# How do physical activity, physical self-concept and sleep habits influence Spanish university students according to their body mass index?

*¿Cómo influye la actividad física, el autoconcepto físico y los hábitos de sueño en los estudiantes universitarios españoles en función de su índice de masa corporal?*


## Authors

Daniel Sanz-Martín [1]
José Luis Ubago-Jiménez [2]
José Manuel Alonso-Vargas [2]
Eduardo Melguizo-Ibáñez [3]

[1] Universidad Isabel I (Spain)
[2] Universidad de Granada (Spain)
[3] Universidad de La Laguna (Spain)

Corresponding author:
José Luis Ubago-Jiménez
jlubago@ugr.es



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## Abstract

Introduction: University students are exposed to lifestyle changes that may negatively affect their physical and psychological health.
Objectives: 1) To identify the levels of body mass index, vigorous physical activity, physical self-concept, and sleep quality among Spanish university students; 2) To analyse the relationships between body mass index and vigorous physical activity, physical self-concept, and sleep quality among university students; 3) To compare the profiles of healthy habits among university students according to body mass index categories.
Methodology: The cross-sectional study involved a representative sample of Spanish university students (mean age = 28.12 ± 10.36 years) who responded to the IPAQ-SF, AF-5, and PSQI questionnaires.
Results: The adjustment of the theoretical model proposed to explain the relationships between the variables in the study was: CFI = 0.915, NFI = 0.901, IFI = 0.920 and RMSEA = 0.088. Students can be classified according to levels of vigorous physical activity, physical self-concept, sleep quality, and age according to the body mass index categories (MANOVA: Pillai's trace = 0.119; $p = 0.007$; $\beta = 1$; $\eta^2p = 0.04$).
Discussion: More than 25% of the participants were classified as overweight or obese. This percentage is higher than those found in previous studies.
Conclusion: The findings highlight the multidimensional relationship between physical, behavioural, and psychological health factors in university students. Higher body mass index levels are associated with poorer sleep quality and lower physical self-concept, whereas vigorous physical activity appears to play a protective role.



## Keywords

Health; profiles; sleep quality; vigorous physical activity; weight.



## Resumen

Introducción: Los estudiantes universitarios se enfrentan a cambios en su estilo de vida que pueden afectar negativamente a su salud física y psicológica.
Objetivos: 1) Identificar los niveles de índice de masa corporal, actividad física vigorosa, autoconcepto físico y calidad del sueño entre los estudiantes universitarios españoles; 2) Analizar las relaciones entre el índice de masa corporal y la actividad física vigorosa, el autoconcepto físico y la calidad del sueño entre los estudiantes universitarios; 3) Comparar los perfiles de hábitos saludables entre los estudiantes universitarios según las categorías de índice de masa corporal.
Metodología: El estudio transversal contó con una muestra representativa de estudiantes universitarios españoles (edad media = 28,12 ± 10,36 años) que respondieron a los cuestionarios IPAQ-SF, AF-5 y PSQI.
Resultados: El ajuste del modelo teórico propuesto para explicar las relaciones entre las variables del estudio fue: CFI = 0,915, NFI = 0,901, IFI = 0,920 y RMSEA = 0,088. Los estudiantes pueden clasificarse según los niveles de actividad física vigorosa, el autoconcepto físico, la calidad del sueño y la edad, respetando las categorías de índice de masa corporal (MANOVA: traza de Pillai = 0,119; $p = 0,007$; $\beta = 1$; $\eta^2p = 0,04$).
Discusión: Más del 25 % de los participantes fueron clasificados como con sobrepeso u obesos. Este porcentaje es superior al observado en estudios previos.
Conclusión: Los resultados ponen de relieve la relación multidimensional entre los factores de salud física, conductual y psicológica en los estudiantes universitarios. Un índice de masa corporal más elevado se asocia con una peor calidad del sueño y una menor autoestima física, mientras que la actividad física intensa parece desempeñar un papel protector.



## Palabras clave

Salud; perfiles; calidad del sueño; actividad física vigorosa; peso.

## Introduction

Today, abnormal body weight (underweight, overweight and obesity) is one of the major public health concerns (Feijoo et al., 2024; Salamero et al., 2022; Uzogara, 2016) because of this relationship with multiple physical and psychological health problems (Chen et al., 2015; Gu et al., 2009; Li et al., 2022), as well as its growing economic burden (Hernáez et al., 2019). Worldwide, 43% of adults were overweight and 16% were obese in 2022 (NCD Risk Factor Collaboration, 2024), whereas in Spain these percentages are 37.1% and 18.7% in 2020, respectively (Spanish Food Safety and Nutrition Agency et al., 2023). Moreover, the obesity rate among Spaniards aged 15 to 24 continued to rise in 2020 (Feijoo et al., 2024).

The study of body weight issues is particularly complex because it is influenced by numerous interrelated variables (Lin & Li, 2021), including sex, age-related changes and lifestyle habits, such as physical activity and sleep quality (Hernáez et al., 2019; Hernández-Segura et al., 2023; Sandri et al., 2025). In Spain, women show higher rates of underweight and normal weight whereas men present higher levels of overweight. In addition, Hernáez et al. (2019) state that the BMI of overweight Spanish adults increases by 0.10 kg/m2/year in men and 0.26 kg/m2/year in women. Moreover, body mass index of university students is negatively correlated with physical activity (Gamarra et al., 2021) and sleep quality (Xu et al., 2025). Similarly, sleep quality is also negatively related to moderate-vigorous physical activity (Memon et al., 2021). Likewise, active people not only have better BMI levels, but also a better overall self-concept (Babic et al., 2014), although there is no clear trend as to whether the relationship is direct (Onetti-Onetti et al., 2019), or indirect (Fernández-Bustos et al., 2025).

Based on the above discussion of the relationships between body mass index, physical activity, sleep quality and self-concept, the evidence suggests that these variables should be considered as an interconnected network of relationships for each specific population group which have a synergistic effect on health (Alosaimi et al., 2023; Duncan et al., 2023). In this context, the structural equation modelling approach provides a suitable framework for analysing these complex relationships, as it allows for the simultaneous estimation of multiple pathways of interaction between health-related variables, whilst taking into account their interdependence (Zyphur et al., 2023).

