

Impacts of Obesity On Absenteeism and Indirect Costs Among Working Adults: A Longitudinal Analysis From The EpiDoc Study

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Research Article

Keywords: Obesity, Absenteeism, Indirect Costs, Cohort Studies.

Posted Date: September 27th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-882530/v1>

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Abstract

Background

Obesity leads to poor health outcomes and may adversely affect work productivity. Here, we aimed to investigate the association between obesity and absenteeism and to assess its indirect costs.

Methods

The study population included individuals actively working at baseline from the Epidemiology of Chronic Diseases Cohort (EpiDoC), a large Portuguese population-based prospective study. Body mass index was measured at baseline and in two follow-up interviews. Absenteeism in each wave of the EpiDoC was assessed by the question “Did you have a sick leave in the previous 12 months? yes/no”, followed by “How many days did you miss work due to sickness in the previous twelve months?”. Association between obesity and absenteeism was estimated with the negative binomial regression model, and indirect costs were computed by the human-capital approach.

Results

The EpiDoC included 4338 working adults at baseline. Prevalence of obesity among these individuals was 15.2% at baseline, and rate of absenteeism was 22.7%. Obesity was associated with a 31% increase in absenteeism incidence rate ratio ($P < 0.01$), with obese individuals missing 3.8 more days per year than those with normal weight (95% confidence interval [95%CI]: 3.1–4.5). This number is higher in women (4.6 days per year; 95%CI: 3.6–5.6), and obese women with white collar professions were 82% ($P < 0.01$) more likely to miss work. Extrapolating to the entire working population, absenteeism due to obesity incurred an additional cost of €236 million per year.

Conclusion

Obesity is an independent risk factor for absenteeism among working adults, leading to high economic costs. These findings suggest improved food and nutrition policies are needed to control the obesity epidemic and reduce the associated economic burden.

Background

Obesity, a condition resulting from excess accumulation of body fat, is a major public health problem that is responsible for increased patient morbidity and mortality (1, 2). In Portugal, rates of obesity are increasing, with a prevalence of 28.6% in 2015 according to the last National Health Examination Survey—almost double that reported in the previous ten years (3) This increase in obesity adversely impacts not only the public health system, but also the economy as a whole, incurring both direct and indirect costs.

The former results from the fact that treatment of obesity and obesity-related chronic conditions increases health expenditures (4). In addition, because obesity and its consequences can impact individual productivity and workforce participation, this condition also affects the labour market, leading to indirect costs. Thus, the impact of obesity can also be observed at the macroeconomic level via negative effects on a country's gross domestic product (GDP) and increased fiscal pressure associated with added costs to the healthcare system and social security (5).

Indirect costs are defined as losses resulting from reduced work productivity due to short-term and long-term inability to work (6). Diseases such as obesity lead to decreased productivity by increasing the number of working days lost due to illness or injury (7). Thus, public health is closely linked to economic output. A simple example of this convergence between public health policies and the economy is the recent scenario wherein the world experienced unprecedented changes in work and life-style habits due to the coronavirus disease 2019 (COVID-19) pandemic. That is, widespread "lockdown restrictions", which were instituted to control spread of the virus and reduce the burden on healthcare systems, affected not only individuals' physical and mental health, but also completely changed the social dynamic and had large impacts on the economy. Further, additional COVID-19-associated indirect costs were incurred due to worsened disease outcomes with obesity and increased cost of care for obese individuals (8, 9).

Two studies from Europe, both conducted in Germany, attempted to calculate the indirect costs of obesity and estimated that these account for 0.47–0.61% of the GDP, with approximately €11,265 million in total costs attributable to obesity, as defined by body mass index (BMI) ≥ 30 (10, 11). Notably, however, almost all existing studies to address this topic were conducted in Northern and Central Europe, and to our knowledge, no recent studies have measured the indirect costs of obesity in Southern Europe (6, 12, 13). Thus, the full costs and burdens associated with obesity in this region remain unknown. Here, to address this question and better understand the costs of obesity in Southern Europe, we conducted a longitudinal study aimed at evaluating the association between obesity and absenteeism in Portugal and to assess its indirect cost over time.

