

## **Gender differences in the association between physical activity and obesity in adults with vision and hearing losses**

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## ABSTRACT

**Background:** Physical inactivity is strongly associated with obesity, which in turn is a major risk factor for many non-communicable diseases. We examined associations between physical inactivity and obesity in Spanish adults with vision and hearing difficulties, and explored differences between men and women.

**Methods:** Data from the Spanish National Health Survey 2017 were analyzed (n=23089 adults [15-103 years, mean age 53.4±18.9 years, 45.9% men]). Participants self-reported difficulties in seeing and hearing. Physical inactivity (exposure) was evaluated with the International Physical Activity Questionnaire Short Form. Obesity (outcome) was defined as body mass index  $\geq 30$  kg/m<sup>2</sup> based on self-reported weight and height. The association between physical inactivity and obesity was assessed with multivariable logistic regression in people with difficulties seeing and hearing, adjusting for significant covariates.

**Results:** Multivariable logistic regression analyses showed that the association between physical inactivity and obesity was stronger in those with difficulty hearing (OR 1.778, 95% CI 1.215-2.602) compared to difficulty seeing (OR 1.375, 95% CI 1.076-1.756). Gender-stratified analyses showed significant association between physical inactivity and obesity in men who reported difficulty hearing (OR 2.319, 95% CI 1.441-3.735) and difficulty seeing (OR 1.556, 95% CI 1.079-2.244), but not in women.

**Conclusions:** A significant association between physical inactivity and obesity was observed in Spanish men with vision and hearing difficulties. Physical activity has an important role in the prevention of obesity in men with seeing and hearing difficulties. Active steps should be taken to encourage physical activity to reduce the risk of obesity in people with sensory impairments.

**Keywords:** Physical activity; obesity; sensory impairment; visual impairment; hearing impairment.

## 1. INTRODUCTION

Approximately 62.0% of adults are overweight and 26.6% have obesity in Spain, and the prevalence of obesity is increasing, with future projections estimating that 36% of men and 21% of women will have obesity by 2030.(1) As overweight and obesity are major risk factors for noncommunicable diseases such as cardiovascular diseases, diabetes, musculoskeletal disorders and some cancers,(2) it is very important to find ways to prevent overweight and obesity. In this context, a large body of literature provides evidence that physical inactivity (<600 MET-minutes/week of physical activity) is associated with obesity in the general population(2). A population group that has an especially high risk of developing obesity are people who have more barriers to physical activity, for example, those who have difficulties seeing, hearing or both.(3,4) Indeed, previous research has shown that people with difficulties seeing and with difficulties hearing carry out less physical activity than people without these difficulties,(5,6) and may, thus, be at higher risk of obesity.(3,7-9)

Sensory-impaired individuals may present a disinclination to leave the home because they might face several environmental barriers that may potentially reduce their physical activity due to fear of falls or other injuries.(10) This reduced physical activity may then influence higher prevalence of excess weight and obesity among people with sensory impairment.(11) This association could be also bidirectional in that obesity may be causing sensory problems.(3)

To the best of our knowledge, there are no representative population-based studies exploring the association between physical inactivity and obesity in men and women with

difficulties seeing and hearing. In particular, assessing gender-differences is important as previous studies have reported significant differences in physical activity and obesity between men and women in the general population.(2,7) Literature also suggests that difficulty in seeing is more prevalent in women (8) while difficulty in hearing is more common in men.(9) Considering the elevated mortality (12) and the decrease in functional capacity and quality of life in people with obesity and sensory impairment,(13,14) and the numerous benefits that regular participation in physical activity can produce in the treatment and management of these problems, epidemiological studies exploring this association including gender differences in these vulnerable groups are needed.