According to Sanz-Martín et al. (2023), research on healthy habits should identify profiles by groups or clusters, which would allow for more effective improvement proposals. This research should focus on studying the relationships between BMI and sleep quality (Fernández-Bustos et al., 2019; Ka et al., 2025) and between the latter and physical activity (Memon et al., 2021), with particular emphasis on vigorous intensity activity due to its potential success in clinical treatment (Kawinchotpaisan et al., 2025; Videira-Silva et al., 2023). In addition, other psychological variables, such as self-concept, should also be considered, since most behavioral problems are related to it (García et al., 2006), as is the case with sleep habits (Tafoya et al., 2022).

In this context of analysing different health habits, one of the priority lines of research should be that relating to university students, because they are in a period of physical, psychological, and social change (Brooks et al., 2021), characterized by increased responsibilities, independence (Richards & Specker, 2019), demands (García-Martínez et al., 2021) and adherence to unhealthy habits (Lemma et al., 2021; Rodríguez-Rodríguez et al., 2018). As a result, there is an increment in weight and body fat (Deliens et al., 2019), amounting from 1.36 kilograms in the first five months of university (Vadeboncoeur et al., 2015) and to 3 kilograms over the four years of study (Gropper et al., 2012).

Based on the above, this study has been designed with the following objectives:

(1) To identify the levels of body mass index, vigorous physical activity, physical self-concept, and sleep quality among Spanish university students.

(2) To analyse the relationships between body mass index and vigorous physical activity, physical self-concept, and sleep quality among university students.

(3) To compare the profiles of healthy habits among university students according to body mass index categories.

Based on these objectives, the following research hypotheses have been formulated:

(1) Most Spanish university students have a normal body mass index, the average weekly duration of vigorous physical activity exceeds the recommended level, and the average sleep quality score is adequate.

(2) The theoretical model is valid for interpreting the direct and indirect relationships between body mass index, age, vigorous physical activity, sleep quality, and physical self-concept.

(3) There are differences in health profiles amongst students across all body mass index categories, due to vigorous physical activity, their perception of their own bodies and the quality of their sleep.

## Method

### *Participants*

The research was approved by the Ethics Committee of Universidad Isabel I (Ui1-PI098; approval date: May 28, 2024) and followed the requirements established in the Declaration of Helsinki. The study design was ex post facto and cross-sectional, with a marked descriptive and correlational character of body mass index, vigorous physical activity, physical self-concept, and various components of sleep quality among Spanish university students.

A non-probabilistic convenience sampling method involving voluntary self-selection was used. Five universities were selected on the basis of their accessibility and their willingness to collaborate in the research. The researchers sent the link to the online questionnaire to university officials, who forwarded it to their students to encourage them to take part in a voluntary basis. Although this sampling strategy enabled efficient data collection from the target population, it may introduce self-selection bias and should therefore be considered when interpreting the external validity of the findings.

Finally, 403 students took part in the study. Taking into account a 95% variance, a standard deviation of 50, and the fact that there were 1,827,272 Spanish university students in the 2024–2025 academic year (Ministry of Science, Innovation and Universities, 2025), the sample assumes an estimation error of 4.88 per cent. In this regard, the sample can be considered representative, as the estimated margin of error is less than 5%, which falls within the range generally accepted for scientific research (Ahmed, 2024; Arrogante, 2022).

Participants came from 16 of Spain's 19 regions (84.21%) and 41 of Spain's 52 provinces (78.85%). In addition, there were 251 female students (62.28%) and the mean age was 28.12 (±10.36) years.

### *Procedure*

An online questionnaire was designed using the Google Forms platform (Mountain View, CA, USA) with the following sections:

#### *Sociodemographic section*

The design was ad hoc in order to determine the sex (male or female), age (years), weight (kilograms) and height (centimeters). Additionally, body mass index was calculated by dividing body weight (kg) by height squared (m2) (Jensen et al., 2014). Subsequently, a person was categorized as underweight when the index was less than 18.5, as normal weight when it was between 18.5 and 24.99, as overweight when it was between 25 and 29.99, and as obese when it was at least 30 (WHO, 2025).

#### *Physical activity section*

It included the validated version for Spanish adults of the IPAQ-SF questionnaire by Rodríguez-Muñoz et al. (2017). The variable used was the weekly time spent on vigorous physical activity (minutes/week), calculated from the results of the first two items in the questionnaire, related to the number of days per week of practice and the mean daily time, respectively.

#### *Self-concept section*

The Spanish version of García and Musitu (1999) of the Self-Concept Questionnaire Form (AF-5) was used. Physical self-concept was calculated by finding the mean of the six questions (5, 10, 15, 20, 25, and 30) on a Likert scale of 1-5 (1 never – 5 always) established by the questionnaire for this dimension, as

was done in previous studies (Melguizo-Ibáñez et al., 2023). The reliability of physical self-concept in Cronbach's α was 0.799.

*Sleep Quality Section*

The Spanish version of The Pittsburgh Sleep Quality Index (PSQI) (Macías & Royuela, 1996) was used and the seven components of sleep quality established were identified: subjective sleep quality, sleep latency, sleep duration, usual sleep efficiency, sleep disturbances, use of hypnotic medication and day-time dysfunction. A higher score implies a worse assessment of the sleep component. In addition, each of the PSQI components and the final score were used as variables in the study, as in previous studies (Park, 2020; Surrati et al., 2024), implying that a higher score corresponds to poorer sleep quality.

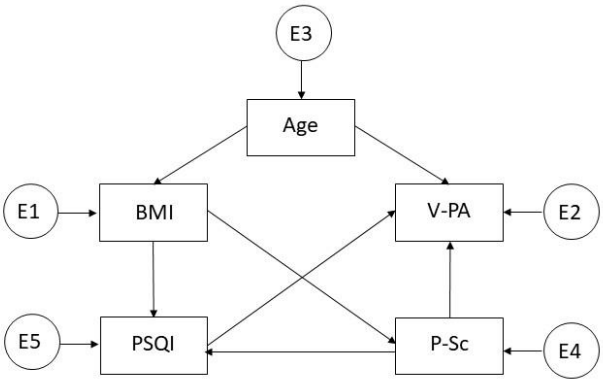
## *Data analysis*

IBM SPSS 26.0 software (International Business Machines Corporation, Armonk, NY, USA) was used to perform statistical analysis based on the Microsoft Excel document (Microsoft Corporation, Redmond, WA, USA) obtained with the participation results.

