiatric disorders treated with medications that affect weight, including antipsychotics or corticosteroids—were excluded in order to reduce confounding bias.

Data on workers were obtained from medical records and an adapted questionnaire (available upon request to the author) based on national and international surveys in Spanish, developed by the WHO and other institutions such as Ecuador's Ministry of Public Health (MSP in spanish) and the Pan American Health Organization (PAHO). The questionnaires used for adaptation were: Pan American Version of the Stepwise Approach to Public Health (STEPS) Basic Questionnaire and Expanded Questionnaire to be administered in Ecuador, May 2018 [19], Global Physical Activity Questionnaire (GPAQ) [20], the Quality of Life Questionnaire (WHOQOL-BREF) short version [21], and the Joint Report of the Food and Agriculture Organization of the United Nations (FAO) and the WHO on Human Requirements for Vitamins and Minerals (FAO/WHO) [22].

Data were collected in an Excel spreadsheet during the workers' regular annual checkups at the institution's occupational health department during the aforementioned data collection months, and laboratory data were retrieved from medical records once the results were available. Anthropometric measurements, including weight and height, were taken using a primary care scale with an integrated digital stadiometer (Health-o-Meter, model 502 KL). BMI was calculated using the formula: weight in kilograms divided by height in meters squared. Waist circumference was measured using a SECA 201 ergonomic tape measure, and body composition (visceral fat level, muscle mass percentage, and total body fat percentage) was assessed using a calibrated OMRON scale (model HBF-514C), based on the bioelectrical impedance method. Other variables related to overweight and obesity were obtained from medical records and the aforementioned adapted WHO questionnaire, including age, sex, alcohol and smoking, serum vitamin D levels, sun exposure, sleep quality, and absenteeism. Variables derived from the questionnaire were categorized according to the criteria established in the WHO instruments: STEPS, GPAQ, WHOQOL-BREF, and FAO, as applicable. The operational definitions, cutoff points, and specific sources for each variable are presented in Appendix 1.

The WHO, in accordance with the Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH), defines the BMI (kg/m²) categories for adults aged 20 years and older as follows: underweight < 18.5; normal weight 18.5–24.9; overweight 25.0–29.9; and obesity ≥ 30.0.

Overweight and obesity were described using frequencies and percentages. Statistical analyses included chi-square tests, Student's t-tests, or Mann-Whitney U tests, as appropriate. Binary logistic regression models, Poisson regression with robust variance, and multiple linear regression were used to assess associations between various factors and the variables of interest. A p-value < 0.05 was considered statistically significant, and the assumptions of each statistical test were checked, including normality. All analyses were performed using the statistical software SPSS (version 29) and Jamovi (version 2.3.28). The study report followed the STROBE guidelines for cross-sectional studies. Missing data were handled using pairwise deletion, so that each analysis included all cases with available information for the corresponding variables. No imputation of missing values was performed. The response rate for the adapted questionnaire was calculated based on the number of participants who completed the survey relative to the total number of eligible participants.

All participants signed an informed consent form prior to their inclusion in the study. The protocol was approved by the Ethics Committee of the Kennedy Clinic (code HCK-CEISH-2023-013) in Guayaquil, Ecuador, and the study was conducted in accordance with the principles established in the Declaration of Helsinki. The data were analyzed anonymously and de-identified, ensuring confidentiality and avoiding the use of names or other identifiable information about the participants.

3. Results

At the start of the study, 1,430 workers were registered in SOLCA. Of these, 104 were excluded because they had known medical conditions that could significantly influence body weight, leaving an eligible population of 1,326 workers. A total of 653 workers agreed to participate and signed the informed consent form, corresponding to a participation rate of 49.2%. The remaining 673 workers did not participate in the study for various reasons: lack of desire to participate (n = 485), vacation during the data collection period (n = 130), sick leave (n = 15), and other/unspecified reasons (n = 43). Among the participants who agreed to participate, 622 completed the questionnaire, representing a questionnaire completion rate of 95.3%.

The frequency of missing data was assessed for the variables included in the analysis. In the descriptive and bivariate analyses, an available-case analysis was used, so the denominator varied depending on the variable or comparison being examined. For the multivariable models—binary logistic regression, Poisson regression with robust variance, and multiple linear regression—only participants with complete data for the dependent variable and the covariates included in each model were included. The effective sample size for each model was reported along with its respective results.