Thus, this study aims to explore these associations in a large sample of Spanish adults who self-reported difficulties in seeing and/or hearing. We hypothesized that physical inactivity will be associated with higher odds for obesity, and that this association will be stronger in women. There are various reasons as to why this association could be stronger in women. Previous research suggests that women in general have reduced O<sub>2</sub> carrying capacity and greater essential gender-specific fat (15), and these aspects could be aggravated due to sensory impairments.(16,17) Also, hormonal factors lead to greater initial levels of high density lipoproteins in women, causing a smaller change in the total cholesterol-high density lipoprotein ratio compared to aerobic training in men.(15) Furthermore, various hormonal fluctuations across women life span such as fluctuations in reproductive hormone concentrations uniquely predispose them to excess weight gain; hormonal changes across the menstrual cycle affect calorie and macronutrient intake and alter 24-hour energy expenditure, leading to weight gain(18). In fact, menopause can exacerbate visual dysfunction (19) contributing to higher weight gain in women.

## 2. METHODS

### 2.1. The Survey

The present study utilized data from the **most recent available version of the** Spanish National Health Survey (year 2017) with data collection taking place between October 2016 and October 2017. A total of 23,089 adults (age range 15-103 years, **mean age 53.4 ± 18.9 years**) participated in this survey, allowing for a representative sample of the adult Spanish population. A detailed description of the Spanish National Health survey is provided in previous literature.(20,21) Briefly, three-stage stratified sampling method was employed for data collection. In the first stage, census sections were taken into consideration, in the second stage the family dwellings, and in the third stage an adult (older than 15 years) was chosen within each dwelling. To select the sections in each stratum, the probability was proportional to their size. With regards to the dwellings, these were chosen with equal probability in each section using systematic sampling through prior arrangement considering the dwelling size. Therefore, due to this process, samples were self-weighting in each stratum. In order to select the person who had to answer the Adult Questionnaire, we applied the random Kish method, which assigns the same probability to all adults  $\geq 15$  years living in the house. The CAPI (computer-assisted personal interviewing) method was used for the data collection, and was implemented in the household of the participants. The interviewers who completed the questionnaires with the responses of the participants had been previously trained in this method. An informed consent form was signed by all participants before responding to the questionnaire. This research was conducted in accordance with the Declaration of Helsinki of the World Medical Association. In accordance with the regulation of the European Union, the file data for public use does not require the approval of an accredited

ethics committee for statistical or research purposes. The present study included 2550 people with difficulty seeing only (11.04% of the total survey sample), 1607 with difficulty hearing only (6.96% of the total survey sample), and 908 with both difficulty seeing and hearing (3.93% of the total survey sample).

## **2.2. Difficulty Seeing and Hearing**

Those who answered affirmatively to the question “Do you have difficulty seeing?” were considered to have visual difficulties. This group included those who may not be using their spectacles or contact lenses habitually as well as those who reported difficulty in seeing with their own spectacles/contact lenses.

Those who answered affirmatively to the question “Do you have difficulty hearing what is being said in a conversation with another person in a quiet place?” were considered to have difficulty hearing. This group was composed of people who may not be using a hearing aid and also those who had difficulty hearing with their hearing aid.

Those who answered affirmatively to the two previous questions were considered to have both difficulty seeing and hearing.

## **2.3. Physical inactivity (Exposure)**

The International Physical Activity Questionnaire (IPAQ) Short Form was used to measure physical activity. The unit of physical activity used was MET-minutes/week, where MET is the Metabolic Equivalent of Task. Total physical activity MET-minutes/week were calculated through the following formula: sum of Walking +

Moderate + Vigorous MET-minutes/week scores.(22) According to current physical activity recommendations and the guidelines for data processing and analysis of the IPAQ,(22) physical inactivity was defined as not achieving at least 600 MET-minutes/week of physical activity. IPAQ was developed for population surveillance of physical activity among adults aged 15–69 years, and its use with older and younger age groups is not recommended.(22) As IPAQ was completed only by people aged 15-69 years and, to avoid losing all the data of people  $\geq 70$  years, a missing category for physical activity was included in the regression analyses. IPAQ has been validated in adult populations from different countries showing acceptable validity ( $\rho=0.30$ , 95% CI: 0.23-0.36) and reliability (Spearman's  $\rho=0.81$ , 95% CI: 0.79-0.82).(23) The IPAQ Short Form has also been validated among Spanish university students showing adequate validity.(24)

#### **2.4. Obesity (Outcome)**

Height and weight were self-reported. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Obesity was defined as BMI  $\geq 30$  kg/m<sup>2</sup>, according to World Health Organization guidelines (<https://www.who.int/topics/obesity>).