In the initial phase of the statistical analysis, the mean scores, standard deviations, confidence intervals, skewness, and kurtosis of the research variables were calculated. The Student's t-test for independent samples was also used to calculate whether there were differences in the values of the variables depending on the sex of the participants. In addition, the effect size was calculated using Cohen's d statistic. Next, the Kolmogorov–Smirnov test was applied, and Pearson's correlations were calculated between all study variables. Furthermore, a multiple linear regression model was estimated using the stepwise procedure to identify the predictors that explained the greatest proportion of variance in body mass index among the candidate variables. The stepwise procedure was selected because the study was exploratory in nature and aimed to determine the relative contribution of several potentially correlated predictors while obtaining the most parsimonious model. Although this approach has recognized limitations, including potential model instability and overfitting, it may be useful as an exploratory variable selection approach, and the results were interpreted cautiously (Whittingham et al., 2006). Furthermore, Thayer (2002) considers that the stepwise procedure can be used to develop a theory or models that can be tested through subsequent research.

Subsequently, IBM SPSS Amos 26.0 software (IBM Corp., Armonk, NY, USA) was used to evaluate the fit of the theoretical model designed to explain the relationships between body mass index, age, vigorous physical activity, sleep quality, and physical self-concept (Figure 1). According to the criteria established by Maydeu-Olivares (2017) and Kyriazos (2018), a structural equation model will have a good fit if the values of the Normal Fit Index (NFI), Comparative Fit Index (CFI), and Incremental Fit Index (IFI) are greater than 0.90 and the fit Root Mean Square Error of Approximation (RMSEA) is less than 0.10.

Figure 1. Theoretical model of the structural equation.




Abbreviations: Body mass index (BMI); Vigorous physical activity (V-PA); Physical self-concept (P-Sc); Sleep quality index (PSQI).

In the last phase, the MANOVA test was applied to check whether there were significant differences between the mean values of the quantitative research variables (dependent variables) according to the four categories of body mass index (independent variable). Pillai's trace test was applied to identify the effect between variables, and Levene's test was applied to check for equality of variances of error. In addition, Tukey's post hoc tests were used if the p-value of Levene's test was equal to or higher than 0.05, and Games-Howell's tests were used for lower values. Next, the Kolmogorov–Smirnov tests, Pearson's correlation, and linear regression models were applied to each body mass index category as initially done. Complementarily, the chi-square and Cramer's V tests were used to identify whether there were differences in the body mass index categories based on the participants' sex.

The significance level for all statistical tests was set at $p \leq 0.05$ and the effect size was classified as low (0.10), moderate (0.30) or high (0.50) in accordance with the criteria established by Cohen (1988).

Given the cross-sectional and observational nature of the study, the analyses were limited to the variables collected (age, body mass index, vigorous physical activity, physical self-concept and sleep quality). Other potential confounding variables (e.g., dietary habits, socioeconomic status, chronic diseases, medication use, smoking, and alcohol consumption) were not available and therefore could not be controlled for in the statistical models. Consequently, the findings should be interpreted as associative rather than causal.

## Results

Table 1 shows the descriptive statistics for the continuous variables in the study and their comparison according to sex. The mean body mass index of Spanish university students is 23.70 (±4.26), the mean time spent in vigorous physical activity is 226.43 (±277.29) minutes/week, and the mean physical self-concept rating is 3.51 (±0.80). In addition, body mass index ($t=-3.43$, $p<0.001$, $d=0.35$), weekly time spent in vigorous physical activity ($t=-4.17$, $p<0.001$, $d=0.44$), and sleep duration ($t=-2.17$, $p=0.03$, $d=0.22$) differ significantly between women and men. These effect sizes are low and moderate, suggesting that, although there are statistically significant differences between women and men, their practical significance is limited.

Table 1. Descriptive statistics of the research variables.

| | Mean (SD) | CI 95% | Skewness | Kurtosis | Women M (SD) | Men M (SD) | t | p | d |
|---|---|---|---|---|---|---|---|---|---|
| Age | 28.12 (10.36) | 27.11 / 29.14 | 1.12 | 0.28 | 28.05 (10.09) | 28.25 (10.81) | -0.19 | 0.85 | 0.02 |
| BMI | 23.70 (4.26) | 23.29 / 24.12 | 1.97 | 7.24 | 23.14 (4.20) | 24.63 (4.22) | -3.43 | <0.001 | 0.35 |
| V-PA | 226.43 (277.29) | 199.28 / 253.58 | 2.21 | 8.66 | 181.00 (256.00) | 301.45 (295.12) | -4.17 | <0.001 | 0.44 |
| P-Sc | 3.51 (0.80) | 3.43 / 3.58 | - 0.43 | 0.04 | 3.46 (0.76) | 3.59 (0.85) | -1.65 | 0.10 | 0.17 |
| S-Q | 1.49 (0.84) | 1.41 / 1.57 | 1.19 | - 0.52 | 1.46 (0.81) | 1.54 (0.89) | -0.92 | 0.36 | 0.10 |
| S-L | 2.93 (1.69) | 2.76 / 3.09 | -0.35 | -0.44 | 2.84 (1.65) | 3.07 (1.77) | -1.36 | 0.18 | 0.14 |
| S-Du | 0.79 (0.75) | 0.72(0.86) | 0.79 | 0.51 | 0.73 (0.71) | 0.89 (0.80) | -2.17 | 0.03 | 0.22 |
| S-E | 0.59 (0.91) | 0.50 / 0.68 | 1.46 | 1.09 | 0.58 (0.89) | 0.61 (0.94) | -0.25 | 0.80 | 0.03 |
| S-Di | 1.67 (0.58 | 1.61 / 1.73 | -0.22 | -0.19 | 1.68 (0.59) | 1.65 (0.56) | 0.51 | 0.61 | 0.05 |
| UHM | 0.56 (1.12) | 0.45 / 0.67 | 1.58 | 0.61 | 0.57 (1.14) | 0.53 (1.10) | 0.35 | 0.72 | 0.04 |
| DD | 1.35 (1.00) | 1.25 / 1.45 | -0.19 | -1.25 | 1.40 (1.02) | 1.27 (0.97) | 1.25 | 0.21 | 0.13 |
| PSQI | 9.37 (3.79) | 9 / 9.75 | 0.34 | -0.11 | 9.26 (3.74) | 9.57 (3.86) | -0.79 | 0.43 | 0.08 |

