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**RESEARCH ARTICLE** **OPEN ACCESS**

# Excess Body Weight and Physical Activity among Healthcare Workers: An Observational Study in the Primary Healthcare

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**Abstract:**

***Objective:*** This study aimed to evaluate the association between Excess Body Eeight (EBW) and the level of Physical Activity (PA) among healthcare workers.

***Materials and Methods:*** A quantitative observational study was conducted in Callao, Peru. The sample consisted of 333 primary healthcare workers. The PA level was measured using the IPAQ, and EBW was assessed based on the Body Mass Index (BMI).

***Results:*** Of the sample, 69.1% (n=230) presented excess body weight, and 42.3% (n=141) presented insufficient levels of PA. Healthcare workers with EBW had an increased risk of hyperglycemia (OR = 2.8, 95% CI: 1.43–5.46) and diabetes (OR = 4.98, 95% CI: 3.03–8.2). On the other hand, healthcare workers with an insufficient PA had an increased risk of non-compliance in participating in short PA sessions (OR = 2.8, 95% CI: 1.7–4.8), less frequent consumption of fruits and vegetables (OR = 1.6, 95% CI: 1.03–2.5), high blood pressure (OR = 3.7, 95% CI: 1.3–10.9), hyperglycemia (OR = 3.2, 95% CI: 1.9–5.6), and diabetes (OR = 2.4, 95% CI: 1.5–3.9). No significant association was found between EBW and PA (p=0.068, OR=1.56, 95% CI: 0.97–2.52). The regression model explained 13% of the variability in body weight ($F = 12.21$, $p < 0.001$). Sex had the highest standardized coefficient ($\beta = 0.35$, $p < 0.001$).

***Conclusion:*** Approximately seven out of ten healthcare workers had EBW, and four out of ten had insufficient PA. EBW was associated with an increased risk of hyperglycemia and diabetes, while insufficient PA was related to multiple risk factors, including high blood pressure, hyperglycemia, diabetes, lower fruit and vegetable consumption, and low adherence to short PA sessions. Male sex was the most relevant predictor of body weight, although its effect was moderate. These findings highlight the need to promote and reinforce healthy lifestyles among healthcare workers.

**Keywords:** Overweight, Obesity, Exercise, Physical activity, Health personnel, Primary health care, Peru.



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## 1. INTRODUCTION

Non-Communicable Diseases (NCDs) constitute an epidemic responsible for causing the greatest burden of disease worldwide. The NCDs epidemic affects people worldwide, with devastating consequences for the health of individuals, families, and communities. It is also responsible for 74% of global deaths [1]. Of the 41 million adult deaths each year due to NCDs, 5 million are due to

high Body Mass Index (BMI) [2]. The four main NCDs associated with the highest volume of deaths are cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes [1]. More than two-thirds of deaths related to high BMI are due to cardiovascular diseases [3].

Obesity is considered a major public health problem and is ranked as the fifth leading cause of death worldwide. Overweight and obesity are one of the main lifestyle-related diseases that cause significant health issues [4]. Obesity is strongly linked to more than 50 medical conditions. The clinical, social, and economic burdens of obesity are considerable, and these burdens could also affect future generations [5]. A high BMI in adults contributes to or even causes a high incidence of cardiovascular diseases and other conditions, as well as increased mortality rates [4]. Obesity is an independent risk factor for viral infections, such as COVID-19, and for greater complications [6].

Higher levels of obesity are associated with a greater likelihood of using health services and reduced work productivity compared to individuals with normal weight [7]. Overweight and obesity have an impact on the global Gross Domestic Product (GDP), causing a loss of 2.19% worldwide, 0.87% of GDP in low-income countries, and 2.46% in high-income countries [8].

Being overweight or obese is the most important predictor of diabetes [9]. Between 80 and 90% of patients with type 2 diabetes are overweight or obese [10]. For its part, diabetes is associated with a 2- to 3-fold increase in the risk of death from a wide range of diseases [11]. The pooled incidence of diabetes in underweight, normal-weight, and overweight/obese adults is 4.5 (95% CI = 2.8-7.3), 2.7 (95% CI = 2.2-3, 3), and 10.5 (95%CI= 9.3-11.8) per 1,000 person-years, respectively [12]. In women, the relative risk of diabetes is 38.8 for a BMI ≥ 35.0, while the risk for a BMI of 30.0 to 34.9 is 20.1, compared to women with a BMI of less than 23.0 [9].

For its part, Physical Activity (PA) has beneficial physiological effects at both the cellular and systemic levels [13]. There is an association between PA and a lower risk of obesity, coronary heart disease, and diabetes [14]. Health workers have a disproportionately higher risk of overweight and obesity compared to the general population [15]. On the other hand, an adequate level of PA is reported among health professionals [16, 17]. However, unfavorable findings have also been observed, specifically that doctors and nurses show significant deficiencies in PA [18].

In the healthcare setting, 70% of patients are overweight or obese, while nearly 80% of physicians do not engage in enough physical activity [19]. Among nurses, sedentary lifestyles and lack of regular physical activity are the most prevalent risk factors [20]. In the Peruvian context, excess body weight is a concern. In certain occupational groups, such as public transport workers, it exceeds 80% [21]. Healthcare professionals and physicians perceive obesity as a health issue that affects overall well-being and is associated with serious diseases. They also believe they should maintain a healthy weight to serve as role models for their patients [22].

The setting of our study includes primary care health facilities, where excess body weight among health workers is easily noticeable. However, initiatives promoting PA habits have emerged, especially among women, whose positive results in terms of weight reduction have encouraged more health workers to participate. The aim is to evaluate the relationship between physical activity and body weight among healthcare workers at the primary care level. Therefore, the objectives of the present study are: 1) to determine the frequency of excess body weight and the level of physical activity, as well as their associated factors, and 2) to evaluate the association between excess body weight and the level of physical activity among primary care workers.

## 2. MATERIALS AND METHODS

### 2.1. Study Type and Design

The study employed a quantitative, observational, cross-sectional analytical design.

### 2.2. Period and Scope of Study

The study was conducted in the second quarter of 2023. The main study setting was the "*Red de Salud Ventanilla*," which consists of 15 primary healthcare establishments (HHEE), including 4 health centers and 11 health posts, located in the Callao Region, Lima-Peru.