Of the 653 participants who agreed to take part, 220 were men (33.7%) and 433 were women (66.3%); there was an approximate ratio of two women to every man among the participants. The mean age was 34.2 ± 8.88 years; it was similar between both groups: 33.8 ± 8.97 for healthcare workers and 36.2 ± 8.14 for non-healthcare workers. The median age was 32 (28–39) years old, with healthcare workers being five years younger on average than non-healthcare workers. The greatest age difference was observed among male healthcare workers (29 years) versus non-healthcare workers (37 years) compared to female healthcare workers (32 years) versus non-healthcare workers (36 years). Table 1 shows the characteristics of workers by job type. The age difference between job types was statistically significant (p = 0.001).

A total of 74.9% of workers were classified as being overweight or obese, of whom 43.2% were overweight and 31.7% had obesity. Figure 1 shows the distribution of BMI by sex and job type.

No statistically significant differences were observed between BMI and job type (p = 0.26). The prevalence of overweight was similar among healthcare workers (43.2%) and non-healthcare workers (45%), as was the prevalence of obesity (31.3% vs. 35%), with no significant differences. Similarly, no significant differences were found between job type and variables such as sex, physical activity level, sleep quality in the past month, sun exposure, serum vitamin D concentration, or smoking and alcohol use in the past 12 months.

In the comparative analysis, no statistically significant differences were observed in alcohol consumption between healthcare and non-healthcare workers (68.2% vs. 77.6%; p = 0.06), nor in the proportion with normal vitamin D levels (53.6% vs. 42.0%; p = 0.07). However, healthcare workers had a lower frequency of alcohol consumption and a higher proportion of normal vitamin D levels. In the total sample, there was a high prevalence of vitamin D insufficiency (43.5%) and deficiency (3.3%).

Using Student's t-test, significant differences were identified between job type and certain anthropometric measurements:

Waist circumference (n = 648): Healthcare workers had a mean value of 91.2 cm, compared with 94.6 cm among non-healthcare workers (p = 0.01), with a small effect size (Cohen's d = 0.27; 95% CI: 0.06–0.49).

Visceral fat level: healthcare workers had a mean level of 8.3, while non-healthcare workers had 9.5 (p = 0.01), with a small to moderate effect size (Cohen's d = 0.32; 95% CI: 0.10–0.53).

No significant differences were found in the annual absenteeism rate between the two job types, according to the Mann-Whitney U test.

The effective sample size varies depending on the availability of data for each variable. In the descriptive and bivariate analyses, data were available for 635 to 653 participants for most variables; specifically, sex, age, and BMI were available for 653 workers, sun exposure and physical activity for 643, smoking and sleep quality for 641, alcohol consumption for 635, and waist circumference for 648. The main exception was vitamin D, which was available for 453 workers. In the multivariable models, the complete-case analysis reduced the effective sample size to 366–367 participants, as detailed in Appendices 2 and 3.

In the binary logistic regression analysis, statistically significant factors associated with higher odds of being overweight or obese were identified (Figure 2).

Table 1. Characteristics of workers by job type

	All Workers (N = 653)		**Healthcare** (n = 553)		**Non-Healthcare** (n = 100)	
	N	%	N	%	N	%
Sex						
Men	220	33.7	179	32.4	41	41.0
Women	433	66.3	374	67.6	59	59.0
Age {years}	653					
Mean (s.d.) ¥	34,2	(8.88)	33.8	(8.97)	36.2	(8.14)
Median (IQR) *	32,0	(28-39)	31.0	(27-38)	36.0	(29-42)
BMI† (kg/m^2)						
Underweight	4	0.6	4	0.7	0	0.0
Normal weight	160	24.5	140	25.3	20	20.0
Overweight	282	43.2	237	42.9	45	45.0
Obesity	207	31.7	172	31.1	35	35.0
Sun exposure	643					
Yes	339	52.7	293	54.0	46	46.0
No	304	47.3	250	46.0	54	54.0
Physical activity	643					
Vigorous	33	5.1	26	4.8	7	7.0
Moderate	157	24.4	130	23.9	27	27.0
Light	228	35.5	194	35.7	34	34.0
Sedentary	225	35.0	193	35.5	32	32.0
Smoking‡	641					
Yes	86	13.4	68	12.5	18	18.2
No	555	86.6	474	87.5	81	81.8
Alcohol‡	635					
Yes	442	69.6	366	68.2	76	77.6
No	193	30.4	171	31.8	22	22.4
Sleep quality§	641					
Good	275	42.9	231	42.7	44	44.0
Regular	292	45.6	246	45.5	46	46.0
Poor	74	11.5	64	11.8	10	10.0
Vitamin D (ng/mL)	453					
Deficiency (< 12)	15	3.3	12	3.1	3	4.3
Insufficiency (12 ~ < 20)	197	43.5	162	42.2	35	50.7
Sufficiency (≥ 20)	235	51.9	206	53.6	29	42.0
Risk of Toxicity (>100)	6	1.3	4	1.0	2	2.9

* IQR stands for interquartile range, † BMI stands for Body Mass Index, ‡ Last 12 months, § Last month, ¥ standard deviation

Figure 1. Distribution of BMI by sex and job type.

