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ORIGINAL ARTICLE

Associations between obesity and ocular health in Spanish adults

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Abstract

Introduction: Obesity has been associated with poor vascular health, but not in a Spanish population. Therefore, the study aimed to investigate associations between obesity and cataract, wearing glasses or contact lenses, and trouble seeing in a large representative sample of the Spanish adult population.

Methods: Cross-sectional data from the Spanish National Health Survey 2017 were analyzed. Body mass index (BMI) was calculated and obesity was defined as BMI ≥ 30 kg/m^2. Ocular health included three dichotomous variables (presence vs absence): self-reported cataract, wearing glasses or contact lenses, and trouble seeing. Multivariable logistic regressions were used to assess associations between obesity (independent variable) and ocular health outcomes (dependent variables). Covariates included in the analysis were sex, age, marital status, education, smoking, alcohol, and diabetes.

Results: A total of 23 089 participants were included (54.1% female; mean [SD] age = 53.4 [18.9] years). After adjusting for sex, age, marital status, education, smoking, alcohol, diabetes, and wearing glasses or contact lenses (for the trouble seeing analysis only), obesity was found to be a risk factor for cataract (odds ratio [OR] = 1.22; 95% confidence interval [CI], 1.09-1.37) and trouble seeing (OR = 1.20; 95% CI, 1.09-1.32) but not for wearing glasses or contact lenses (OR = 0.99; 95% CI, 0.91-1.08). These findings were corroborated in participants ≥64 years.

Conclusions: In this large representative sample of Spanish adults, we found that obesity was a risk factor for cataract and trouble seeing. Lifestyle interventions aiming at the reduction of obesity in this population may indirectly improve ocular health. Such lifestyle interventions are important to implement considering the rising trend of obesity in Spain.

KEYWORDS
cataract, cross-sectional study, diabetic eye disease, glasses/contact lenses, obesity, ocular health, Spain, visual impairment

1 | INTRODUCTION

Approximately 62.0% of adults are overweight and 26.6% obese in Spain.[1] The prevalence of obesity is increasing in Spain, and it is estimated that 36% of men and 21% of women will be obese in this country in 2030. This increasing trend is of concern as obesity is an important risk factor for many chronic conditions such as cardiovascular disease,[2] diabetes,[3] cancer,[4] osteoarthritis,[5] and depression.[6]

Importantly, in addition to the commonly recognized health outcomes associated with obesity, there is an increasing body of literature suggesting that overweight and obesity are associated with poor ocular health (eg, cataract,[7–10] visual impairment,[11,12] and poor visual acuity[13]). For example, an Australian study of 3654 participants aged ≥49 years identified obesity as a risk factor for both cortical (odds ratio [OR] = 1.6) and posterior subcapsular cataract (OR = 2.1).[8] Another Swedish longitudinal study including almost 1000 elderly showed that there was a negative correlation between body mass index (BMI) and visual acuity.[13] Although the mechanisms behind the association between obesity and poor ocular health are insufficiently understood, potential mediators may be high intraocular pressure, oxidative stress, inflammation, diabetes, and hypertension.[14]

Several studies have investigated in the past two decades the prevalence of poor ocular health in Spain. A first cross-sectional observational study including 1155 elderly from the province of Cuenca estimated that the prevalence of visual impairment and blindness in the sample was 6.3% and 2.0%, respectively.[15] These findings were corroborated in a second study of 15 926 adults from Catalonia, as poor vision was reported by 5.3% of women and 4.1% of men.[16] However, to date, to the best of our knowledge, associations between obesity and ocular health have not been studied in a Spanish population. Major between-country differences may exist due to a wide range of factors (eg, medical, cultural, and political), and therefore the results of the previous studies may not be generalizable to Spain.