Abbreviations: Body mass index (BMI); Vigorous physical activity (V-PA); Physical self-concept (P-Sc); Sleep quality (S-Q); Sleep latency (S-L); Sleep duration (S-Du); Sleep efficiency (S-E); Sleep disturbances (S-Di); Use of hypnotic medication (UHM); Daytime dysfunction (DD); Sleep quality index (PSQI).

The body mass index of university students is negatively related to physical self-concept ($r=-0.25$, $p<0.01$) and positively related to subjective quality ($r=0.14$, $p<0.01$) and sleep latency ($r=0.16$, $p<0.01$). Similarly, vigorous physical activity is positively related to university students' physical self-concept ($r=0.31$, $p<0.01$). The correlations between the variables are low, except for the correlation between vigorous physical activity and physical self-concept, which is moderate. Table 2 shows the remaining correlations between the continuous variables in the study.

Table 2. Correlations between continuous research variables.

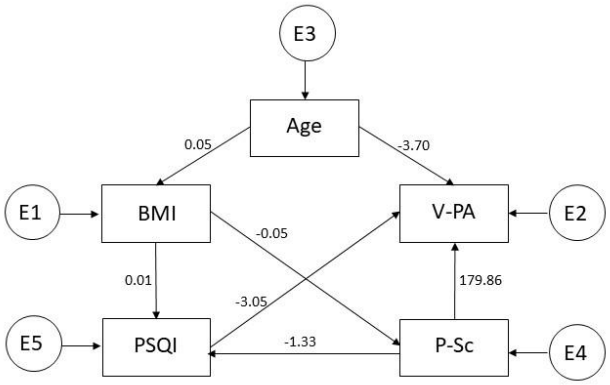
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age | 0.13* | -0.20** | -0.14** | 0.01 | -0.21** | 0.14** | 0.01 | -0.16** | 0.02 | -0.04 | -0.09 |
| 2. BMI | - | -0.09 | -0.25** | 0.14** | -0.01 | 0.16** | 0.04 | -0.01 | 0.03 | 0.01 | 0.08 |
| 3. V-PA | | - | 0.31** | -0.04 | -0.10* | -0.07 | -0.01 | -0.08 | -0.04 | -0.09 | -0.12* |
| 4. P-Sc | | | - | -0.22** | -0.21** | -0.19** | -0.08 | -0.08 | -0.09 | -0.18** | -0.28** |
| 5. S-Q | | | | - | 0.19** | 0.40** | 0.09 | 0.13** | 0.09 | 0.23** | 0.51** |
| 6. S-L | | | | | - | 0.22** | 0.23** | 0.16** | 0.16** | 0.16 ** | 0.70** |
| 7. S-Du | | | | | | - | 0.19** | 0.09 | 0.09 | 0.22** | 0.53** |
| 8. S-E | | | | | | | - | 0.07 | 0.12* | 0.02 | 0.45** |
| 9. S-Di | | | | | | | | - | 0.20** | 0.27** | 0.42** |
| 10. UHM | | | | | | | | | - | 0.24** | 0.53** |
| 11. DD | | | | | | | | | | - | 0.55** |
| 12. PSQI | | | | | | | | | | | - |

Abbreviations: Body mass index (BMI); Vigorous physical activity (V-PA); Physical self-concept (P-Sc); Sleep quality (S-Q); Sleep latency (S-L); Sleep duration (S-D); Sleep efficiency (S-E); Sleep disturbances (S-Di); Use of hypnotic medication (UHM); Daytime dysfunction (DD); Sleep quality index (PSQI); $p < 0.05$ (*); $p < 0.01$ (**).

The multiple linear regression model valid for predicting body mass index is as follows (R2= 0.074; Adjusted R2= 0.069; F(p value)= 5.807(0.016); Durbin-Watson= 1.961): 27.367 – 1.195*physical self-concept + 0.673*sleep duration. The predictive model has limited explanatory power due to the low adjusted $R^2$ value obtained (6.9% of the variance).

The structural equation model proposed for Spanish university students obtained a good fit (figure 2): the Chi-Square test showed a significant value (Chi-Square=12.427; Degrees of Freedom=3; Probability Level=0.006), the Comparative Fit Index was 0.915, the Normal Fit Index was 0.901, the Incremental Fit Index was 0.920 and the fit index Root Mean Square Error of Approximation was 0.088. Therefore, the structural equation model has a good fit, although not perfectly.

Figure 2. Standardised regression weights together with the theoretical model




Abbreviations: Body mass index (BMI); Vigorous physical activity (V-PA); Physical self-concept (P-Sc); Sleep quality index (PSQI).

The MANOVA test was applied to validate the differentiation of BMI categories based on the other research variables. The assumption of goodness of the Pillai's Trace test values was met (Pillai's Trace = 0.119; F(27,1179) = 1.81; p = 0.007; β = 1; $\eta^2p$ = 0.04. The partial eta-squared indicated a small multivariate effect, suggesting that BMI category explained only a modest proportion of the variability in the study variables.

Table 3 shows the regression weights and standardized regression weights of the model obtained to demonstrate the relationships between the variables in Spanish university students.