### 2.3. Participants

#### *2.3.1. Study population (N)*

The study population consisted of healthcare workers from the 15 HHEE of the "*Red de Salud Ventanilla*." During the study period, there were 970 healthcare workers. For this study, 6 HHEE were selected based on convenience sampling, considering accessibility and the availability of collaborators.

#### *2.3.2. Sample (n)*

The sample size was calculated using the following formula: n = [EDFF*Np (1-p)]/ [(d2/Z21-α/2*(N-1) + p*(1-p)], where: N= 970 (total population), design effect (EDFF=1), 95% certainty (Z_∝^2= 1.96), expected proportion (p) of 50%, and precision (d) of 5%. The minimum calculated sample size was 276 subjects. However, during the study period, 344 participants were recruited.

#### *2.3.3. Sampling*

A simple random probabilistic sampling technique was used. The selected workers were contacted at their respective workstations, or an opportune time for the interview was arranged with them. The selection process took place during work shifts, both morning and afternoon, from Monday to Saturday. All healthcare workers aged 18 or older from the selected HHEE who voluntarily agreed to participate in the study and provided informed consent were included.

### 2.4. Study Variables

Excess body weight: It is considered a state of abnormal or excessive fat accumulation in adipose tissue, which can be harmful to health [23]. All subjects were considered overweight and obese according to the classification based on Body Mass Index (BMI): underweight (BMI < 18.5), normal (BMI: 18.5-24.99), overweight or pre-obese (BMI: 25.00-29.99), obese class I (BMI: 30.00-34.99), obese class II (BMI: 35.00-39.99) and obese class III (BMI ≥ 40.00) [23]. For bivariate analysis purposes, two new categories were generated: without excess body weight (underweight + normal) and with excess body weight (overweight + obesity).

Physical Activity (PA): PA is defined as any body movement produced by skeletal muscles that requires energy expenditure. The PA can be performed at various intensities and can be accumulated through work, housework, transportation, or during leisure time, or by participating in sporting activities, walking, cycling, active leisure, and active play. Physical inactivity consists of performing insufficient PA to meet current PA recommendations. Sedentary behavior is defined as any waking behavior in a sitting, reclining, or lying position with low energy expenditure [24].

Other variables included in the study: Sociodemographic variables [age, sex, marital status, occupation, pathological history (no/yes), disability (no/yes), food intake at home (no/yes), additional work (no/yes), and active breaks (no/yes)].

The risk of diabetes mellitus was evaluated through the Finnish Diabetes Risk Score (FINDRISC), and state of mind was assessed using the Mood Assessment Scale (EVEA) [25-27]. For the diabetes risk classification, the following ranges of scores were taken into account: low (0-7), slightly high (8-11), moderate (12-14), high (15-20), and very high (≥21 points) [28]. For the analysis, scores from 0 to 7 were considered low risk, and scores greater than 7 were considered increased risk.

The state of mind classification was based on the 25th percentile cut-off point (p25): low mood (<p25) and good mood (≥p25).

### 2.5. Measurement Instruments

Excess body weight: It was determined by estimating the BMI (BMI=Weight/Height2). For weight measurement, a platform scale (Health o meter® with a digital display, a capacity of 250 kg, and a resolution of 100 g) was used. Height was measured using a rigid stadiometer integrated into the scale.

Physical activity: The short version of the International Physical Activity Questionnaire (IPAQ) was used [29]. The IPAQ is the most widely used and validated instrument in several countries. In Peru, both the long and short versions have been applied to students [30-32], patients [33], and workers [34-35]. Due to its simplicity and brevity, we chose to apply the short version.

Based on the IPAQ scoring protocol (short version), continuous results were expressed in MET-min/week = MET score*minutes of activity/day*days of the week. Additionally, the following MET scores were considered: Walking = 3.3 METs, Moderate Intensity = 4.0 METs, and Vigorous Intensity = 8.0 METs. Total MET-minutes/week = Walking (METs*min*days) + Moderate (METs*min*days) + Vigorous (METs*min*days). The discrete results were classified into three categories: Category 1 (Low), Category 2 (Moderate), and Category 3 (High). For the bivariate analysis, two new categories were generated: insufficient physical activity (Low PA) and sufficient physical activity (Moderate PA+ High PA).

### 2.6. Procedures

Data collection was conducted using the survey technique with a virtual questionnaire designed in Google Forms (administered in person or online) and completed via a mobile device. In the in-person survey, the interviewer-administered the entire survey, including anthropometric measurements. For health workers with limited time, the survey staff took the anthropometric measurements and provided a notebook containing the collected data and the survey´s QR code. In these cases, participants were free to complete the online survey at a later time.

The instrument was applied, and anthropometric measurements were taken during June and July 2023. The survey was conducted by nursing students and collaborating technical or professional staff, all of whom were previously trained in handling the questionnaire and taking anthropometric measurements.

### 2.7. Statistical Analysis

The survey generated a self-created database, which was then subjected to a cleaning process based on the study criteria. The univariate analysis was conducted, determining the measures of central tendency and their respective measures of dispersion. For qualitative or categorical variables, absolute and relative frequencies were calculated. For relevant numerical variables, normality tests [Kolmogorov-Smirnov (KS)] were performed.

To assess the association of categorical variables, the Chi-square test was used. The strength of the association was determined using the Odds Ratio (OR) with the corresponding 95% confidence intervals.

To develop a multiple linear regression model, the variables to be included in the model were identified. Body weight was considered the dependent variable, while age, sex, physical activity (total MET), and state of mind were considered independent variables. Before the analysis, compliance with the following assumptions was verified: linearity, independence of errors, homoscedasticity, normality of residuals, and independence of independent variables.

To evaluate linearity, the scatter plots were examined, and the Spearman correlation (KS, $p<0.001$) was also performed: body weight vs. age ($\rho=0.116$, $p=0.035$), body weight vs. total MET ($\rho=0.115$, $p=0.036$), and body weight vs. mood ($\rho=0.013$, $p=0.815$). The independence of the

errors was verified with the Durbin-Watson test (2.042). To evaluate homoscedasticity, the Breusch-Pagan test was used [F=1.368, p>0.245). Verification of the normality of the residuals was carried out with the KS test (p<0.05), and for the independence of the independent variables, the variance inflation factor (VIF~1) was calculated.