#### **2.5. Covariates**

Participants reported their gender (woman/man) and the analyses were carried out following the international recommendations regarding gender in public health research.(25,26) The selection of the control variables was based on bivariate analyses and on past literature.(3,5,27-30) In addition to gender, sociodemographic variables included age, marital status, living as a couple, and education. Age was categorized

according to the accepted international definition of older adults as  $< 65$  years and  $\geq 65$  years.(31) Marital status was categorized as married and single/widowed/divorced/separated. Living as a couple was categorized as yes/no. Education was based on the highest educational level achieved and was categorized as  $\leq$  primary, secondary, and  $\geq$  tertiary. Smoking status was self-reported and categorized as never, current smoker, and past smoker. Alcohol consumption in the last 12 months was categorized as yes (any) and no (none). Participants who responded affirmatively to the questions “Do you use glasses or contact lenses” and “Do you use hearing aid?” were considered to use glasses or contact lenses and hearing aid, respectively.

## **2.6. Statistical Analysis**

The statistical analysis was performed with SPSS 23.0 (IBM, NY, USA). The prevalence of physical inactivity (exposure) and obesity (outcome) in Spanish men and women with seeing and hearing difficulties was studied in the following groups: difficulty in seeing only (n=2550, 60.4% women); difficulty in hearing only (n=1607, 50.7% women); difficulty seeing and hearing (n=908, 65.9% women). The prevalence of obesity (outcome) in Spanish adults, by physical activity and by covariates, was analyzed and significant differences between groups were tested with chi-square tests. All covariates that were significant in predicting obesity (outcome) were included in the regression models.

We conducted multivariable logistic regression analysis to assess the association between physical inactivity (exposure) and obesity (outcome) in the groups with seeing and hearing difficulties. Interactions of physical inactivity with gender were analyzed. Logistic regression analyses were adjusted for gender (except the gender-stratified



analyses), age, marital status, living as a couple, education, smoking, alcohol, glasses/contact lenses and hearing aid use. All variables were included in the models as categorical variables. Results from the logistic regression analyses are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The level of statistical significance was set at  $p < 0.05$ .

The missing data in the whole survey of 23089 individuals were: obesity (n=1070; 4.6%), physical activity (n=5312; 23.0%), marital status (n=39; 0.2%), living as a couple (n=139; 0.6%), smoking (n=22; 0.1%), alcohol consumption (n=26; 0.1%), hearing aid (n=1; 0.004%). The missing data in the group with difficulty seeing only (n=2550) were: obesity (n=178; 7.0%), physical activity (n=802; 31.5%), marital status (n=2; 0.1%), living as a couple (n=13; 0.5%), smoking (n=5; 0.2%), alcohol consumption (n=4; 0.2%), hearing aid (n=7; 0.3%). Missing data in the group with difficulty of hearing only (n=1607) were: obesity (n=107; 6.7%), physical activity (n=927; 57.7%), marital status (n=1; 0.1%), living as a couple (n=3; 0.2%), smoking (n=1; 0.1%), alcohol consumption (n=1; 0.1%). Missing data in the group with dual sensory impairment (n=908) were: obesity (n=125; 13.8%), physical activity (n=707; 77.9%), smoking (n=2; 0.2%), alcohol consumption (n=1; 0.1%).

### **3. RESULTS**

In the total sample of the Spanish National Health Survey (n=23089), there were 2550 people (1748 completed the IPAQ) who reported difficulty with seeing alone, 1607 (680 completed the IPAQ) people who had difficulty hearing alone and 908 (201 completed the IPAQ) people with difficulty with both.