Table 3. Standardised regression weights for university students.

| Associations between variables | R.W. | | | | S.R.W. |
|---|---|---|---|---|---|
| | Estimations | S.E. | C.R. | p | Estimations |
| BMI ←Age | 0.051 | 0.020 | 2.524 | 0.012 | 0.125 |
| Physical self-concept ←BMI | -0.046 | 0.009 | -5.069 | <0.001 | -0.245 |
| PSQI ←BMI | 0.008 | 0.044 | 0.172 | 0.863 | 0.008 |
| PSQI ←Physical self-concept | -1.335 | 0.235 | -5.678 | <0.001 | -0.280 |
| Vigorous physical activity ←Age | -3.695 | 2.234 | -1.654 | 0.098 | -0.078 |
| Vigorous physical activity ←Physical self-concept | 179.857 | 30.330 | 5.930 | <0.001 | 0.293 |
| Vigorous physical activity ←PSQI | -3.053 | 6.365 | -0.480 | 0.632 | -0.024 |

Abbreviations: Body mass index (BMI); Sleep quality index (PSQI).

Table 4 shows the mean levels of the research variables according to body mass index categories. In addition, there are differences according to the sex of the participants between the body mass index categories ($X^2(3)=9.47$, p=0.02; Cramer's V=0.15), indicating a small association.

Table 4. Levels of research variables according to BMI category.

| | N (%) | Women (%) | Age | BMI | V-PA | P-Sc | S-Q | S-L | S-Du | S-E | S-P | UHM | DD | PSQI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Under | 19 (4.71) | 17 (89.5) | 23.05 (4.65) | 17.68 (0.60) | 269.21 (298.27) | 3.61 (0.97) | 1.37 (0.76) | 3.37 (1.67) | 1.05 (0.85) | 0.95 (1.18) | 1.68 (0.58) | 0.26 (0.81) | 1.32 (1.16) | 10.00 (3.27) |
| Normal | 277 (68.73) | 176 (63.5) | 27.91 (10.30) | 22.08 (1.68) | 233.54 (280.97) | 3.60 (0.71) | 1.44 (0.81) | 2.86 (1.65) | 0.72 (0.72) | 0.52 (0.86) | 1.66 (0.58) | 0.55 (1.11) | 1.34 (0.99) | 9.09 (3.60) |
| Over | 78 (19.35) | 41 (52.6) | 28.81 (10.45) | 26.86 (1.43) | 246.74 (287.44) | 3.47 (0.83) | 1.51 (0.86) | 3.04 (1.84) | 0.82 (0.70) | 0.58 (0.86) | 1.67 (0.53) | 0.64 (1.20) | 1.31 (0.93) | 11.17 (4.64) |
| Obese | 29 (7.20) | 17 (58.6) | 31.69 (12.13) | 34.65 (4.93) | 75.86 (122.43) | 2.67 (0.92) | 1.93 (1.00) | 3.00 (1.73) | 1.24 (0.91) | 1.03 (1.12) | 1.79 (0.68) | 0.62 (1.24) | 1.55 (1.18) | 9.56 (4.07) |

Abbreviations: Body mass index (BMI); Vigorous physical activity (V-PA); Physical self-concept (P-Sc); Sleep quality (S-Q); Sleep latency (S-L); Sleep duration (S-D); Sleep efficiency (S-E); Sleep disturbances (S-Di); Use of hypnotic medication (UHM); Daytime dysfunction (DD); Sleep quality index (PSQI); Underweight (Under); Normal weight (normal); overweight (over). Except for N and women, the rest of the variables show the mean and standard deviation.

The results of Levene's test for physical self-concept (F(3,399) = 2.49), sleep latency (F(3,399) = 0.44), sleep duration (F(3,399) = 1.22), sleep disturbances (F(3,399) = 0.52), daytime dysfunction (F(3,399) = 2.48), and mean sleep quality (F(3,399) = 2.25) were not significant (p > 0.05), so, assuming equal variances, Tukey's post hoc test was selected. In contrast, the results for age (F(3,399) = 7.066, p < 0.001), vigorous physical activity (F(3,399) = 4.001, p = 0.01), sleep quality (F(3,399) = 4.657, p = 0.003), sleep efficiency (F(3,399) = 3.896, p = 0.009), and taking sleeping pills (F(3,399) = 3.149, p = 0.03) were significant, so the Games-Howell post hoc test was applied. Table 5 presents the multiple post hoc comparisons of the variables according to BMI categories.

Table 5. Multiple post hoc comparisons of variables based on BMI categories.