For all tests, p<0.05 was considered statistically significant. Statistical analysis was performed using SPSS version 26, with data edited and organized in Microsoft Excel® spreadsheets.

## 3. RESULTS

Out of a total of 344 participants of both sexes, 11 subjects were excluded due to incomplete or inconsistent data. The valid sample consisted of 333 subjects, with a median age of 36 years (Min: 20, Max: 70, IQR= 14, Q1= 30, Q3= 44). Of the sample, 73.3% (n=244) were female, and 63.7% (n=212) were aged between 30 and 49 years. Table (**1**) demonstrates the frequencies of the sample characteristics.

According to BMI, 0.3% (n=1) were thin, 30.6% (n=102) were normal, 45.9% (n=153) were overweight, 18% (n=60) were class I obese, 3.3% (n=11) were class II obese and 1.8% (n=6) were class III obese. Regarding Physical Activity (PA), 42.3% (n=141) had low PA, 30.9% (n=103) had moderate PA, and 26.7% (n=89) had high PA (Table **2**). No significant association was found between excess weight and physical activity (p=0.068, OR=1.56, 95% CI: 0.97 to 2.529) (Table **3**). Healthcare workers with excess body weight had an increased risk of hyperglycemia (OR = 2.8, 95% CI: 1.43–5.46), and diabetes (OR = 4.98, 95% CI: 3.03–8.2) (Table **3**).

**Table 1. Sample characteristics. Excess body weight and physical activity among healthcare workers. Callao, Lima-Peru.**

| Sample Characteristics | n | % |
|---|---|---|
| Total | 333 | 100 |
| **Gender** | | |
| Female | 244 | 73.3 |
| Male | 89 | 26.7 |
| **Age (years)** | | |
| <30 | 68 | 20.4 |
| 30 a 49 | 212 | 63.7 |
| 50 a 59 | 39 | 11.7 |
| 60+ | 14 | 4.2 |
| **Occupation** | | |
| Administrative worker | 70 | 21.0 |
| Nursing technician | 89 | 26.7 |
| Bachelor of Science in Nursing | 44 | 13.2 |
| Physician | 46 | 13.8 |
| Other health care professionals | 25 | 7.5 |
| Other technical assistants | 35 | 10.5 |
| Other | 24 | 7.2 |
| **Marital Status** | | |
| Married | 81 | 24.3 |
| Cohabitant | 79 | 23.7 |
| Divorced | 20 | 6.0 |
| Single | 151 | 45.3 |
| Widowed | 2 | 0.6 |
| **Pathological History** | | |
| No | 293 | 88.0 |
| Yes | 40 | 12.0 |
| **Disability** | | |
| No | 331 | 99.4 |
| Yes | 2 | 0.6 |
| **Food Intake** | | |
| In the home | 253 | 76.0 |
| Outside the home | 80 | 24.0 |
| **Additional work** | | |
| No | 253 | 76.0 |
| Yes | 80 | 24.0 |
| **Active breaks** | | |

*(Table 1) contd.....*

| Sample Characteristics | n | % |
|---|---|---|
| No | 154 | 46.2 |
| Yes | 179 | 53.8 |

**Table 2. Body mass index and level of physical activity among healthcare workers. Callao, Lima-Peru**

| Variables | Total | | Female | | Male | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Total | 333 | 100 | 244 | 100 | 89 | 100 | |
| Body mass index | | | | | | | |
| Underweight | 1 | 0.3 | 0 | 0.0 | 1 | 1.1 | 0.263 |
| Normal | 102 | 30.6 | 82 | 33.6 | 20 | 22.5 | |
| Overweight | 153 | 45.9 | 107 | 43.9 | 46 | 51.7 | |
| Obese class I | 60 | 18.0 | 43 | 17.6 | 17 | 19.1 | |
| Obese class II | 11 | 3.3 | 8 | 3.3 | 3 | 3.4 | |
| Obese class III | 6 | 1.8 | 4 | 1.6 | 2 | 2.2 | |
| Excess body weight** | 230 | 69.1 | 162 | 66.4 | 68 | 76.4 | 0.080 |
| Physical activity level | | | | | | | |
| Low | 141 | 42.3 | 102 | 41.8 | 39 | 43.8 | 0.879 |
| Moderate | 103 | 30.9 | 75 | 30.7 | 28 | 31.5 | |
| High | 89 | 26.7 | 67 | 27.5 | 22 | 24.7 | |

(*) Chi-squared test. (**) Excess body weight = overweight + obesity

**Table 3. Excess body weight and associated variables among healthcare workers. Callao, Lima-Peru.**

| Variables | With Excess Weight | | Without Excess Weight | | p-value | OR | 95%CI |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | | | |
| Total | 230 | 100 | 103 | 100 | | | |
| Sex | | | | | | | |
| Female | 162 | 70.4 | 82 | 79.6 | 0.080 | 0.610 | [0.350 - 1.065] |
| Male | 68 | 29.6 | 21 | 20.4 | | | |
| Age (years) | | | | | | | |
| <30 | 38 | 16.5 | 30 | 29.1 | 0.530 | 0.482 | [0.278 - 0.834] |
| 30 a 49 | 156 | 67.8 | 56 | 54.4 | | | |
| 50 a 59 | 26 | 11.3 | 13 | 12.6 | | | |
| ≥ 60 | 10 | 4.3 | 4 | 3.9 | | | |
| Pathological history | | | | | | | |
| Yes | 25 | 10.9 | 15 | 14.6 | 0.338 | 0.715 | [0.360 - 1.422] |
| No | 205 | 89.1 | 88 | 84.5 | | | |
| Disability | | | | | | | |
| Yes | 2 | 0.9 | 0 | 0 | 0.342 | 1.452 | [1.350 - 1.561] |
| No | 228 | 99.1 | 103 | 100 | | | |
| Additional work | | | | | | | |
| Yes | 58 | 25.2 | 22 | 21.4 | 0.446 | 1.242 | [0.711 - 2.168] |
| No | 172 | 74.8 | 81 | 78.6 | | | |
| Food intake | | | | | | | |
| Outside the home | 57 | 24.8 | 23 | 22.3 | 0.628 | 1.146 | [0.660 - 1.990] |
| In the home | 173 | 75.2 | 80 | 77.7 | | | |
| Active breaks | | | | | | | |
| No | 108 | 47.0 | 46 | 44.7 | 0.698 | 1.097 | [0.688 - 1.750] |
| Yes | 122 | 53.0 | 57 | 55.3 | | | |
| Short-term physical activity | | | | | | | |
| No | 162 | 70.4 | 66 | 64.1 | 0.249 | 1.336 | [0.816 - 2.185] |
| Yes | 68 | 29.6 | 37 | 35.9 | | | |
| Fruit and vegetable consumption | | | | | | | |