Owing to an increase in the number of Spanish adults with obesity,[1,17] a relatively high prevalence of poor ocular health,[15,16,18–21] an important economic burden associated with eye diseases,[22] and the fact that no studies have been carried out on associations between obesity and ocular health in this country, it is important to investigate these potential relationships in Spain. Thus, the present study aims to investigate associations between obesity and cataract, wearing glasses or contact lenses, and trouble seeing in a large representative sample of the Spanish adult population. Our hypothesis was that there would be a significant association between obesity and these clinical (cataract) and functional ocular variables (wearing glasses or contact lenses, and trouble seeing).

2 | METHODS

2.1 | The survey

Data from the Spanish National Health Survey 2017 were analyzed. This survey was undertaken in Spain between October 2016 and October 2017. Details of the survey method have previously been published.[23] In brief, for the data collection, a stratified three-stage sampling was used in which the census sections were first considered, then the family dwellings, and then an adult (15 years or more) was selected within each dwelling. The sections were selected within each stratum with probability proportional to their size. The dwellings, in each section, were selected with equal probability by systematic sampling, prior arrangement by size of the dwelling. This procedure leads to self-weighting samples in each stratum. For the selection of the person who had to complete the Adult Questionnaire, the random Kish method was used, which assigns equal probability to all people aged 15+ years in the household. The sample was representative of the adult population resident in Spain and consisted of 23 089 adults aged 15-103 years (average age 53.4 ± 18.9 years; 45.9% males). The method of data collection used was computer-assisted personal interviewing (CAPI), conducted in the homes of the selected participants. Trained interviewers completed the questionnaires with the responses provided by the participants. All participants signed an informed consent form before responding to the survey questions.

2.2 | Obesity (independent variable)

Height and weight were self-reported. BMI was calculated as weight in kilograms divided by height in meters squared. Using the standard World Health Organization (WHO) definition,[24] obesity was defined as BMI ≥ 30 kg/m^2. Previous research has

confirmed the validity and high accuracy of self-reported diagnosis of obesity.[25–27]

2.3 | Ocular health outcomes (dependent variables)

Ocular health included three dichotomous variables (presence vs absence): cataract, wearing glasses or contact lenses, and trouble seeing. Those who answered affirmatively to the question "Have you ever been diagnosed with cataracts?" were considered to have cataracts. Those who answered affirmatively to the question "Do you wear glasses or contact lenses?" were considered to wear glasses or contact lenses. Those who answered affirmatively to the question "Do you have difficulty seeing?" were considered to have trouble seeing (in the case of participants wearing glasses or contact lenses, they were asked if they had difficulty seeing when using their glasses or contact lenses). Previous research has confirmed the validity and high accuracy of self-reported diagnosis of ocular health.[28,29]

2.4 | Covariates

The selection of the control variables was based on past literature.[30,31] These control variables are confounding factors and the obesity-poor ocular health relationship may be biased if these variables are not accounted for in the statistical analyses. Sociodemographic variables included sex, age, marital status (married vs single/widowed/divorced/separated), and education (≤primary, secondary, and ≥tertiary). Smoking status was self-reported and categorized as never, past smoking, and current smoking. Alcohol consumption in the last 12 months was self-reported and categorized as yes (any) and no (none). Finally, diabetes was assessed with a yes-no question.

2.5 | Statistical analysis

The statistical analysis was performed with R 3.5.2 (The R Foundation).[32] Differences in the sample characteristics by obesity status were assessed by Chi-squared tests for all variables except age (*t*-test). We conducted multivariable logistic regression analyses to assess the association between obesity (independent variable) and ocular health outcomes (dependent variables) in the overall sample and in three age groups (ie, 15-44, 45-63, and ≥64 years). Logistic regression models were adjusted for sex, age, marital status, education, smoking, alcohol, and diabetes. The models including trouble seeing as a dependent variable were further adjusted for wearing glasses or contact lenses. All variables were included in the models as categorical variables with the exception of age, which was included as a continuous variable. There were missing data only for the following variables: marital status (n = 39; 0.17%), smoking (n = 22; 0.10%), alcohol consumption (n = 26; 0.11%), obesity (n = 1070; 4.63%), wearing glasses or contact lenses (n = 17; 0.07%), and trouble seeing (n = 26; 0.11%). Complete-case analysis was carried out. Results from the logistic regression analyses are presented as ORs and 95% confidence intervals (CIs). The level of statistical significance was set at $P < .05$.