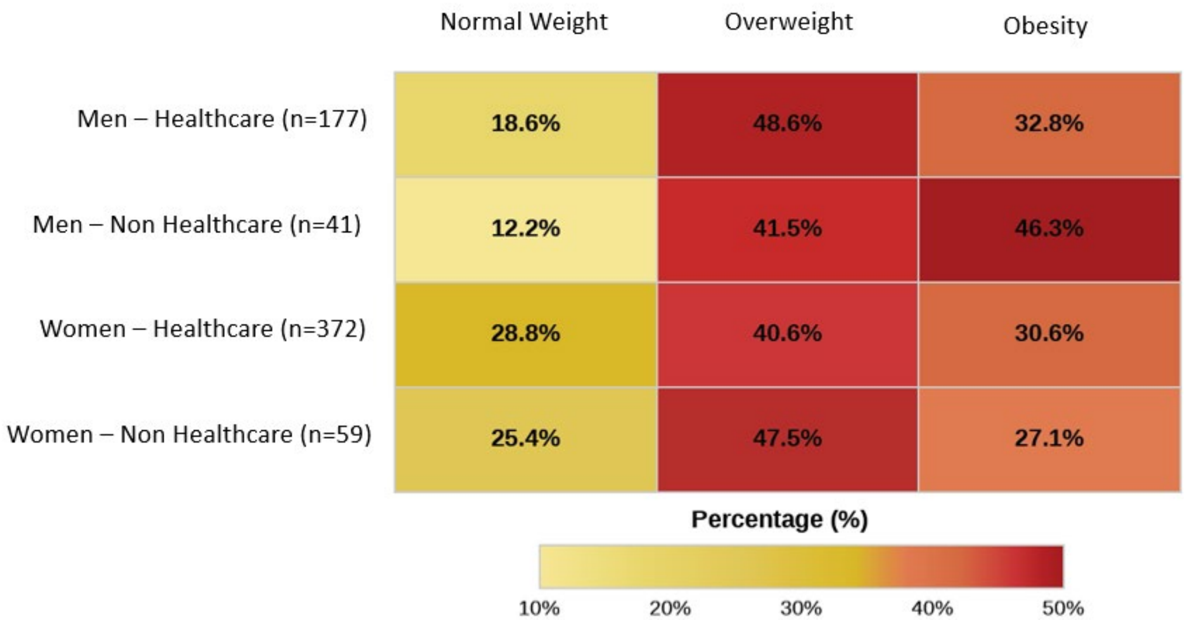


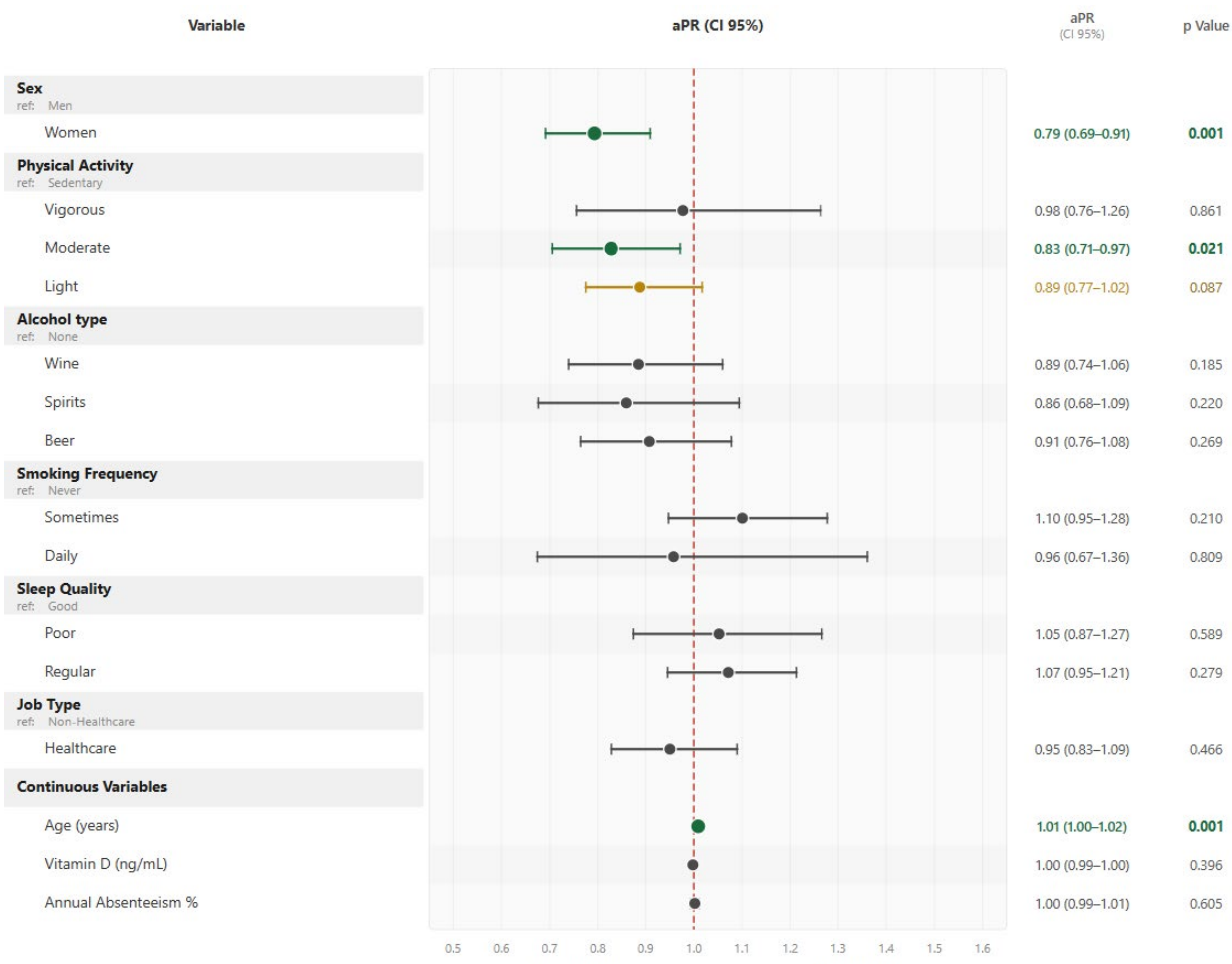
Figure 2. Forest plot of factors associated with overweight/obesity using binary logistic regression.

Note: The estimators represent the log odds of “overweight/obesity = yes” versus “overweight/obesity = no.” Logarithmic scale. P.A. = physical activity.

Each additional year of age was associated with a 4.8% increase in the odds of being overweight or obese (OR = 1.048; 95% CI: 1.014–1.083; $p = 0.005$). Similarly, men had approximately three times the odds of being overweight/obese compared with women (OR = 2.989; 95% CI: 1.548–5.771; $p = 0.001$). Compared with a sedentary lifestyle, moderate physical activity was associated with lower odds of being overweight/obese (OR = 0.443; 95% CI: 0.220–0.893; $p = 0.023$); however, vigorous physical activity was not associated, likely due to the small number of workers in this category, which could limit precision. No significant associations were observed with type of alcohol consumed, smoking frequency, vitamin D level, sleep quality, absenteeism, or job type ($p > 0.05$ in all cases). Overall, the model was globally significant ($\chi^2 = 27.1$; df = 15; $p = 0.028$), although its explanatory power was modest (McFadden's $R^2 = 0.067$; Nagelkerke's $R^2 = 0.107$). The model included n = 367 participants with complete data for the dependent variable and all included covariates.

Given that the primary outcome had a high prevalence, Poisson regression with robust variance (Figure 3) was used—and is therefore considered the primary analysis—to estimate adjusted prevalence ratios (aPR) and 95% confidence intervals. Binary logistic regression was initially used to explore associations, but odds ratios were interpreted with caution because, for common outcomes, they may overestimate the magnitude of the association compared to prevalence ratios.

Figure 3. Forest plot of factors associated with overweight/obesity using Poisson regression with robust variance.