Methods

Study population

The data analysed in this study were collected as part of the Epidemiology of Chronic Diseases Cohort (EpiDoC), which was initiated in 2011. The EpiDoC is a closed prospective cohort that aimed to create a large population database for medical and health-related research in Portugal. It comprises a representative sample of adults (≥ 18 years old) who were non-institutionalized and living in private households in mainland Portugal or its islands (Azores and Madeira). Participants were selected using multistage, random sampling, as described elsewhere (14), and baseline assessment involved a face-to-face interview. All participants enrolled in EpiDoC 1 (2011–2013; $n = 10,661$) and those who provided their telephone number were enrolled in the subsequent follow-up evaluations, EpiDoC 2 (2013–2015)

and EpiDoC 3 (2015–2016) (15). Data were collected via a structured questionnaire through phone interviews, using a computer-assisted personal interview system.

The population of interest for the present study included all subjects ≥ 18 years of age who were employed either full-time or part-time at baseline (EpiDoC 1). A flowchart illustrating the population of our study in each of the three evaluation periods is presented in Figure 1.

Outcome definition and measurement

Absenteeism was measured by the following questions: 1)"Have you had a sick leave in the last 12 months? yes/no"; and 2)" How many days did you miss work due to being sick in the last 12 months?". Answers to both questions from individuals in our population of interest were evaluated at EpiDoC 1 baseline and were retrieved for all of the same participants who remained in the study in EpiDoC 2 and EpiDoC 3 through telephone interviews.

Explanatory variables

Self-reported height and weight were collected, and BMI (weight/height², in kg/m²) was calculated. Individuals were then classified into one of four categories according to the World Health Organization (WHO) classification guidelines, as follows: underweight, <18.5 kg/m²; normal weight, 18.5–24.9 kg/m²; pre-obese, 25–29.9 kg/m²; and obese, ≥ 30 kg/m². However, for the purpose of this study, we used obesity as binary variable and considered BMI ≥ 30 kg/m² as positive predictor and BMI ≤ 30 kg/m² as a negative predictor of absenteeism, with normal weight as the reference category (16).

Covariates

To avoid possible confounding bias, we included demographic and socio-economic characteristics (*i.e.*, age, sex, education level) as covariates. For example, women are expected to have higher rates of obesity than men, and individuals with lower education are more likely to have poor eating habits and higher rates of chronic disease, and consequently, to miss more days at work due to sickness (17, 18). We also included ethnicity, marital status, and Nomenclature of Territorial Units for Statistics (NUTS II) code as categorical variables. Type of work was classified into one of two categories: white collar (management and administrative jobs) and blue collar (manual jobs). Differences in absenteeism are expected in these two groups, as BMI may be lower in workers who perform more physically active roles. However, these individuals also tend to have a lower level of education, and thus, blue collar work may simultaneously act as a protective variable and a risk factor in this population. In a further attempt to control for potential confounders, we used self-reported chronic disease status (mental disease, rheumatic disease, neoplastic disease, allergies pulmonary disease, gastrointestinal disease and urinary disease) as a binary (yes/no) response and accounted for lifestyle habits, including frequency of alcohol intake (daily, occasionally, never), smoking habits (daily, occasionally, past smoker, never smoked) and physical activity (yes/no). We then determined whether these factors could change the estimate of the association between the main independent variable, being obese, and the outcome, absenteeism.

Indirect cost calculation

We estimated the costs of work absenteeism using the human capital approach (HCA), a method that estimates indirect costs due to productivity loss. The HCA considers the entire period of absence from work due to illness and values this based on achievable gross income (19).