| | Weight Category (I) | Weight category (J) | Difference of means (I-J) | Error deviation | Sig. | Confidence interval (95%) | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower limit | Upper limit |
| Age | Under | Normal | -4.85 | 2.44 | 0.05 | -9.65 | -0.06 |
| | Under | Over | -5.76 | 2.63 | 0.03 | -10.93 | -0.58 |
| | Under | Obese | -8.64 | 3.04 | 0.01 | -14.61 | -2.67 |
| | Normal | Over | -0.90 | 1.32 | 0.49 | -3.49 | 1.69 |
| | Normal | Obese | -3.78 | 2.01 | 0.06 | -7.73 | 0.16 |
| | Over | Obese | -2.88 | 2.24 | 0.20 | -7.28 | 1.52 |
| V-PA | Under | Normal | 35.67 | 70.48 | 0.96 | -161.38 | 232.72 |
| | Under | Over | 22.47 | 75.77 | 0.99 | -185.02 | 229.95 |
| | Under | Obese | 193.35 | 72.11 | <0.001 | -6.86 | 393.56 |
| | Normal | Over | -13.21 | 36.66 | 0.98 | -108.71 | 82.30 |
| | Normal | Obese | 157.68 | 28.32 | <0.001 | 83.02 | 232.33 |
| | Over | Obese | 170.88 | 39.70 | <0.001 | 67.20 | 274.56 |
| P-Sc | Under | Normal | 0.01 | 0.18 | 1.00 | -0.46 | 0.47 |
| | Under | Over | 0.14 | 0.19 | 0.90 | -0.37 | 0.64 |
| | Under | Obese | 0.93 | 0.22 | <0.001 | 0.35 | 1.51 |
| | Normal | Over | 0.13 | 0.10 | 0.53 | -0.12 | 0.38 |
| | Normal | Obese | 0.93 | 0.15 | <0.001 | 0.55 | 1.31 |
| | Over | Obese | 0.80 | 0.17 | <0.001 | 0.37 | 1.22 |
| S-Q | Under | Normal | -0.08 | 0.18 | 0.98 | -0.58 | 0.43 |
| | Under | Over | -0.14 | 0.20 | 0.89 | -0.69 | 0.40 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Under | Obese | -0.56 | 0.26 | 0.14 | -1.24 | 0.12 |
| | Normal | Over | -0.07 | 0.11 | 0.92 | -0.35 | 0.22 |
| | Normal | Obese | -0.49 | 0.19 | 0.07 | -10.01 | 0.03 |
| | Over | Obese | -0.42 | 0.21 | 0.21 | -0.98 | 0.14 |
| S-L | Under | Normal | 0.51 | 0.40 | 0.58 | -0.52 | 1.55 |
| | Under | Over | 0.33 | 0.43 | 0.87 | -0.79 | 1.45 |
| | Under | Obese | 0.37 | 0.50 | 0.88 | -0.92 | 1.66 |
| | Normal | Over | -0.18 | 0.22 | 0.83 | -0.74 | 0.38 |
| | Normal | Obese | -0.14 | 0.33 | 0.97 | -1.00 | 0.71 |
| | Over | Obese | 0.04 | 0.37 | 1.00 | -0.91 | 0.99 |
| S-Du | Under | Normal | 0.33 | 0.17 | 0.22 | -0.12 | 0.78 |
| | Under | Over | 0.23 | 0.19 | 0.61 | -0.25 | 0.72 |
| | Under | Obese | -0.19 | 0.22 | 0.82 | -0.75 | 0.37 |
| | Normal | Over | -0.10 | 0.09 | 0.70 | -0.35 | 0.14 |
| | Normal | Obese | -0.52 | 0.14 | <0.01 | -0.89 | -0.15 |
| | Over | Obese | -0.42 | 0.16 | 0.04 | -0.83 | -0.01 |
| S-E | Under | Normal | 0.42 | 0.28 | 0.43 | -0.35 | 1.20 |
| | Under | Over | 0.37 | 0.29 | 0.58 | -0.42 | 1.17 |
| | Under | Obese | -0.09 | 0.34 | 0.99 | -1.00 | 0.83 |
| | Normal | Over | -0.05 | 0.11 | 0.96 | -0.34 | 0.23 |
| | Normal | Obese | -0.51 | 0.21 | 0.10 | -1.09 | 0.07 |
| | Over | Obese | -0.46 | 0.23 | 0.21 | -1.07 | 0.16 |
| S-Di | Under | Normal | 0.03 | 0.14 | 1.00 | -0.33 | 0.38 |
| | Under | Over | 0.02 | 0.15 | 1.00 | -0.36 | 0.40 |
| | Under | Obese | -0.11 | 0.17 | 0.92 | -0.55 | 0.33 |
| | Normal | Over | -0.01 | 0.07 | 1.00 | -0.20 | 0.18 |
| | Normal | Obese | -.14 | 0.11 | 0.62 | -0.43 | 0.15 |
| | Over | Obese | -0.13 | 0.13 | 0.75 | -0.45 | 0.20 |
| UHM | Under | Normal | -0.29 | 0.20 | 0.48 | -0.83 | 0.26 |
| | Under | Over | -0.38 | 0.23 | 0.36 | -0.99 | 0.24 |
| | Under | Obese | -0.36 | 0.30 | 0.62 | -1.14 | 0.43 |
| | Normal | Over | -0.09 | 0.15 | 0.93 | -0.49 | 0.30 |
| | Normal | Obese | -0.07 | 0.24 | 0.99 | -0.72 | 0.58 |
| | Over | Obese | 0.02 | 0.267 | 1.00 | -0.69 | 0.73 |
| DD | Under | Normal | -0.03 | 0.24 | 1.00 | -0.64 | 0.59 |
| | Under | Over | 0.01 | 0.26 | 1.00 | -0.65 | 0.67 |
| | Under | Obese | -0.24 | 0.30 | 0.86 | -1.00 | 0.53 |
| | Normal | Over | 0.04 | 0.13 | 0.99 | -0.30 | 0.37 |
| | Normal | Obese | -0.21 | 0.20 | 0.71 | -0.71 | 0.30 |
| | Over | Obese | -0.24 | 0.22 | 0.68 | -0.81 | 0.32 |
| PSQI | Under | Normal | 0.91 | 0.89 | 0.31 | -0.84 | 2.66 |
| | Under | Over | 0.44 | 0.96 | 0.65 | -1.46 | 2.33 |
| | Under | Obese | -1.17 | 1.11 | 0.29 | -3.35 | 1.01 |
| | Normal | Over | -0.47 | 0.48 | 0.33 | -1.42 | 0.47 |
| | Normal | Obese | -2.08 | 0.73 | 0.01 | -3.53 | -0.64 |
| | Over | Obese | 1.61 | 0.82 | 0.05 | 0.00 | 3.22 |

Abbreviations: Vigorous physical activity (V-PA); Physical self-concept (P-Sc); Sleep quality (S-Q); Sleep latency (S-L); Sleep duration (S-D); Sleep efficiency (S-E); Sleep disturbances (S-Di); Use of hypnotic medication (UHM); Daytime dysfunction (DD); Sleep quality index (PSQI); Underweight (Under); Normal weight (normal); overweight (over). Except for N and women, the rest of the variables show the mean and standard deviation.

Vigorous physical activity among students is positively and significantly related to physical self-concept regardless of body mass index category (underweight: r=0.48, p<0.05; normal weight: r=0.23, p<0.05; overweight: r=0.40, p<0.01; obese: r=0.41, p<0.05) and sleep quality negatively and significantly with physical self-concept (underweight: r=-0.47, p<0.01; normal weight: r=-0.19, p<0.01; overweight: r=-0.43, p<0.01), with the exception of the obese category, which is only negative (r=-0.16, p>0.05). The correlations between the variables are low and moderate, although some are close to high values (r≥0.50).

No valid regression models were found to predict body mass index including the continuous research variables in the underweight, normal weight, and obese categories. The valid multiple linear regression model for predicting the body mass index of overweight university students is as follows ($R^2$= 0.088; Adjusted $R^2$= 0.076; F(p value)= 7.293(0.009); Durbin-Watson= 2.205): 28.204 – 0.804*sleep disturbance. The predictive model has limited explanatory power due to the low adjusted $R^2$ value obtained (7.6% of the variance).