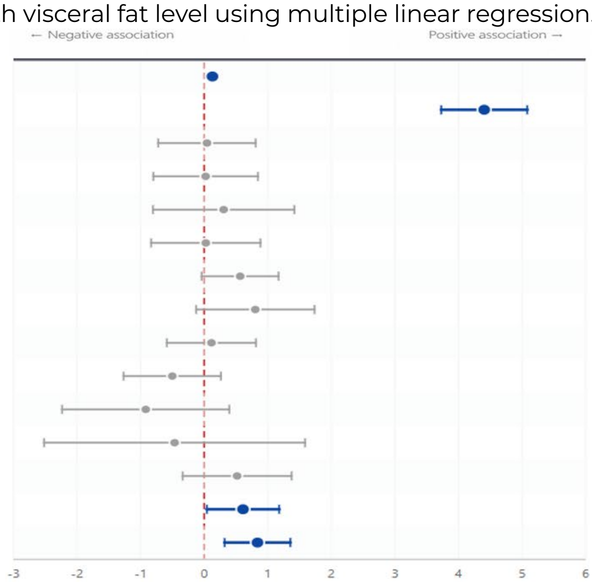


In the multivariable Poisson regression model (n = 367) with robust variance, adjusted for sex, physical activity, type of alcohol, smoking frequency, sleep quality, job type, age, vitamin D, and annual absenteeism rate, women had a lower prevalence ratio of overweight/obesity compared with men (aPR: 0.79; 95% CI: 0.69–0.91; p = 0.001). Likewise, age was positively associated with the outcome, with a 0.9% increase in the prevalence ratio for each additional year of age (aPR: 1.009; 95% CI: 1.004–1.015; p = 0.001). Although the overall effect of physical activity was not statistically significant (p = 0.102), the moderate physical activity category showed a lower prevalence ratio for overweight/obesity compared with the sedentary group (aPR: 0.83; 95% CI: 0.71–0.97; p = 0.021). As in the logistic regression model, vigorous physical activity was not associated, likely due to the small number of workers in this category, which could limit precision. No statistically significant associations were observed with type of alcohol consumed, smoking frequency, sleep quality, job type, vitamin D level, or annual absenteeism rate. Appendix 2 shows the effective N and missing data by variable for this Poisson regression analysis.

After testing the assumptions, a multiple linear regression analysis was performed to determine which variables were associated with visceral fat levels (Figure 4).

Figure 4. Coefficient plot of factors associated with visceral fat level using multiple linear regression.

PREDICTOR	B	CI 95%	P
Age	**0.13**	**[0.10; 0.16]**	**0.001**
Men vs Women	**4.40**	**[3.73; 5.08]**	**0.001**
Healthcare vs Non-Healthcare	0.04	[-0.72; 0.81]	0.909
Beer vs None (Alcohol)	0.02	[-0.80; 0.84]	0.956
Spirits vs None (Alcohol)	0.31	[-0.81; 1.42]	0.589
Wine vs None (Alcohol)	0.03	[-0.83; 0.89]	0.953
Regular vs Good (Sleep)	0.57	[-0.04; 1.17]	0.066
Poor vs Good (Sleep)	0.80	[-0.13; 1.74]	0.090
Light vs Sedentary (P.A.)	0.11	[-0.59; 0.81]	0.749
Moderate vs Sedentary (P.A.)	-0.50	[-1.27; 0.26]	0.198
Vigorous vs Sedentary (P.A.)	-0.92	[-2.23; 0.40]	0.170
Daily vs Never (Smoking)	-0.47	[-2.52; 1.59]	0.656
Sometimes vs Never (Smoking)	0.52	[-0.34; 1.37]	0.235
Low Vitamin D vs Normal	**0.61**	**[0.04; 1.18]**	**0.035**
Glycated Hemoglobin	**0.84**	**[0.32; 1.35]**	**0.002**



Note: The β coefficients represent the change in visceral fat level for each unit increase in the associated factor. P.A. = physical activity; Hb = hemoglobin.

In the multiple linear regression model, age was positively associated with visceral fat level, with an average increase of 0.13 points for each additional year of age (B = 0.1295; 95% CI: 0.0970 to 0.1620; p < 0.001). Likewise, men were associated with an average increase of 4.40 points in visceral fat level compared with women (B = 4.4049; 95% CI: 3.7289 to 5.0810; p < 0.001). Low vitamin D level (< 20 ng/mL, including both insufficiency and deficiency), compared with normal level, was also associated with higher average visceral fat values, although with a less precise estimate and close to zero (B = 0.6107; 95% CI: 0.0423 to 1.1790; p = 0.035). Similarly, glycated hemoglobin was positively associated with visceral fat level (B = 0.8384; 95% CI: 0.3222 to 1.3550; p = 0.002). No statistically significant associations were observed for job type, type of alcohol, physical activity, smoking frequency, or sleep quality. In particular, the categories of regular sleep quality (p = 0.06) and poor sleep quality (p = 0.09), compared with good sleep quality, had confidence intervals that included the null value; therefore, they were not considered statistically significantly associated with visceral fat level. The model explained 44.9% of the variability in visceral fat level ($R^2 = 0.449$). The overall fit was significant (F (15.350) = 19.0; p < 0.001). The analysis was performed with n = 366 participants with complete data for the dependent variable and the associated factors included in the model. Appendix 3 shows the effective sample size and missing data by variable for this multiple linear regression analysis.