*(Table 3) contd.....*

| Variables | With Excess Weight | | Without Excess Weight | | p-value | OR | 95%CI |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | | | |
| Not every day | 90 | 39.1 | 37 | 35.9 | 0.577 | 1.147 | [0.708 - 1.857] |
| Every day | 140 | 60.9 | 66 | 64.1 | | | |
| History of high blood pressure | | | | | | | |
| Yes | 16 | 7.0 | 2 | 1.9 | 0.061 | 3.776 | [0.852 - 16.735] |
| No | 214 | 93.0 | 101 | 98.1 | | | |
| Hyperglycemia | | | | | | | |
| Yes | 62 | 27.0 | 12 | 11.7 | 0.002 | 2.799 | [1.434 - 5.462] |
| No | 168 | 73.0 | 91 | 88.3 | | | |
| Family history of diabetes | | | | | | | |
| Yes | 94 | 40.9 | 37 | 35.9 | 0.393 | 1.233 | [0.762 - 1.994] |
| No | 136 | 59.1 | 66 | 64.1 | | | |
| Physical activity level (IPAQ) | | | | | | | |
| Low | 105 | 45.7 | 36 | 35.0 | 0.068 | 1.563 | [0.966 - 2.529] |
| Adequate | 125 | 54.3 | 67 | 65.0 | | | |
| Diabetes risk | | | | | | | |
| Increased | 173 | 75.2 | 39 | 37.9 | <0.001 | 4.981 | [3.027 - 8.196] |
| Low | 57 | 24.8 | 64 | 62.1 | | | |
| State of mind | | | | | | | |
| Low | 50 | 21.7 | 26 | 25.2 | 0.481 | 0.823 | [0.478 - 1.417] |
| Good | 180 | 78.3 | 77 | 74.8 | | | |

Healthcare workers with insufficient Physical Activity (PA) had an increased risk of non-compliance in participating in short PA sessions (OR = 2.8, 95% CI: 1.7–4.8), less frequent consumption of fruits and vegetables (OR = 1.6, 95% CI: 1.03–2.5), high blood pressure (OR = 3.7, 95% CI: 1.3–10.9), hyperglycemia (OR = 3.2, 95% CI: 1.9–5.6), and diabetes (OR = 2.4, 95% CI: 1.5–3.9) (Table **4**).

Table **1**. Sample characteristics. Excess body weight and physical activity among healthcare workers. Callao, Lima-Peru.

The ANOVA test for the regression model proposed was significant, explaining 13% of the variability in body weight (F= 12.206, p<0.001) (Table **5**).

Sex had the highest standardized coefficient (β = 0.35, p < 0.001). This indicates that being male was the most relevant predictor of body weight, although its effect was moderate (Table **5**).

**Table 4. Physical activity level (IPAQ) and associated variables among healthcare workers. Callao, Lima- Peru.**

| Variables | Insufficient PA | | Sufficient PA | | p-value* | OR | 95%CI |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | | | |
| Total | 141 | 100 | 192 | 100 | | | |
| **Sex** | | | | | | | |
| Female | 102 | 72.3 | 142 | 74 | 0.742 | 0.921 | 0.564 - 1.503 |
| Male | 39 | 27.7 | 50 | 26 | | | |
| **Age (years)** | | | | | | | |
| <30 | 21 | 14.9 | 47 | 24.5 | 0.093 | 0.540 | 0.306 - 0.953 |
| 30 a 49 | 97 | 68.8 | 115 | 59.9 | | | |
| 50 a 59 | 19 | 13.5 | 20 | 10.4 | | | |
| ≥ 60 | 4 | 2.8 | 10 | 5.2 | | | |
| **Pathological history** | | | | | | | |
| Yes | 18 | 12.8 | 22 | 11.5 | 0.717 | 1.131 | 0.582 - 2.198 |
| No | 123 | 87.2 | 170 | 88.5 | | | |
| **Disability** | | | | | | | |
| Yes | 1 | 0.7 | 1 | 0.5 | 0.826 | 1.364 | 0.085 - 21.999 |
| No | 140 | 99.3 | 191 | 99.5 | | | |
| **Additional Work** | | | | | | | |
| Yes | 31 | 22 | 49 | 25.5 | 0.456 | 0.822 | 0.492 - 1.375 |
| No | 110 | 78 | 143 | 74.5 | | | |

*(Table 4) contd.....*

| Variables | Insufficient PA | | Sufficient PA | | p-value* | OR | 95%CI |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | | | |
| **Food Intake** | | | | | | | |
| Outside the home | 34 | 24.1 | 46 | 24 | 0.974 | 1.009 | 0.606 - 1.677 |
| In the home | 107 | 75.9 | 146 | 76 | | | |
| **Active Breaks** | | | | | | | |
| No | 73 | 51.8 | 81 | 42.2 | 0.083 | 1.471 | 0.950 - 2.278 |
| Yes | 68 | 48.2 | 111 | 57.8 | | | |
| **Short-term Physical Activity** | | | | | | | |
| No | 114 | 80.9 | 114 | 59.4 | <0.001 | 2.889 | 1.737 - 4.805 |
| Yes | 27 | 19.1 | 78 | 40.6 | | | |
| **Fruit and Vegetable Consumption** | | | | | | | |
| Not every day | 63 | 44.7 | 64 | 33.3 | 0.035 | 1.615 | 1.033 - 2.527 |
| Every day | 78 | 55.3 | 128 | 66.7 | | | |
| **History of High Blood Pressure** | | | | | | | |
| Yes | 13 | 9.2 | 5 | 2.6 | 0.008 | 3.798 | 1.322 - 10.916 |
| No | 128 | 90.8 | 187 | 97.4 | | | |
| **Hyperglycemia** | | | | | | | |
| Yes | 48 | 34 | 26 | 13.5 | <0.001 | 3.295 | 1.919 - 5.658 |
| No | 93 | 66 | 166 | 86.5 | | | |
| **Family History of Diabetes** | | | | | | | |
| Yes | 62 | 44 | 69 | 35.9 | 0.138 | 1.399 | 0.897 - 2.182 |
| No | 79 | 56 | 123 | 64.1 | | | |
| **Diabetes Risk** | | | | | | | |
| Increased | 106 | 75.2 | 106 | 55.2 | <0.001 | 2.457 | 1.526 - 3.956 |
| Low | 35 | 24.8 | 86 | 44.8 | | | |
| **State of Mind** | | | | | | | |
| Low | 21 | 14.9 | 55 | 28.6 | 0.003 | 0.436 | 0.249 - 0.763 |
| Good | 120 | 85.1 | 137 | 71.4 | | | |

(*) PA: Physical Activity, Chi-squared test, OR: Odds Ratio.