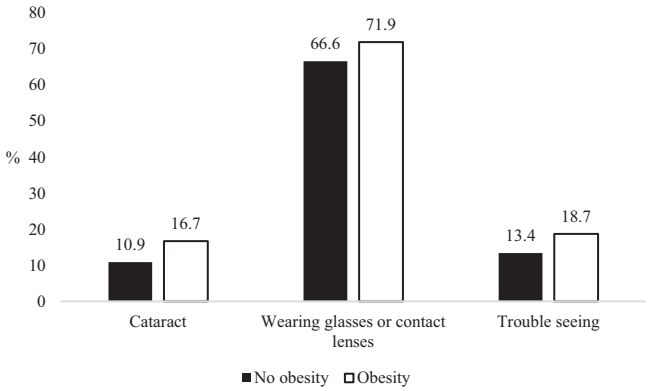

FIGURE 1 Ocular health by obesity status in a sample of 23 089 Spanish adults

Note. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared based on self-reported weight and height. Using the standard World Health Organization (WHO) definition, obesity was defined as ≥30 kg/m^2. Ocular health included three dichotomous variables (presence vs absence): cataract, glasses or contact lenses, and trouble seeing. Ocular health was compared between participants with and without obesity using chi-squared tests, and all *P*-values were lower than .001

3 | RESULTS

There were 23 089 participants included in the present study. The prevalence of obesity was 17.7% in the population. Sample characteristics (overall and by obesity status) are displayed in Table 1. The mean age of the sample was 53.4 years (standard deviation [SD] 18.9 years) and 45.9% were male. Individuals with obesity were more likely to be male, older, and married than those without obesity, whereas the prevalence of low education, past smoking, no alcohol, and diabetes was higher in the obesity than in the no obesity group. Cataract (16.7% vs 10.9%; $P < .001$), wearing glasses or contact lenses (71.9% vs 66.6%; $P < .001$), and trouble seeing (18.7% vs 13.4%; $P < .001$) were significantly more frequent in people with than in those without obesity (Figure 1). The results of the multivariate logistic regression models are shown in Tables 2 and S1. After adjusting for sex, age, marital status, education, smoking, alcohol, diabetes, and wearing glasses or contact lenses (for the trouble seeing analysis only), obesity was found to be a risk factor in the overall sample for cataract (OR = 1.22; 95% CI, 1.09-1.37) and trouble seeing (OR = 1.20; 95% CI, 1.09-1.32) but not for wearing glasses or contact lenses (OR = 0.99; 95% CI, 0.91-1.08). These findings were corroborated in people aged ≥64 years, but not in those aged 15-44 or 45-63 years.

TABLE 1 Sample characteristics (overall and by obesity status)

Characteristics	Category	Overall	No obesity	Obesity	*P*-value[a]
Sex	Male	45.9	46.4	48.8	.009
	Female	54.1	53.6	51.2	
Age	Mean (SD)	53.4 (18.9)	51.8 (18.8)	57.9 (16.5)	<.001
Marital status	Single/widowed/ divorced/separated	45.9	46.0	41.8	<.001
	Married	54.1	54.0	58.2	
Education	≤Primary	31.2	27.0	42.4	<.001
	Secondary	43.0	44.4	40.6	
	≥Tertiary	25.8	28.6	17.0	
Smoking	Never	50.8	50.0	49.3	<.001
	Past	25.8	25.1	31.9	
	Current	23.4	24.9	18.8	
Alcohol	No	35.8	33.6	40.9	<.001
	Yes	64.2	66.4	59.1	
Diabetes	No	90.2	92.3	82.0	<.001
	Yes	9.8	7.7	18.0	

Note. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared based on self-reported weight and height. Using the standard World Health Organization (WHO) definition, obesity was defined as ≥30 kg/m^2.
Abbreviation: SD, standard deviation.
[a] *P*-values were based on chi-squared tests except for age (*t*-test).