4. Discussion

This study examined the prevalence of overweight and obesity, as well as associated factors among healthcare and non-healthcare workers at a cancer hospital in Ecuador. The findings indicate a high prevalence of overweight and obesity (74.9%), consistent with global trends observed among healthcare workers [1,23]. Despite the absence of significant differences in BMI by job type, disparities in waist circumference and visceral fat level underscore the importance of implementing targeted interventions to reduce central obesity among non-healthcare workers.

The high prevalence of overweight and obesity is comparable to that reported in regional studies in Latin America, where these conditions have reached epidemic levels due to lifestyle changes, including a sedentary lifestyle and unhealthy dietary patterns [24,25]. Among healthcare workers, the prevalence of obesity was higher than that reported in other hospital settings [26-29], which may reflect regional trends.

Interestingly, no significant associations were found between job type and factors such as physical activity levels, sleep quality, or serum vitamin D concentrations. However, trends toward lower alcohol consumption and higher vitamin D levels among healthcare workers may indicate modest differences in lifestyle. The high overall prevalence of vitamin D insufficiency (43.5%) and deficiency (3.3%) is consistent with findings from other studies, thus highlighting the global challenge of addressing hypovitaminosis D [30,31]. Evidence suggests that vitamin D plays a critical role in metabolic health and that its deficiency may exacerbate inflammation and increase the risk of obesity-related comorbidities [32].

Logistic regression and Poisson regression with robust variance identified age and sex as factors associated with overweight and obesity, albeit with limited precision. These findings are consistent with the literature, which shows that age and sex influence not only the distribution and expression of adiposity but also the magnitude and pattern of associated cardiometabolic risk, including metabolic syndrome, hypertension, diabetes, and dyslipidemia [33–36].

In the multiple linear regression analysis, age and sex were independently associated with visceral fat levels. Furthermore, vitamin D levels showed an inverse association with visceral fat levels, such that lower vitamin D concentrations were associated with higher visceral fat levels, after adjusting for the other variables included in the model. This finding is consistent with previous research that has described associations between vitamin D status, adiposity, and inflammatory processes [37–39]. However, due to the cross-sectional design of the study, these results should be interpreted as associations and do not allow for establishing causality or attributing a protective effect of vitamin D on visceral fat. Longitudinal or intervention studies are required to clarify the direction and possible mechanisms of this relationship.

The lack of significant differences in absenteeism rates between healthcare and non-healthcare workers may reflect shared occupational stressors or common challenges within the hospital setting. However, the small to moderate effect sizes observed for waist circumference and visceral fat level across job types highlight the need to implement tailored workplace wellness programs that address the specific needs of healthcare and non-healthcare workers.

However, obesity is a multifactorial phenomenon involving biological, behavioral, environmental, and social determinants. Therefore, although some variables in the present study showed an association with overweight/obesity, the model's explanatory power was limited, suggesting that other unmeasured factors could also contribute to the outcome, such as dietary patterns, energy balance, genetic predisposition, stress, working conditions, and other environmental determinants.

4.1 Strengths and Limitations

The study's strengths include an adequate sample size to describe the characteristics of the participating workers, a rigorous methodology, and the use of validated tools for anthropometric and body composition measurements. However, certain limitations must be acknowledged. The cross-sectional design precludes causal inferences, and reliance on self-reported data for some variables, such as physical activity and alcohol consumption, may introduce bias. Future longitudinal studies are needed to establish causal relationships and explore the impact of targeted interventions on the health outcomes of healthcare and non-healthcare staff.

An inherent limitation of our study is that it relied exclusively on BMI as an indicator of excess weight. In January 2025, the Editorial Board of The Lancet Diabetes & Endocrinology [40] published a new diagnostic framework that distinguishes "preclinical obesity" from "clinical obesity," incorporating fat distribution and the presence of organ dysfunction to define the disease. Our results remain valid for estimating the magnitude of the problem in 2023; however, future studies should apply these expanded criteria to more accurately identify the burden of clinical obesity and guide targeted interventions.