**Table 5. Results of the multiple linear regression model in healthcare workers. Callao, Lima-Peru.**

| Independent Variables | B | Standard Rrror | β | t | p-value | 95%CI | Tolerance | VIF |
|---|---|---|---|---|---|---|---|---|
| Constant | 62.035 | 3.088 | _ | 20.088 | <0.001 | [55.960 - 68.110] | | |
| Age | 0.104 | 0.068 | 0.081 | 1.542 | 0.124 | [-0.029 - 0.237] | 0.969 | 1.032 |
| Sex | 10.379 | 1.520 | 0.352 | 6.830 | <0.001 | [7.390 - 13.369] | 0.997 | 1.003 |
| Physical activity | -9.406E-05 | <0.001 | -0.020 | -0.375 | 0.708 | [-0.001 - 0.000] | 0.946 | 1.057 |
| State of mind | 0.028 | 0.094 | 0.016 | 0.300 | 0.765 | [-0.157 - 0.213] | 0.952 | 1.050 |

* $R^2$=0.130; $R^2$ adjusted = 0.119; F (4, 328) = 12.206, p < 0.001, VIF: variance inflation factor.
* Physical activity expressed in total METs.

## 4. DISCUSSION

The objectives of this study were to evaluate the frequency of excess body weight, the level of physical activity, and their respective associated factors. Moreover, this study aimed to evaluate the association between excess body weight and the level of physical activity among healthcare workers.

In relation to body weight, more than 69% of the workers had excess body weight, which means that 7 out of 10 workers were overweight or obese, regardless of sex. Regarding physical activity, 42.3% (4 out of 10) of the healthcare workers had a low level of PA. No significant association was found between physical activity and excess body weight among workers. In this study, the proportion of excess body weight in healthcare workers was higher compared to that of the Peruvian population aged 15 years and older, which is 63.1% [36]. This study also supports the claim that healthcare workers have a disproportionately higher risk of overweight and obesity compared to the general population [15]. Our study is also consistent with findings from other studies, which indicate that health professionals, particularly physicians and nurses, do not engage in adequate levels of physical activity [18-20].

In the present study, overweight health professionals had nearly three times the risk of hyperglycemia (OR = 2.8; 95% CI: 1.43–5.46) and almost five times the risk of diabetes (OR = 4.98; 95% CI: 3.03–8.2). By “risk of diabetes,”’ we refer to obtaining a higher FINDRISC score

rather than the disease itself. The higher the score, the greater the risk of diabetes.

Excess body weight is recognized as the most important predictor of diabetes [9-10]. Hyperglycemia is the expression of decreased insulin sensitivity due to a reduction in the functional mass of pancreatic B cells, with excess weight being a powerful driver in its development and progression. Many patients with obesity may go through a transitional stage ("Prediabetes") before developing hyperglycemia. On the other hand, 2/3 of patients with DM2 had bodyweight problems [37].

The overall Relative Risk (RR) of diabetes for obese people compared to those with normal weight was 7.19 (95% CI: 5.74- 9.0), and for overweight was 2.99 (95% CI: 2.42- 3.72) [38]. BMI was the dominant predictor of diabetes mellitus risk. The RR of diabetes mellitus among women who gained 5.0 to 7.9 kg was estimated at 1.9 (95% CI: 1.5 - 2.3) and the RR for women gaining 8.0 to 10.9 kg was 2.7 (CI: 2.1 - 3.3). Conversely, women who lost more than 5.0 kg reduced the risk of diabetes mellitus by 50% or more [39].

Another variable in our study was physical activity. Health professionals with insufficient PA had approximately three times the risk (OR = 2.8; 95% CI: 1.7–4.8) of non-compliance with short PA sessions, nearly twice the probability of lower fruit and vegetable consumption (OR = 1.6; 95% CI: 1.03–2.5), almost four times the risk of high blood pressure (OR = 3.7; 95% CI: 1.3–10.9), three times the risk of hyperglycemia (OR = 3.2; 95% CI: 1.9–5.6), and twice the risk of diabetes (OR = 2.4; 95% CI: 1.5–3.9).

Short but frequent bouts of light activity throughout the day reduce postprandial glucose (-17.5%; 95% CI -26.2 to -8.7) and insulin levels (-25.1%; 95% CI -31.8 to -18.3) compared to continuous sitting [40]. However, the goal is to eliminate sedentary behavior. Light PA can help create positive experiences, which may pave the way for greater future participation [41].

In older adults in China, a higher intake of vegetables (≥10 servings/day) was associated with a greater likelihood of performing vigorous and moderate levels of PA compared with a lower intake (≤ 4 servings/day). However, a higher intake of fruit was associated with a lower likelihood of performing vigorous PA compared with no intake [42]. In Brazil, a similar finding was observed: low levels of PA were associated with inadequate intake of fruits and vegetables among adolescents [43].

In our study, it is likely that workers who had experienced hyperglycemia or were at risk of diabetes were more aware of the potential future health consequences, which may have motivated them to increase PA and adopt other healthy habits, such as fruit and vegetable consumption. Similarly, PA initiatives, especially among women, may have encouraged other workers to engage in more PA and adopt additional healthy habits. It is well known that PA can improve glucose control in patients with diabetes. Physically active patients with diabetes are 2.4 times more likely to have a controlled blood glucose level compared to physically inactive patients with diabetes (OR = 2.4, 95% CI = 1.57, 3.69) [44]. PA also has beneficial effects on glycemic control in people with prediabetes [45].