TABLE 2 The association of obesity (independent variable) with ocular health outcomes (dependent variables) estimated by multivariate logistic regression models

	Cataract			Wearing glasses or contact lenses			Trouble seeing		
	Odds ratio	95% confidence interval	*P*–value	Odds ratio	95% confidence interval	*P*–value	Odds ratio	95% confidence interval	*P*–value
Overall	1.22	1.09–1.37	<.001	0.99	0.91–1.08	0.814	1.20	1.09–1.32	<.001
15–44 years	0.78	0.18–2.42	.706	1.13	0.97–1.30	0.108	1.23	0.94–1.59	.118
45–63 years	1.18	0.88–1.57	.262	0.88	0.76–1.03	0.103	1.08	0.91–1.28	.361
≥64 years	1.18	1.04–1.33	.012	0.94	0.79–1.11	0.456	1.23	1.07–1.41	.003

Note. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared based on self-reported weight and height. Using the standard World Health Organization (WHO) definition, obesity was defined as ≥30 kg/m^2. Ocular health included three dichotomous variables (presence vs absence): cataract, glasses or contact lenses, and trouble seeing. Logistic regression models were adjusted for sex, age, marital status, education, smoking, alcohol, and diabetes. The models including trouble seeing as a dependent variable were further adjusted for wearing glasses or contact lenses.

4 | DISCUSSION

4.1 | Main findings

In this large representative sample of Spanish adults, the prevalence of cataract, wearing glasses or contact lenses, and trouble seeing was significantly higher in those with than in those without obesity. Furthermore, obesity was identified in the overall sample as a risk factor for cataract and trouble seeing, but not for wearing glasses or contact lenses. These results were corroborated in older participants. To the best of our knowledge, this is the first study to investigate the relationships between obesity and ocular health in Spain.

4.2 | Interpretation of the findings

Findings from the present study support previous literature showing that obesity is negatively associated with ocular health including an increased risk of cataracts[7–10] and trouble seeing (eg, visual impairment[11–12] and poor visual acuity[13]). For example, a US study including 87 682 women and 45 549 men followed for at least 10 years found that obesity was a risk factor for any type of cataract (relative risk = 1.36) after adjusting for several potential confounders (eg, age, smoking, and lutein/zeaxanthin intake), and that this association was the strongest for posterior subcapsular cataract.[7] Another cross-sectional study conducted in Afghanistan (n = 1281 adults aged

50 years or over) showed that the prevalence of visual impairment was 22.6%, and that overweight and obesity were associated with a 1.4-fold increase in the risk of visual impairment.[12]

Obesity has been linked to difficulty seeing as it has been shown to increase intraocular pressure and ocular hypertension.[33] High intraocular pressure damages vessels in the eye and leads to glaucoma, visual field loss, and in some cases blindness.[34] Moreover, overweight and obesity can lead to type 2 diabetes,[35] and one important sight threatening comorbidity of diabetes is diabetic retinopathy.[36] The relationship between obesity and cataracts is less clear but several hypotheses have been established. First, those with obesity exhibit hyperleptinemia and leptin resistance.[37–39] Leptin has also been found to increase accumulation of reactive oxygen species in various cellular models.[40,41] Second, a strong positive association between overweight/obesity and systemic oxidative stress has been observed.[42] Importantly, oxidative stress may play an important pathogenic role in cataract formation.[43] Obesity is associated with inflammation including elevated levels of C-reactive proteins[44] and fibrinogen,[45] whereas there is a positive inflammation-cataract relationship, thus partially explaining the role played by inflammation in the association between obesity and cataract.[46,47] Third, obesity is associated with hypertension, hyperlipidemia, insulin resistance, glucose intolerance, and diabetes,[48–50] and these conditions are known risk factors for cataracts.[7,8,51] Finally, one should bear in mind that the reverse association is possible, and cataract and trouble seeing may increase the odds of high BMI and obesity. Previous research has suggested that mobility difficulty is more frequent in people with than without visual impairment,[52] and there is a bidirectional relationship between mobility disability and BMI.[53] Therefore, trouble seeing may lead to reduced physical activity and reduced mobility that likely leads to weight gain and hypokinetic disease.