Another significant limitation of the study was the considerable proportion of eligible workers who did not participate. Although the questionnaire completion rate was high among those who agreed to participate, the participation rate relative to the eligible population was 49.2%. This could introduce nonresponse bias if the workers who did not participate differed systematically from the participants in variables related to nutritional status, cardiometabolic risk, sex, age, occupation type, or health habits.

It was not possible to compare the characteristics of participants and non-participants due to the lack of individual data available for workers who declined to participate. Consequently, the results should be interpreted with caution, and their generalizability to all workers at the institution may be limited. However, the final sample included both healthcare and non-healthcare staff, which allowed us to explore differences between occupational groups within the participating population.

Another limitation of the study was that the level of visceral fat estimated by the OMRON HBF-514C was treated as a continuous dependent variable in the multiple linear regression model, even though it corresponds to an ordinal scale with 1 to 30 levels rather than an actual percentage of visceral fat. This decision may affect the interpretation of the coefficients, given that differences between consecutive levels do not necessarily represent equivalent changes in actual visceral fat. Results of the multivariate model, conducted on 366 participants, should be interpreted with caution as an exploratory approximation of the factors associated with visceral fat levels.

Finally, a major limitation was the amount of missing data in some variables. We used a "censored cases" approach for descriptive and bivariate analyses, and a "complete cases" approach for multivariate models. Consequently, the effective sample size varied across analyses. This approach may reduce statistical precision and introduce bias if the missing data were not randomly distributed.

5. Conclusions

It is suggested that future studies be conducted to evaluate interventions aimed at reducing the burden of overweight and obesity among hospital workers, given the high prevalence observed in this population. Furthermore, based on the findings of prospective cohorts, these intervention or follow-up studies should consider strategies aimed at promoting physical activity, improving dietary habits, and addressing vitamin D deficiency, the high prevalence of which was also evident in the present study.

Similarly, in line with the literature, tailored interventions targeting groups with larger waist circumferences and higher levels of visceral fat such as non-healthcare workers—could yield health benefits and help improve workplace productivity. Overweight and obesity showed a consistent association with age and sex, identifying men and older workers as groups with a higher burden of these conditions. Although the cross-sectional design precludes inferring causality, these results can guide institutional strategies for cardiometabolic prevention and monitoring focused on groups with the highest prevalence.

6. Abbreviations

SOLCA: Sociedad de Lucha Contra el Cáncer

WHO: World Health Organization

STROBE: Strengthening the Reporting of Observational studies in Epidemiology

BMI: Body Mass Index

WC: Waist Circumference

NCDs: Noncommunicable Diseases

VITAL: Vitamin D and Omega-3 Trial

MSP: Ministry of Public Health / Ministerio de Salud Pública

PAHO: Pan American Health Organization

CDC: Centers for Disease Control and Prevention

NIH: National Institutes of Health

SPSS: Statistical Package for the Social Sciences

aPR: Adjusted Prevalence Ratios

HCK: Kennedy Clinic Hospital / Hospital Clínica Kennedy

CEISH: Human Research Ethics Committee / Comité de Ética de Investigación en Seres Humanos

7. Administrative information

7.1 Author Contributions

Walter Morquecho: conceptualization, methodology, software, statistical analysis, research, data curation, drafting, and revision and editing.

Dolores Rodríguez: conceptualization, methodology, software, statistical analysis, research, data curation, drafting, and revision and editing.

Luís Noles: research, validation, preparation of the first draft, review, and editing.

Miguel Zapata and Héctor Cuzme: data collection, validation, data cleansing, review, and editing.

Juan Roca: conceptualization, research, review, and editing.

Camila Manrique: methodology, data collection, review, and editing.

Ana Espinoza: conceptualization, methodology, software, validation, formal analysis, data curation, review, and editing.

7.2 Conflict of interest

None, as stated by the authors

7.3 Source of research funding:

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7.4 Ethical considerations

The study has been approved by the Ethics Committee of Hospital Clínica Kennedy, with approval code HCK-CEISH-2023-013.