In the present study, the ANOVA test for the regression model was significant, explaining 13% of the variability in body weight ($F= 12.21$, $p<0.001$). Sex had the highest standardized coefficient ($\beta = 0.352$, $p < 0.001$), indicating that it accounted for the greatest variability in workers' body weight. In our study, compared to females, males were associated with a significant increase in body weight.

This finding aligns with the PA adherence initiative observed among females. However, it contradicts other studies, as discussed below.

In the United States, among women of reproductive age, low baseline PA was significantly associated with a twofold increase in the odds of transitioning from a normal BMI to overweight/obesity (OR= 2.11, 95% CI: 1.06 - 4.2) [46]. In India, women are more likely than men to be overweight (OR: 2.18; CI: 1.86, 2.55) and obese (OR: 3.79; CI: 2.86, 5.03). However, among both older men and women, those with a high educational level are 2.29 times (OR: 2.29; CI: 1.0, 4.11) and 2.71 times (OR: 2.71; CI: 1.78, 4.11) more likely, respectively, to be overweight. Similarly, highly educated men and women are 2.64 times (OR: 2.64; CI: 1.71, 4.09) and 2.94 times (OR: 2.94; CI: 1.40, 6.2) more likely, respectively, to be obese [47]. The risk of being overweight (RR=5.28, CI 4.787-5.816) and obese (RR=12.31, CI: 10.163-14.904) is higher among older women (≥35 years) compared to the reference group (15-24 years) [48].

In this study, a high frequency of overweight healthcare workers with insufficient physical activity was observed. The body weight of the workers was not associated with their level of physical activity; however, several components included in the FINDRISC were associated with excess weight and insufficient physical activity. In the proposed model, male sex was associated with a significant increase in body weight, which could be related to the physical activity initiative among women and the tendency for female health workers to encourage their peers of the same sex to participate in gym-based or equivalent activities.

Additionally, there are indications of the adoption of healthy eating habits, and the exploration of alternative medicine approaches to regain or maintain an ideal feminine appearance. Women are generally less likely to engage in moderate or vigorous physical activity [49]. In a study conducted in Lima among gym users, body image perception was primarily characterized by the presence of excess body weight [50].

The following limitations and strengths should be considered in this study: Among the limitations, six healthcare facilities were selected using a convenience sampling method. Additionally, the number of participants from each facility was not proportional to the total number of workers, with two facilities having a higher proportion

of participants. Although the personnel responsible for measuring anthropometric parameters followed national guidelines, some workers did not complete the survey on-site. In these cases, anthropometric data were provided either via WhatsApp text messages or in physical format to be completed later, which may have led to potential alterations. Lastly, both the data corresponding to the FINDRISC components and physical activity, which were used to determine the risk of diabetes, and the level of physical activity based on the IPAQ protocol correspond to the data provided by the participants. Despite these limitations, the study presents important findings on an issue that affects not only the primary care setting but also healthcare workers in general.

## CONCLUSION

Excess body weight and insufficient physical activity are prevalent issues among healthcare workers. Approximately seven out of ten healthcare workers had EBW, and four out of ten had insufficient PA. EBW was associated with an increased risk of hyperglycemia and diabetes, while insufficient PA was related to multiple risk factors, including high blood pressure, hyperglycemia, diabetes, lower fruit and vegetable consumption, and low adherence to short PA sessions. Male sex was the most relevant predictor of body weight, although its effect was moderate.

It is important to give proper attention to a problem that negatively impacts the health of the workers. Therefore, adherence to regular physical activity and healthy eating, along with other alternatives, represents a significant challenge in the healthcare work environment.

A noteworthy aspect is the initiative taken by women to engage in physical activity and the subsequent adherence of other healthcare workers to this habit, along with other healthy lifestyle practices. These findings can serve as a basis for exploring the key motivations behind the adoption of healthy lifestyles.

## AUTHORS' CONTRIBUTION

The authors confirm their contributions to the paper as follows: MIACM, ANLH, MACA, ETR, and PRAB contributed to the study conception and design, data collection, analysis, and interpretation of results. JM performed the statistical analysis, interpreted the results, and drafted the manuscript.All authors have reviewed the results and approved the final version of the manuscript.

## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| NCD | = | Non-Communicable Diseases |
| Ebw | = | Excess Body Weight |
| Pa | = | Physical Activity |
| Ipaq | = | International Physical Activity Questionnaire |
| Met | = | Metabolic Equivalent |
| Hbp | = | High Blood Pressure |
| DM | = | Diabetes Mellitus |
| FINDRISC | = | Finnish Diabetes Risk Score |
| EVEA | = | Mood Assessment Scale |
| GDP | = | Gross Domestic Product |
| HHEE | = | Healthcare Establishments |
| Q1 | = | 25th Percentile |
| Q3 | = | 75th Percentile |
| IQR | = | Interquartile Range |
| OR | = | Odds Ratio |
| 95%CI | = | 95% Confidence Interval |
| VIF | = | Variance Inflation Factor |

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The research protocol was evaluated and approved by the Ethics Committee of the University of Sciences and Humanities Lima, Peru (*Act* CEI No. 057, Code: 060-23).

## HUMAN AND ANIMAL RIGHTS

All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committees and with the 1975 Declaration of Helsinki, as revised in 2013.

## CONSENT FOR PUBLICATION

Informed consent was obtained from all participants of this study.

## STANDARD OF REPORTING

STROBE guidelines were followed.

## AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author [J.M.] on special request. The database is also available at: https://doi.org/10.5281/zenodo.14989151.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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## REFERENCES

[1] Monitoring health for the SDGs, sustainable development goals 2023.
[2] World obesity atlas 2024. Obesity and its consequences 2024.
[3] Afshin A, Forouzanfar MH, Reitsma MB, *et al*. Health effects of overweight and obesity in 195 countries over 25 years. N Engl J Med 2017; 377(1): 13-27.