Here, to calculate the total amount lost in productivity based on days of work lost due to illness, it was necessary to create a new variable that represents the gross salary of each individual, as the EpiDoC included only family income, not individual income. To this end, we calculated the average income value for each wave, EpiDoC 1 (2011–2013), EpiDoC 2 (2013–2015), and EpiDoC 3 (2015–2016), by sex and age group, based on data available from the National Institute of Statistics (INE) (20). In order to adjust these wages for the corresponding inflation period, we used an Actualization Factor (AF) based on rates of variation of the Consumer Price Index (CPI) from the INE, for the period of interest. The income value for each sex and group age was then multiplied by the respective AF to obtain the final estimated wage value for each individual.

Monthly wages were converted into yearly wages and divided by 365 to obtain the value of a workday. For each individual, we then multiplied this value by the number of missed workdays per person year, to obtain the daily amount in euros spent for each day absent from work per individual/year. We then multiplied the prevalence of obesity by the total number of active people employed in 2015, based on INE data, and estimated the cost of absenteeism due to obesity per person/year for the entire population using the HCA.

Statistical analysis

Mean values, standard deviations, and 95% confidence intervals (95%CI) were computed for continuous variables, and categorical data were expressed as percentage values. We used the *t*-test with a significance cut-off of 0.05 to determine which predictors variables to include in the model. All significant predictors were tested using a forward selection model before fitting the final regression.

Previous studies have performed multivariate analyses of count data models determine the factors associated with workplace absenteeism (21, 22). Here, to choose the final analysis model, non-independence of observations was considered. We also took into account that the number of days absent from work it is a non-negative integer number, and that the conditional variance exceeds the conditional mean, which is indicative of the overdispersion phenomenon. We performed a series of regression models, including Poisson with fixed and random effects, negative binomial regression, and mixed-effect negative binomial regression, before choosing the final model.

The negative binomial model was chosen from a set of potential count data models, based on model fit (predicted probabilities for counts) and estimated prediction error (Akaike information criterion [AIC] and cross-validation). In the multivariate model, the magnitude of each association was expressed as incidence rate ratio (IRR) and 95%CI. Negative binomial regression was used to build models in which

potential confounders (*i.e.*, age, sex, education level, and NUTII) were adjusted simultaneously for the association between dependent and independent variables.

To test the association between obesity and absenteeism and ensure that this association remains independent despite the presence of other factors, we built scenarios to test this hypothesis. To this end, we compared each group of variables, including BMI, chronic disease, and lifestyle, with different regression models, and the model with the lowest AIC was chosen. The significance level was previously set at $P < 0.05$, and all analyses conducted out using the statistical software package STATA v.15.

Results

Sample characteristics

Of the 10,661 participants in the EpiDoC at baseline, 4,338 working adults were included in this study (Fig. 1), most of which were female 2482 (57.2%), Caucasian 4190 (96.6%), and blue-collar workers 2683 (61.8%) (Table 1). The average BMI was 25.8 kg/m² with 37% ($n = 1577$) of staff being overweight and 15.2% being obese ($n = 649$) and rate of absenteeism was 22.7% at baseline. The complete sociodemographic features and employment characteristics of individuals included in this study are listed in Table 1.

Health information and lifestyle habits of individuals included in this study are listed in Tables 1 and 2. High cholesterol was the most prevalent chronic disease among workers in all three waves, with frequencies of 20%, 22.2%, and 35.5%, respectively. Regarding lifestyle habits, more than 45% of employed and actively working individuals reported consuming alcohol occasionally and 15% consume alcohol daily. Most workers were non-smokers and reported that they were physically inactive

Association Between Bmi And Absenteeism

In the multivariate analysis, we tested the association between our main outcome (absenteeism) and four different sets of variables: 1) BMI only, 2) BMI plus chronic disease, 3) BMI plus lifestyle habits (*i.e.*, alcohol consumption, smoking habits, and physical activity), and 4) BMI plus chronic diseases and lifestyle habits. All sets were tested using three different regression models, including Poisson, negative binomial regression, and mixed-effect binomial regression. Overdispersion was detected, indicating negative binomial regression as the most appropriate model. However, for comparison purposes, results of all methods described are presented in Table 3. In all models, obesity was positively and significantly associated with absenteeism, independent of the set of variables that were tested. Based on negative binomial regression, obesity was associated with a 31% increase in absenteeism incidence rate (IRR: 1.31, 95%CI: 1.15–1.49; $P < 0.01$). This analysis was adjusted for sex, age, education level, income, and NUTII.