The overall prevalence of physical inactivity (exposure) was 36.0% in those with seeing difficulty only, 39.6% in those with hearing difficulty only and 44.8% in those with both seeing and hearing difficulties. The higher prevalence of physical inactivity in the group with both seeing and hearing difficulties was maintained in both men and women. Women had higher levels of physical inactivity in all the groups. **(Table 1).**

The overall prevalence of obesity (outcome) was 22.2% in those with seeing difficulty, 22.5% in those with hearing difficulty and 26.1% in those with both seeing and hearing difficulties. **(Table 2).** With regards to the prevalence of obesity (outcome) in Spanish adults, by physical activity and by covariates **(Table 3)**, obesity was significantly more prevalent in adults with the following characteristics: < 600 MET-minutes/week of physical activity, men, age  $\geq$  65 years, married, living as a couple,  $\leq$  primary education, past smokers, no alcohol consumption, use of glasses/contact lenses and use of hearing aid.

Multivariable logistic regression in the overall sample showed that physical inactivity was significantly associated with obesity in those with difficulty hearing and in those with difficulty seeing (ORs 1.778 [95% CI 1.215-2.602] and 1.375 [95% CI 1.076-1.756] respectively) with significant interactions with gender. After stratifying by gender, the significant associations between physical inactivity and obesity were maintained in men (ORs 2.319 [95% CI 1.441-3.735] and 1.556 [95% CI 1.079-2.244], respectively), but not in women **(Table 4).**

#### 4. DISCUSSION

This is the first representative population-based study exploring associations between the levels of physical inactivity and obesity in Spanish men and women who have difficulties seeing and hearing. To note, the overall prevalence of physical inactivity (exposure) was 36.0%, 39.6% and 44.8% in the people with seeing only difficulty, hearing only difficulty and with both seeing and hearing difficulties, respectively. The overall prevalence of obesity (outcome) was 22.2%, 22.5% and 26.1% in people with seeing only difficulty, with only hearing difficulty and with both seeing and hearing difficulties, respectively. In addition, women had slightly higher levels of physical inactivity in all the groups compared to men. These results are consistent with previous studies that have reported higher levels of physical inactivity in people with multiple sensory impairment (32) and in women.(7) For example, a study of 6001 US participants (age distribution: 1766 adolescents between 12 and 19 years old and 4235 adults at least 20 years old; gender distribution: 3174 men and 2827 women) found that women with non-refractive visual impairment had lower levels of physical activity and higher levels of sedentary time compared to those with normal vision (33).

On exploring the association between physical inactivity and obesity, multivariate logistic regression showed a significant association between physical inactivity and obesity in men, but not in women. Our hypothesis outlined above was not upheld in that women would show a stronger association than men. These results indicate that physical activity has an important role in the prevention of obesity in men who have seeing and hearing difficulties, compared to women. There may a number of possible explanations for this. It has been shown that to prevent obesity, women resort more to healthy diets, such as the Mediterranean diet while men have been reported more to physical activity to reduce obesity. It is possible that changes in diet are more easily achievable than physical activity

in people with sensory difficulties.(34,35) It has also been reported that the type of physical activity performed normally by men has a higher intensity which becomes difficult in people with sensory impairments.(36) In addition, other methods to combat obesity, such as bariatric surgery, weight-loss medications and hormone therapies are more frequent in women than in men and this may indeed be true in people with sensory difficulties.(37) More research is needed to explore these factors further.

The main strengths of this study are the large representative sample and the use of a validated, reliable and internationally recognized questionnaire to measure physical activity.(22) However, the results of this study should be considered within its limitations. The age group of adults  $\geq 70$  years was not considered, as the IPAQ short form is designed for the age range of 15-69 years. The assessment of physical activity, obesity and difficulties seeing and hearing was self-reported, introducing scope for bias. Moreover, the design of this study was cross-sectional. Finally, diet and the use of bariatric surgery or weight-loss medications was not assessed in this study. Therefore, future longitudinal studies are recommended to explore the effect of physical activity interventions in the prevention and treatment of obesity in people with difficulties seeing and hearing, and these future studies should evaluate also diet and the use of bariatric surgery, weight-loss medications and hormone therapies in the participants.