http://dx.doi.org/10.1056/NEJMoa1614362 PMID: 28604169
[4] Safaei M, Sundararajan EA, Driss M, Boulila W, Shapi'i A. A systematic literature review on obesity: Understanding the causes & consequences of obesity and reviewing various machine learning approaches used to predict obesity. Comput Biol Med 2021; 136(September): 104754. http://dx.doi.org/10.1016/j.compbiomed.2021.104754 PMID: 34426171
[5] Lam BCC, Lim AYL, Chan SL, Yum MPS, Koh NSY, Finkelstein EA. The impact of obesity: A narrative review. Singapore Med J 2023; 64(3): 163-71. http://dx.doi.org/10.4103/singaporemedj.SMJ-2022-232 PMID: 36876622
[6] Bhattacharya I, Ghayor C, Dominguez PA, Weber FE. From influenza virus to novel corona virus (SARS-CoV-2)–the contribution of obesity. Front Endocrinol (Lausanne) 2020; 11(October): 556962. http://dx.doi.org/10.3389/fendo.2020.556962 PMID: 33123087
[7] Ishida M, D'Souza M, Zhao Y, *et al*. Author Correction: The association between obesity, health service use, and work productivity in Australia: A cross-sectional quantile regression analysis. Sci Rep 2023; 13(1): 8839. http://dx.doi.org/10.1038/s41598-023-35911-0 PMID: 37258619
[8] Okunogbe A, Nugent R, Spencer G, Powis J, Ralston J, Wilding J. Economic impacts of overweight and obesity: Current and future estimates for 161 countries. BMJ Glob Health 2022; 7(9): e009773. http://dx.doi.org/10.1136/bmjgh-2022-009773 PMID: 36130777
[9] Hu FB, Manson JE, Stampfer MJ, *et al*. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. N Engl J Med 2001; 345(11): 790-7. http://dx.doi.org/10.1056/NEJMoa010492 PMID: 11556298
[10] Nianogo RA, Arah OA. Forecasting obesity and type 2 diabetes incidence and burden: The vila-obesity simulation model. Front Public Health 2022; 10: 818816. http://dx.doi.org/10.3389/fpubh.2022.818816
[11] Yang JJ, Yu D, Wen W, *et al*. Association of diabetes with all-cause and cause-specific mortality in asia. JAMA Netw Open 2019; 2(4): e192696. http://dx.doi.org/10.1001/jamanetworkopen.2019.2696 PMID: 31002328
[12] Yu H, Ho M, Liu X, Yang J, Chau PH, Fong DYT. Incidence and temporal trends in type 2 diabetes by weight status: A systematic review and meta-analysis of prospective cohort studies. J Glob Health 2023; 13: 04088. http://dx.doi.org/10.7189/jogh.13.04088
[13] Pojednic R, D'Arpino E, Halliday I, Bantham A. The benefits of physical activity for people with obesity, independent of weight loss: A systematic review. Int J Environ Res Public Health 2022; 19(9): 4981. http://dx.doi.org/10.3390/ijerph19094981 PMID: 35564376
[14] Cleven L, Krell-Roesch J, Nigg CR, Woll A. The association between physical activity with incident obesity, coronary heart disease, diabetes and hypertension in adults: A systematic review of longitudinal studies published after 2012. BMC Public Health 2020; 20(1): 726. http://dx.doi.org/10.1186/s12889-020-08715-4 PMID: 32429951
[15] Mohanty A, Kabi A, Mohanty A. Health problems in healthcare workers: A review. J Family Med Prim Care 2019; 8(8): 2568-72. http://dx.doi.org/10.4103/jfmpc.jfmpc_431_19 PMID: 31548933
[16] Marques-Sule E, Miró-Ferrer S, Muñoz-Gómez E, *et al*. Physical activity in health care professionals as a means of primary prevention of cardiovascular disease. Medicine 2021; 100(22): e26184. http://dx.doi.org/10.1097/MD.0000000000026184 PMID: 34087883
[17] Nnadozie UU, Anekwu EM, Asouzu NC, *et al*. Physical activity among healthcare workers in a major tertiary hospital. West Afr J Med 2023; 40(1): 72-7. PMID: 36716489
[18] George L, Lais H, Chacko M, Retnakumar C, Krishnapillai V. Motivators and barriers for physical activity among health-care professionals: A qualitative study. Indian J Community Med 2021; 46(1): 66-9. http://dx.doi.org/10.4103/ijcm.IJCM_200_20 PMID: 34035579
[19] Sabgir D, Dorn J. Walk with a doc—a call to action for physician-led walking programs. Curr Cardiol Rep 2020; 22(7): 44. http://dx.doi.org/10.1007/s11886-020-01297-y PMID: 32561999
[20] Khani S, Rafiei S, Ghashghaee A, *et al*. Cardiovascular risk factors among nurses: A global systematic review and meta-analysis. PLoS One 2024; 19(3): e0286245. http://dx.doi.org/10.1371/journal.pone.0286245 PMID: 38512844
[21] Quichua L, Trejo DC, Basilio MR, Morales J. Overweight and obesity among workers of the public transportation service of lima. Open Public Health J 2021; 14(1): 154-9. http://dx.doi.org/10.2174/1874944502114010154
[22] Khamseh ME, Emami Z, Iranpour A, *et al*. Attitude and belief of healthcare professionals towards effective obesity care and perception of barriers; an updated systematic review and meta-analysis. Arch Iran Med 2023; 26(9): 529-41. http://dx.doi.org/10.34172/aim.2023.78 PMID: 38310408
[23] Obesity: Preventing and managing the global epidemic. WHO Technical Report Series 2000.
[24] Global status report on physical activity 2022 2022. Available from: https://www.who.int/teams/health-promotion/physical-activity/global-status-report-on-physical-activity-2022
[25] Lindström J, Tuomilehto J. The diabetes risk score: A practical tool to predict type 2 diabetes risk. Diabetes Care 2003; 26(3): 725-31. http://dx.doi.org/10.2337/diacare.26.3.725 PMID: 12610029
[26] Bernabe-Ortiz A, Perel P, Miranda JJ, Smeeth L. Diagnostic accuracy of the finnish diabetes risk score (FINDRISC) for undiagnosed T2DM in peruvian population. Prim Care Diabetes 2018; 12(6): 517-25. http://dx.doi.org/10.1016/j.pcd.2018.07.015 PMID: 30131300
[27] Fernández Sanz. An instrument to evaluate the effectiveness of mood induction procedures: The "Mood Assessment Scale" (EVEA). Anal Modif Behavior 2001; 27(111): 71-110.
[28] Golfetto S, Núñez O, Peña M, *et al*. Risk of developing type 2 diabetes according to LA FINDRISC and peripheral arterial disease. Postgrad Dig Mag 2020; 9(2): e208. http://dx.doi.org/10.37910/RDP.2020.9.2.e208
[29] IPAQ. Guidelines for data processing and analysis of the international physical activity questionnaire (IPAQ) – short and long forms. 2005. Available from: https://sites.google.com/view/ipaq/score
[30] Quispe JM, Ramos RJ, Oré SCA. [Level of physical activity among adolescents in a district of the Callao region]. Rev Peru Med Exp Salud Publica 2016; 33(3): 471-7. http://dx.doi.org/10.17843/rpmesp.2016.333.2312 PMID: 27831610
[31] Barrionuevo-Victorio V, Coronado-Llerena AME, Asencios-Celiz RJ, Tapia-Cruz CV, Molina-Escalante LE, Morales J. Level of physical activity in university students from the north of lima city. Peruvian J Heal Care Glob Heal 2021; 5(1): 6-12. http://dx.doi.org/10.22258/hgh.2021.51.89
[32] Janampa-Apaza A, Pérez-Mori T, Benites L, *et al*. Physical activity and sedentary behavior in medical students at a Peruvian public university. Medwave 2021; 21(5): e8210. http://dx.doi.org/10.5867/medwave.2021.05.8210 PMID: 34214068
[33] Morales J, Carcausto W, Varillas Y, Pérez J, Salsavilca E. Physical activity in patients with diabetes mellitus in primary care in North Lima Rev Latinoam Hipertens 2018; 13(1): 1-9.
[34] Villanueva F, Hurtado E, Palomino Y. Physical activity among public transport workers in smaller motorized vehicles of North Lima. Heal Care Glob Heal 2019; 3(1): 35-8. http://dx.doi.org/10.22258/ hgh.2019.31.53
[35] Sanabria-Rojas H, Tarqui-Mamani C, Portugal-Benavides W, Pereyra-Zaldívar H, Mamani-Castillo L. [The physical activity level