## Discussion

The mean body mass index of university students in Spain is higher than that reported by Muñoz-Rodríguez et al. (2021), Martínez-Bebia et al. (2021), and Moreno-Gómez et al. (2012), who found levels of 22.5, 23.55, and 21.99, respectively. With regard to the percentage of students by body mass index category, most of them are of normal weight, although more than 25% are overweight or obese. This differs from the findings of Hernández-Segura et al. (2023) and Moreno-Gómez et al. (2012), who found that 13.6% and 11.1% of university students were overweight, respectively. In addition, the levels of underweight university students are lower than those obtained by Muñoz-Rodríguez et al. (2021) (8.9% vs. 9.4%). Similarly, there is a difference in body mass index between men and women, with men having a higher index, following the trend found by Martínez-Bebia et al. (2021). The differences between the body mass index levels in this study and those in other studies may be due to the fact that in the other studies the mean age of the participants was lower and that participants from so many Spanish regions were not included, which would be consistent with the findings of Feijoo et al. (2024). The increasing trend in body mass index in recent decades would also have an influence (Cebrián & Escalada, 2025).

The mean body mass index of students is negatively related to their physical self-concept, as found by Fernández-Bustos et al. (2019) in both women and men. Additionally, the higher the body mass index category, the lower the level of physical self-concept, with significant differences between underweight and obesity, normal weight and obesity, and overweight and obesity. Similarly, the higher the body mass index, the worse the subjective sleep quality and latency. This is consistent with the findings of Xu et al. (2025), who demonstrated that obesity is positively related to poorer sleep patterns.

The mean age of participating university students is 28.12 years, higher than in previous studies (Martínez-Bebia et al., 2021; Muñoz-Rodríguez et al., 2021. This may be due to the fact that in recent years there has been an increase in the number of university students (Ministry of Science, Innovation and Universities, 2025), that these students are older (Cebrían & Escalada, 2025), and that online universities allow students to combine their studies with work and family responsibilities, which would be much more difficult if they were attending classes in person (Waterhouse et al., 2022). Furthermore, these responsibilities, such as working at night, are negatively related to body mass index (De Pedro-Jiménez et al., 2022).

Age is positively related to body mass index and negatively related to vigorous physical activity and physical self-concept. The relationship between age and physical activity is consistent with the findings of Mielgo-Ayuso et al. (2016), who demonstrated this negative trend, although it was not linear. In addition, older age is associated with a poorer assessment of sleep quality (Gadie et al., 2017), which, among other factors, could be due to caring for young children (Hagen et al., 2013).

The vigorous physical activity obtained in this study is higher than that found by Paulo et al. (2024) for Spanish, Portuguese, and Italian university students and lower than that obtained by Sanz-Martín et al. (2025) for university students from four Spanish regions. Moreover, sex determines levels of vigorous physical activity, which are 1.66 times higher in men than in women. Espada et al. (2023) also demonstrated significant differences in favor of men in vigorous, moderate, and moderate-vigorous physical activity among university students. According to Durán et al. (2022) and Bobo-Arce et al. (2024), these sex differences could be due to greater socialization in sports among men and a lower willingness to participate among women.

The overall vigorous physical activity of students is positively related to physical self-concept, as is the case in each of the body mass index categories. This same positive relationship was demonstrated by Torres et al. (2024). Furthermore, this relationship between physical activity and self-concept could be influenced by physical condition (Sáez et al., 2020) and motivation to engage in physical activity (Estrada-Araoz et al., 2024). Similarly, high-intensity physical activity improves the overall quality of sleep and sleep latency among Spanish university students. This is also consistent with previous scientific evidence, as Chen et al. (2022) also found this relationship, and Zhang et al. (2025) demonstrated that high-intensity circuit training objectively and subjectively improved different sleep parameters.

The underweight group engages in the most vigorous physical activity, followed by the overweight, normal weight, and obese groups, with significant differences between the activity levels of obese individuals and those in all other categories, with obese individuals scoring lower in all comparisons. Başoğlu

(2025) also demonstrated the same trend, although he did not identify the underweight category. Based on the findings of Herazo (2011), the differences in levels of vigorous physical activity could be not due to the number of days of practice, but to the daily duration.

Underweight people engage in 3.55 times more physical activity than obese people, and 89.5% of underweight people are women. This could be due to several biological and psychological factors, such as women having a lower body mass index (Martínez-Bebia et al., 2021) and being more concerned with body beauty related to thinness (Wang et al., 2025), which is linked to eating disorders such as anorexia and bulimia (Cuntz et al., 2023) and addiction to physical exercise (Wang et al., 2025).

Physical self-concept is a psychological factor that is particularly important in healthy habits (García et al., 2006). This study has shown that a more positive body image is associated with higher levels of subjective well-being, shorter time taken to fall asleep, longer sleep duration and better average sleep quality, as well as fewer sleep disturbances. Furthermore, as demonstrated by Onetti-Onetti et al. (2019) and Babic et al. (2014), vigorous physical activity is positively related to self-concept.

The mean sleep quality score is quite high (9.37 points), which implies poor quality, being higher than those obtained by Ramón-Arbués et al. (2022) for Spanish university students (6.39 points). Furthermore, these levels are also higher than those achieved by Merellano-Navarro et al. (2022) during the Covid-19 pandemic (8.4 points), a period in which all healthy habits worsened (Ruiz-Zaldibar et al., 2022).