In conclusion, those with combined seeing and hearing difficulties had the highest prevalence of physical inactivity (44.8%) and obesity (26.1%). Whilst women had higher levels of physical inactivity than men in all the groups, multivariate analysis showed a significant association between physical inactivity and obesity in Spanish men with difficulty seeing or hearing, but not in women. This supports advice that Spanish adults

should be encouraged to be as physically active as possible, especially men who have difficulties seeing or hearing. An effective strategy to increase the levels of physical activity in this population group would be through targeted intervention programs based on health education and physical education.

**Conflict of interest:** None.

**Funding:** None.

Key points:

- 2550 people with difficulty seeing alone, 1607 with difficulty hearing alone and 908 with both difficulty seeing and hearing.
- The association between physical inactivity and obesity was stronger in those with difficulty hearing (OR 1.778, 95% CI 1.215-2.602) compared to difficulty seeing (OR 1.375, 95% CI 1.076-1.756).
- The association between physical inactivity and obesity is significant in men who reported difficulty hearing (OR 2.319, 95% CI 1.441-3.735) and difficulty seeing (OR 1.556, 95% CI 1.079-2.244).
- Physical activity has an important role in the prevention of obesity in men with seeing and hearing difficulties.

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**Table 1.** Prevalence of physical inactivity (exposure) in Spanish adults, by seeing & hearing difficulties and by gender

| OVERALL                     | N    | ≥ 600 MET-minutes/week | < 600 MET-minutes/week | Missing values |
|-----------------------------|------|------------------------|------------------------|----------------|
| Difficulty seeing only      | 2550 | 1118 (64.0)            | 630 (36.0)             | 802            |
| Difficulty hearing only     | 1607 | 411 (60.4)             | 269 (39.6)             | 927            |
| Difficulty seeing & hearing | 908  | 111 (55.2)             | 90 (44.8)              | 707            |
| MEN                         |      |                        |                        |                |
| Difficulty seeing only      | 1010 | 497 (65.4)             | 263 (34.6)             | 250            |
| Difficulty hearing only     | 793  | 252 (64.3)             | 140 (35.7)             | 401            |
| Difficulty seeing & hearing | 310  | 59 (60.2)              | 39 (39.8)              | 212            |
| WOMEN                       |      |                        |                        |                |
| Difficulty seeing only      | 1540 | 621 (62.9)             | 367 (37.1)             | 552            |
| Difficulty hearing only     | 814  | 159 (55.2)             | 129 (44.8)             | 526            |
| Difficulty seeing & hearing | 598  | 52 (50.5)              | 51 (49.5)              | 495            |

*Values expressed in Frequencies (Valid %). "Valid percent" is the percent when missing data are excluded from the calculations.*

**Table 2.** Prevalence of obesity (outcome) in Spanish adults, by seeing & hearing difficulties and by gender

| OVERALL                     | N    | Without obesity | With obesity | Missing values |
|-----------------------------|------|-----------------|--------------|----------------|
| Difficulty seeing only      | 2550 | 1845 (77.8)     | 527 (22.2)   | 178            |
| Difficulty hearing only     | 1607 | 1162 (77.5)     | 338 (22.5)   | 107            |
| Difficulty seeing & hearing | 908  | 579 (73.9)      | 204 (26.1)   | 125            |
| MEN                         |      |                 |              |                |
| Difficulty seeing only      | 1010 | 762 (78.2)      | 212 (21.8)   | 36             |
| Difficulty hearing only     | 793  | 586 (76.1)      | 184 (23.9)   | 23             |
| Difficulty seeing & hearing | 310  | 218 (76.5)      | 67 (23.5)    | 25             |
| WOMEN                       |      |                 |              |                |
| Difficulty seeing only      | 1540 | 1083 (77.5)     | 315 (22.5)   | 142            |
| Difficulty hearing only     | 814  | 576 (78.9)      | 154 (21.1)   | 84             |
| Difficulty seeing & hearing | 598  | 361 (72.5)      | 137 (27.5)   | 100            |

*Values expressed in Frequencies (Valid %). "Valid percent" is the percent when missing data are excluded from the calculations.*