Probability Of Missing Work

When assessing the likelihood of absenteeism, we found that obese women were 68% (odds ratio [OR]: 1.68, 95%CI: 1.33–2.14; $P < 0.01$) more likely to miss work than their normal weight peers (Fig. 2). However, a significant increase in probability of missing work was not detected in pre-obese (overweight) women. Notably, increased probability of missing work due to obesity relative to normal weight employees was noted for women in both professional categories. That is, obesity increased odds of absenteeism by 82% (OR: 1.82, 95%CI: 1.33–2.50; $P < 0.01$) and by 48% (OR: 1.48, 95%CI: 1.00–2.18; $P < 0.01$) in women with white-collar and blue-collar professions, respectively. In contrast, we did not observe statistically significant increases in the probability of missing work among obese men overall or for those in either professional category (Fig. 2), although a pattern similar to that noted for women was detected.

Differences in absenteeism days and indirect costs across BMI categories

When assessing the total number of workdays missed by normal weight and obese employees, we found that obese employees miss an average 10.2 workdays per year, which is 3.8 more than normal weight employees, corresponding to a 31% difference ($P < 0.01$) (Table 4). Among men, obese individuals missed 3.5 more workdays per year, although as with the previous results, this difference was not significant. In contrast, women employees who were obese missed an additional 4.6 workdays per year (41% more) than normal weight women ($P < 0.01$).

We then calculated the indirect cost of absenteeism due to obesity for the total population and found that this ranged from €297.3 to €467.2 per employee per year (Table 2). In addition, for obese individuals, absenteeism cost an average of €158.8 more than for individuals with normal weight. For each obese adult man, we estimated the cost of obesity to be €361.5 per year, ranging from €213.6 to €509.6, and for each obese woman it was €398.6 per year, ranging from €301 to €496. Overall, the indirect cost of absenteeism per year for obese employees in Portugal was predicted at €568 million, which is €236 million more per year than for people with normal weight (Table 4).

Discussion

In this study, we investigated the relationship between obesity and absenteeism and found that obesity increased the incidence rate ratio of absenteeism by 31% in our study cohort, independent of other risk factors, including chronic disease and unhealthy lifestyle choices. Obese women, in particular, are more likely to miss work, especially those with white-collar professions, and we estimate that absenteeism due to obesity imposes a considerable financial burden on states, totalling an additional €236 million per year in Portugal.

In previously published study, obesity was found to increase the absenteeism incidence rate ratio by approximately 27%, than normal weight peers.(23). Some authors, when applying a longitudinal methodology to understand the causal relationship between obesity and absenteeism, found that obesity could act both as a direct explanatory variable and as a mediator for other variables linked to loss of

productivity, as obesity is also considered a risk factor for several chronic diseases(6, 23). These results are consistent with our findings showing similar degrees of obesity-associated effects on absenteeism, both when it is evaluated separately and when associated with other risk factors, such as chronic diseases and lifestyle habits. However, as has been recommended by other authors, prospective analyses are necessary to determine the time of occurrence, that is, whether diseases occur before or after an individual has become overweight or obese. Such studies would help to establish a clear causal framework for a meaningful attribution of the indirect costs of obesity(6).