Interestingly, no association was found between obesity and the wearing of vision correctives. This may be because wearing of correctives is predominantly a result of refractive vision problems that obesity is not associated with. Next, the wearing of correctives may facilitate physical activity by allowing those with poor eyesight to overcome barriers to exercise participation. Indeed, engagement in physical activity is associated with weight loss.[54] Finally, these findings were corroborated in participants aged ≥64 years but not in those aged 15-44 or 45-63 years, and this could be explained by the fact that cataract and trouble seeing were not frequent conditions in young adults. Indeed, lens opaqueness is generally considered to be a common age-related progression and ages above 50 years have increased risk of developing all types of cataract.[55] Moreover, oxidative stress has a major function in the etiology of age-related cataracts[55] and those with obesity have higher levels of oxidative stress.[56]

4.3 | Clinical implications and directions for future research

Based on the present findings, health professionals should be aware of the fact that people with obesity are at an increased risk for cataract and trouble seeing compared with people without obesity. Given the associations identified in the present study, general practitioners should consider asking patients with obesity about their ocular health, and refer those with ocular symptoms to ophthalmologists. Even in the absence of visual symptoms, ophthalmologic evaluations should be offered on a regular basis (eg, every 2 years). Regarding the management of obesity, poor ocular health may be of concern as it may increase physical inactivity.[57] Finally, future studies of longitudinal design are warranted to corroborate our findings, to gain a better understanding of the potential causality of the associations between obesity and ocular health, and to identify mediators involved in these relationships.

4.4 | Strengths and limitations

Strengths of the present study include the large representative sample of Spanish adults and the first investigation between obesity and several ocular health outcomes in such a sample. However, the present study should be interpreted in light of its limitations. First, obesity and ocular health were self-reported, and this may have biased the present findings. Second, there was no information on the volume of smoking and alcohol consumption, and more data on these behaviors would have allowed more detailed analyses. Third, the data are of a cross-sectional nature and it is therefore not known whether poor ocular health is driving obesity or whether obesity is driving poor ocular health. The relationship is likely to be bidirectional.

4.5 | Conclusions

In conclusion, we found in this large representative sample of Spanish adults that obesity was a risk factor for cataract and trouble seeing. Lifestyle interventions aiming at the reduction of obesity in this population (for example through physical activity and healthy diet) may indirectly improve ocular health. Such lifestyle interventions are important to implement considering the rising trend of obesity in Spain.

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AUTHOR CONTRIBUTIONS

Louis Jacob contributed to the design of the study, managed the literature searches, undertook the statistical analysis, wrote the first draft of the manuscript, and contributed to the correction of the manuscript. Lee Smith contributed to the design of the study, managed the literature searches, wrote the first draft of the manuscript, and contributed to the correction of the manuscript. Ai Koyanagi, Shahina

Pardhan, Peter Allan, Lin Yang, Igor Grabovac, Jae Il Shin, and Mark Tully contributed to the design of the study and the correction of the manuscript. Guillermo F. López-Sánchez contributed to the design of the study, managed the literature searches, wrote the first draft of the manuscript, and contributed to the correction of the manuscript. All authors contributed to and have approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data are available upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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