**Table 3.** Prevalence of obesity (outcome) in Spanish adults, by physical activity and other covariates

| <b>Variables</b>         | <b>Categories</b>                                  | <b>Obesity</b> |
|--------------------------|--|----------------|
| Overall (n=23089)        | -  | 3910 (17.8)    |
| Physical activity *      | < 600 MET-minutes/week (n=5366, 30.2%)             | 1137 (22.2)    |
|                          | ≥ 600 MET-minutes/week (n=12411, 69.8%)            | 1712 (14.1)    |
| Gender *                 | Women (n=12494, 54.1%)                             | 2001 (17.1)    |
|                          | Men (n=10595, 45.9%)                               | 1909 (18.5)    |
| Age *                    | <65 years (n=16066, 69.6%)                         | 2423 (15.1)    |
|                          | ≥ 65 years (n=7023, 30.4%)                         | 1487 (21.2)    |
| Marital status *         | Married (n=12465, 54.1%)                           | 2270 (18.9)    |
|                          | Single/widowed/divorced/separated (n=10585, 45.9%) | 1636 (16.4)    |
| Living as a couple *     | Yes (n=12475, 54.4%)                               | 2260 (18.7)    |
|                          | No (n=10475, 45.6%)                                | 1632 (16.6)    |
| Education *              | ≤ Primary (n=7206, 31.2%)                          | 1658 (25.3)    |
|                          | Secondary (n=9936, 43.0%)                          | 1590 (16.5)    |
|                          | ≥ Tertiary (n=5947, 25.8%)                         | 662 (11.3)     |
| Smoking *                | Current smoker (n=5398, 23.4%)                     | 732 (14.0)     |
|                          | Past smoker (n=5962, 25.8%)                        | 1245 (21.5)    |
|                          | Never (n=11707, 50.8%)                             | 1932 (17.6)    |
| Alcohol consumption*     | Yes (n=14803, 64.2%)                               | 2309 (16.1)    |
|                          | No (n=8260, 35.8%)                                 | 1600 (20.8)    |
| Glasses/contact lenses * | Yes (n=15629, 67.7%)                               | 2806 (18.9)    |
|                          | No (n=7443, 32.3%)                                 | 1101 (15.4)    |
| Hearing aid *            | Yes (n=957, 4.1%)                                  | 187 (21.2)     |
|                          | No (n=22108, 95.9%)                                | 3720 (17.6)    |

Values expressed in Frequencies (Valid %). "Valid percent" is the percent when missing data are excluded from the calculations.

\* Significant differences in the prevalence of obesity.

Significant differences between groups were calculated with chi-square tests.

As all covariates were significant in predicting obesity (outcome), all of them were included in the regression models (Table 4).

**Table 4.** Associations between physical inactivity (exposure) and obesity (outcome) in Spanish adults with difficulties seeing and hearing, estimated by multivariable logistic regression (overall and by gender)

|  | Overall<br>(N=23089; 17777 with IPAQ) | Men<br>(N=10595; 8529 with IPAQ) | Women<br>(N=12494; 9248 with IPAQ) |
|--|---------------------------------------|----------------------------------|------------------------------------|
| Only difficulty seeing (n=2550; 1748 with IPAQ)    | 1.375 (1.076-1.756)*                  | 1.556 (1.079-2.244)*             | 1.254 (0.896-1.756)                |
| Only difficulty hearing (n=1607; 680 with IPAQ)    | 1.778 (1.215-2.602)**                 | 2.319 (1.441-3.735)***           | 1.442 (0.739-2.813)                |
| Difficulty seeing & hearing (n=908; 201 with IPAQ) | 1.745 (0.894-3.407)                   | 1.757 (0.655-4.717)              | 1.761 (0.679-4.567)                |

Values expressed in Odds Ratio (95% Confidence Interval). \* P < 0.05. \*\* P < 0.01. \*\*\* P < 0.001.

Logistic regression analyses were adjusted for gender (except the gender-stratified analyses), age, marital status, living as a couple, education, smoking, alcohol, glasses/contact lenses, and hearing aid.

IPAQ: International Physical Activity Questionnaire Short Form.