The structural equation model proposed to explain the relationships between age, body mass index, vigorous physical activity, sleep quality, and physical self-concept among university students is valid because it fits well, although not perfectly. In this model, the directions of association between the variables are similar to the trends in the scientific literature and have been detailed above. The fit of the model obtained is optimal, as is that achieved by Hoseini et al. (2022) in their initial model to explain the relationships between body mass index, physical activity, and quality of life, and by Lemes et al. (2024) to explain the relationships between obesity indicators, quality of life, and components of physical literacy. Furthermore, it adds the novel finding that age is indirectly related to sleep quality through body mass index and vigorous physical activity. This indirect relationship could also occur through other factors not considered in the present study, such as cognition (Huijun et al., 2025) and dietary patterns (Ahmed et al., 2025). Furthermore, it is worth noting that, although the proposed model adequately replicates the observed covariance structure, a considerable proportion of the variance in the endogenous variables remains unexplained, as reflected in the residuals. This finding is consistent with the multifactorial nature of body mass index, physical activity, sleep quality and body image, all of which are influenced by numerous biological, behavioural, psychological and environmental factors that were beyond the scope of the present study. Therefore, future structural models should incorporate additional determinants in an attempt to achieve excellent or perfect fits.

Only two regression models have been identified as valid for predicting body mass index: one for the entire population and one for those in the overweight category, accounting for 7.4% and 7.6% of the variance, respectively. Although these values indicate a limited explanatory capacity, they are not unexpected given the multifactorial nature of body mass index. Body mass index is influenced by numerous biological, behavioural, psychological, socioeconomic and environmental factors that were not included in the present study, such as depression, diet (Ahmed et al., 2025), and a sedentary lifestyle (Carneiro-Barrera et al., 2020). Consequently, a substantial proportion of the variability in body mass index remains unexplained. Nevertheless, the identified models provide useful evidence regarding the independent associations between physical self-concept and BMI within the analysed population and may contribute to the development of more comprehensive explanatory models in future research.

The study has some limitations that should be considered. One limitation stems from the type of study, which means that only the relationships between variables can be described, but no causality between them can be identified. Despite that, a series of variables have been identified that are associated with body mass index and that allow for the design of more contextualized improvement proposals that would enable causalities to be established. There is another limitation relating to the self-reported method of determining the participants' weight and height, which was used to calculate their body mass index. Ideally, the young people would have been measured and weighed using the same objective instruments as set out in some of the current medical protocols, but this has not been possible because

the students live in 41 towns across Spain, making it impractical and very expensive for the research team to travel to obtain objective anthropometric measurements. Furthermore, when completing the questionnaire from home, participants were able to record their weight and height at that time or refer to the results of recent medical tests. In summary, it would have been more accurate to take these measurements on site, but this would have increased the costs of the study and it would not have been possible to increase the selected sample or include students from online universities, which are essential aspects in epidemiological studies (Mohajan & Kumar, 2023). As a result of this measurement limitation, it is assumed that there may be some bias in the data. Another limitation is due to the use of a questionnaire to measure vigorous physical activity, rather than using other more accurate instruments such as accelerometers. This limitation was offset by using a questionnaire validated for Spanish adults, which allowed access to a larger population using fewer resources. Finally, there is another limitation to this study arising from the use of non-probabilistic convenience sampling and the selection of universities based on criteria of accessibility and willingness to collaborate. This procedure may introduce sampling bias and limit the representativeness of the sample; consequently, the results should be interpreted with caution and their generalisation to the university population as a whole may be limited. However, an attempt has been made to compensate for this limitation to some extent by reducing the sampling error (to less than 5%) and by selecting participants from 41 of Spain's 52 provinces.

Based on the discussion of the results obtained, some future lines of research emerge. First, interventions should be designed to improve the quality of sleep among university students. These interventions could include high-intensity interval training, as this reduces body weight and improves sleep (Ka et al., 2025; Kawinchotpaisan et al., 2025), and other variables such as improving emotional intelligence and reducing burnout (Biaigo et al., 2025). Similarly, it would be appropriate to conduct a longitudinal study to determine how the variables studied vary in university students in other academic years and in the same students as they age. Other variables such as adherence to dietary patterns and use of social media could also be included.

## Conclusions

Based on the results obtained and their analysis in accordance with scientific literature, it can be concluded that:

(1) Most Spanish university students have a normal body mass index. This is also observed when differentiated by sex, although it is higher in men.

(2) The mean weekly time spent by students engaging in vigorous physical activity is higher than that recommended for their age group. This remains the case across all four body mass index categories, although the levels are lower for those classified as obese.

(3) The physical self-concept of university students does not show differences based on sex, but it does differ based on body mass index category, being lower in students who are obese.

(4) The sleep quality of university students is very poor, being lower in men and in those who are overweight.

(5) Young people's body mass index is directly and negatively related to their physical self-concept and positively related to the quality of sleep duration.

(6) The theoretical model is valid for interpreting the direct and indirect relationships between body mass index, age, vigorous physical activity, sleep quality, and physical self-concept.

(7) There are differences in health profiles among students in different body mass index categories, mainly due to age, vigorous physical activity, physical self-concept, and mean sleep quality.

(8) The correlations between the research variables vary between body mass index categories; however, all show a positive relationship between vigorous physical activity and physical self-concept.

(9) Optimal regression models have only been obtained to predict the body mass index of university students and those in the overweight category, although most of the variance remains unexplained.

With regard to the research hypotheses, it can be stated that:

(1) The first hypothesis is partially supported, as, although it is true that the majority of Spanish university students have a normal body mass index and that the average weekly duration of vigorous physical activity exceeds the recommended level, they experience very poor sleep quality.

(2) The second hypothesis has been confirmed because the theoretical model is valid for interpreting the direct and indirect relationships between body mass index, age, vigorous physical activity, sleep quality and body image. However, although the theoretical model is valid, the data fits well, but not perfectly.

(3) The third hypothesis has been partially confirmed. It has been shown that there are significant differences in levels of vigorous physical activity, body image and sleep quality between young people in any weight category and those who are obese, with the exception of sleep quality between underweight and obese students.

Finally, it should also be noted that, given the nature of the study carried out, it has been possible to demonstrate the relationships between the different variables, but causality cannot be established.

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## Authors and translators' details:


| | | |
|---|---|---|
| Daniel Sanz-Martín | daniel.sanz6718@ui1.es | Author |
| José Luis Ubago-Jiménez | jlubago@ugr.es | Author |
| José Manuel Alonso-Vargas | alonsojm@ugr.es | Author |
| Eduardo Melguizo-Ibáñez | emelguiz@ull.edu.es | Author |
| Daniel Sanz-Martín | daniel.sanz6718@ui1.es | Translator |