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APPENDIX 1. Operationalization of the variables

Variable	Operational definition	Categories used	Source or Reference
Sex	A person's biological sex (male or female)	Men - Women	Medical records
Age	Time a person has lived	Chronological age	Medical records
BMI	Relationship between weight in kilograms and height in square meters	Weight (kg) / Height (m^2) Underweight, Normal weight, Overweight, Obese	WHO/CDC/NIH
Sun exposure	Direct exposure to sunlight for ≥30 minutes a day	Yes - No	WHO /FAO
Physical Activity	The amount of physical activity the worker engages in on a regular basis	Vigorous, moderate, light, sedentary	WHO/GPAQ
Smoking	Worker's tobacco use over the past 12 months	Yes - No	WHO/STEPS
Frequency of smoking	Frequency of tobacco use in the past 12 months	Never, Sometimes, Daily	WHO / STEPS
Alcohol	Employee alcohol consumption over the past 12 months	Yes - No	WHO/STEPS
Alcohol type	Type of alcohol consumed in the past 12 months	Beer, Wine, Distilled spirits (Whiskey, Vodka, Tequila, Rum, Puro, Aguardiente)	WHO/STEPS
Sleep quality	The participant's subjective perception of their rest	Good, Regular, Poor	WHO/ WHOQOL-BREF
Vitamin D	Blood levels of this fat-soluble substance (ng/ml)	* Deficiency (< 12) * Insufficiency (12 ~ < 20) * Sufficiency (≥ 20) * Risk of Toxicity (>100)	SOLCA Laboratory Reference Values
Waist circumference	Anthropometric measurement of abdominal circumference at the midpoint between the lower costal margin (10th rib) and the anterior superior iliac spine, with the patient standing, at the end of a normal exhalation, using a non-stretchable measuring tape held parallel to the floor.	Measured in centimeters	WHO
Glycated hemoglobin	Blood sugar levels over the past 2–3 months or so	Blood HbA1c level (%)	SOLCA Laboratory Reference Values
Visceral fat level	Bioimpedance measurement that estimates visceral fat levels	Estimation of visceral fat level on a scale of 1–30, in increments of 1	Scale measurement
Annual absenteeism (%)	A frequency indicator that measures the proportion of workdays lost by an employee relative to the total number of workdays during which the employee was legally required to work during the calendar year	Annual absenteeism rate % (2022)	SOLCA's internal records
Variable	**Operational definition**	**Categories used**	**Source or Reference**

Type of job	Classification of workers according to the nature of their duties at the institution: they are classified as healthcare workers when they perform care-related activities or activities directly related to healthcare, and as non-healthcare workers when they perform administrative, operational, or non-clinical support duties.	* Healthcare (doctors, nurses, medical technologists, and healthcare staff in general) * Non-healthcare (secretaries, assistants, and administrative staff in general)	SOLCA's internal records

APPENDIX 2. Poisson regression with robust variance: effective N and missing data

Variables		Effective N = 367	Missing Data	N Total
Sex	Women	241	192	433
	Men	126	94	220
Physical Activity	Vigorous	21	12	33
	Moderate	97	60	157
	Light	134	94	228
	Sedentary	115	110	225
Alcohol Type	Wine	98	47	145
	Spirits	39	22	61
	Beer	161	80	241
	None	69	29	98
Smoking Frequency	Sometimes	47	24	71
	Daily	6	3	9
	Never	314	239	553
Sleep Quality	Poor	46	28	74
	Regular	170	122	292
	Good	151	124	275
Type of Job	Healthcare	308	245	553
	Non-Healthcare	59	41	100
Continuous Variables	Age	367	286	653
	Vitamin D	367	86	453
	Annual Absenteeism %	367	265	632
Dependent Variable	Overweight/Obesity	367	286	653

APPENDIX 3. Multiple linear regression: effective N and missing data

Variables		Effective N = 366	Missing Data	N Total
Sex	Women	242	191	433
	Men	124	96	220
Physical Activity	Vigorous	20	13	33
	Moderate	95	62	157
	Light	134	94	228
	Sedentary	117	108	225
Alcohol Type	Wine	96	49	145
	Spirits	42	19	61
	Beer	160	81	241
	None	68	30	98
Smoking Frequency	Sometimes	48	23	71
	Daily	7	2	9
	Never	311	242	553
Sleep Quality	Poor	45	29	74
	Regular	168	124	292
	Good	153	122	275
Vitamin D	Normal	199	36	235
	Low	167	45	212
Type of Job	Healthcare	307	246	553
	Non-Healthcare	59	41	100
Continuous Variables	Age	366	287	653
	Glycated hemoglobin	366	91	457
Dependent Variable	Level of visceral fat	366	283	649