of people working at a regional health office in Lima, Peru]. Rev Salud Publica 2014; 16(1): 53-62.
http://dx.doi.org/10.15446/rsap.v16n1.38672 PMID: 25184452

[36] National institute of statistics and informatics. non-communicable and communicable diseases. 2023. Available from: https://proyectos.inei.gob.pe/endes/2022/salud/enfermedades_endes_2022.pdf

[37] Ruze R, Liu T, Zou X, Song J, Chen Y, Xu R. Obesity and type 2 diabetes mellitus: Connections in epidemiology, pathogenesis, and treatments. Front Endocrinol 2023; 14: 1161521.
http://dx.doi.org/10.3389/fendo.2023.1161521

[38] Abdullah A, Peeters A, Courten DM, Stoelwinder J. The magnitude of association between overweight and obesity and the risk of diabetes: A meta-analysis of prospective cohort studies. Diabetes Res Clin Pract 2010; 89(3): 309-19.
http://dx.doi.org/10.1016/j.diabres.2010.04.012 PMID: 20493574

[39] Colditz GA, Willett WC, Rotnitzky A, Manson JE. Weight gain as a risk factor for clinical diabetes mellitus in women. Ann Intern Med 1995; 122(7): 481-6.
http://dx.doi.org/10.7326/0003-4819-122-7-199504010-00001 PMID: 7872581

[40] Chastin SFM, Craemer DM, Cocker DK, *et al*. How does light-intensity physical activity associate with adult cardiometabolic health and mortality? Systematic review with meta-analysis of experimental and observational studies. Br J Sports Med 2019; 53(6): 370-6.
http://dx.doi.org/10.1136/bjsports-2017-097563 PMID: 29695511

[41] Telford DM, Meiring RM, Gusso S. Moving beyond moderate-to-vigorous physical activity: The role of light physical activity during adolescence. Front Sports Act Living 2023; 5: 1282482.
http://dx.doi.org/10.3389/fspor.2023.1282482

[42] Guan M. Associations of fruit & vegetable intake and physical activity with poor self-rated health among Chinese older adults. BMC Geriatr 2022; 22(1): 10.
http://dx.doi.org/10.1186/s12877-021-02709-6 PMID: 34979973

[43] Silva DAS, Silva RJDS. [Association between physical activity level and consumption of fruit and vegetables among adolescents in northeast Brazil]. Rev Paul Pediatr 2015; 33(2): 167-73.
http://dx.doi.org/10.1016/j.rpped.2014.09.003 PMID: 25887930

[44] Asfaw MS, Dagne WK. Physical activity can improve diabetes patients' glucose control; A systematic review and meta-analysis. Heliyon 2022; 8(12): e12267.
http://dx.doi.org/10.1016/j.heliyon.2022.e12267 PMID: 36578408

[45] Zhang H, Guo Y, Hua G, *et al*. Exercise training modalities in prediabetes: A systematic review and network meta-analysis. Front Endocrinol 2024; 15(15): 1308959.
http://dx.doi.org/10.3389/fendo.2024.1308959 PMID: 38440785

[46] Hillemeier MM, Weisman CS, Chuang C, Downs DS, McCall-Hosenfeld J, Camacho F. Transition to overweight or obesity among women of reproductive age. J Womens Health 2011; 20(5): 703-10.
http://dx.doi.org/10.1089/jwh.2010.2397 PMID: 21599427

[47] Saha A, Mandal B, Muhammad T, Barman P, Ahmed W. RETRACTED ARTICLE: Gender-specific determinants of overweight and obesity among older adults in India: Evidence from a cross-sectional survey, 2017-18. BMC Public Health 2023; 23(1): 2313.
http://dx.doi.org/10.1186/s12889-023-17156-8 PMID: 37993827

[48] Gouda J, Prusty RK. Overweight and obesity among women by economic stratum in urban India. J Health Popul Nutr 2014; 32(1): 79-88.
PMID: 24847596

[49] Mlangeni L, Makola L, Naidoo I, *et al*. Factors associated with physical activity in south africa: Evidence from a national population based survey. Open Public Health J 2018; 11(1): 516-25.
http://dx.doi.org/10.2174/1874944501811010516

[50] Huamani-Huaracca AA, Zela-Garcia MN, Rojas-Villarreal MM, Quinteros-Domínguez FDM, Flores-Hiyo AM, Morales J. Muscle dysmorphia and satisfaction with body image among gym users in lima. Inter J Human Mov Sports Sci 2024; 12(5): 759-68.
http://dx.doi.org/10.13189/saj.2024.120501