Obese workers are more likely to report poor work ability or limitations in the amount, type, or quality of work they perform than their normal-weight counterparts (24). In the present study, we found that obese women were 68% ($P < 0.01$) more likely to miss work than normal-weight women, with significant increases in likelihood of absenteeism observed for women in both white- and blue-collar professions (82% and 48%, respectively). However, although similar trends were observed with men, the differences were not significant. Consistent with these results, a study from the United States found that the probability of missing work was significant across all professional categories for obese women, although among men, the results varied by occupation (4). This discrepancy with our findings for men may be due to the higher prevalence of obesity observed in the American study population, reported to be 23% among men; in contrast, male obesity rate in our study was 6.59%(25). Among women, similar rates of obesity were noted in both studies. This may be due to biological aspects related to the process of body fat accumulation, which begin at puberty and continue throughout life, as well as the complex interactions between genetic, epigenetic, and hormonal issues, and may explain the similar results reported in both studies [21, 23]

Numerous studies have shown that obesity is strongly associated with absenteeism. In one case, Finkelstein *et al.* reported that grade-I obese women (BMI, 30–34.9) in the United States miss 5.2 days per year due to illness or injury, which is 1.8 days more than normal-weight women, while grade-II (BMI, 35–39.9) and grade-III (BMI, ≥ 40) obese women miss 3.0 and 4.8 more days, respectively, than normal-weight women, with all increases statically significant (25). In contrast, grade-II and grade-III obese men miss approximately two more workdays per year than normal weight men, similar to what has been found in other studies(4, 25). Here, we found that obese individuals miss 10.2 workdays on average per year—3.8 more than their normal-weight peers. Obese women and men lose 12 and 8 working days per year, respectively, which is 4.6 and 3.5 days more, respectively, than their normal weight counterparts, with only results for women showing statistical significance. Similarly, a study conducted in London reported a loss of 9.5 workdays per year for obese workers. European countries have many common characteristics, relating to population distribution, sociodemographic characteristics, and prevalence of obesity itself. Thus, it makes sense that our results are more similar to those reported in London (26) than to findings from the United States(4, 24, 25). Regardless, all these studies report the key finding that obesity has a substantial impact on lost working days (4, 26). Adiposity and fat distribution are closely associated with whole body metabolism and long-term health, and consequently, obese individuals often have more chronic conditions associated with poor health status. Thus, we expect that this is the reason

that people with obesity display greater absence from work due to sickness, as well as increased healthcare consumption, relative to their non-obese counterparts.

Critically, absenteeism due to obesity imposes a considerable financial burden on states. In this study, we estimated that obese workers incur an additional cost of €236 million per year when compared to non-obese workers. These costs range from to €297 to €467 per year for each obese employee and are higher for women than men (€398.6 vs. €361.5, respectively). A previous study by Pereira *et al.* estimated the total indirect cost of obesity in Portugal in 2002 at €199,8 million, indicating that obesity causes considerable economic losses for the country [27]. Comparison with our findings reveals a difference of €37 million between the study by Pereira *et al.* and our estimate for obesity-associated costs due to absenteeism per year, despite that, it is important to say, that the methodology between the two studies is different, while Pereira *et al.* used Attributable Risk to calculate the number of deaths attributable to obesity, taking into account the relative risk of obesity prevalence estimates, (27), in our study we used absenteeism as main outcome and estimated the costs through the HCA extrapolating to all population using the prevalence of obesity in the years of study.

In Europe, the estimated cost of absenteeism varies from €117 to €1873, depending on cost category or comparison group (11), and worldwide, this same trend is observed (6, 12, 13, 26, 28). Further, international studies have attributed increases in health sector spending ranging from 30–60% to absenteeism, with indirect costs reaching \$8.65 billion per year in 2012(23, 25). Thus, the economic impact of obesity on both the health sector and society as a whole is undeniable, and numerous studies have reported this issue as a critical problem that is increasing in prevalence. We therefore expect that the implementation of strategies to prevent obesity could generate gains in productivity, as well as reduce the economic burden imposed by this disease.

We note, however, that this study has several limitations. First, the BMI values were based on self-reported weight and height, which could generate systematic bias, as people often underreport their weights and overestimate their heights (29). Second, our dependent variable, absenteeism, had a high number of zero observations, which substantially reduces the sample size of the study. However, by using appropriate statistical modelling and comparing different statistical approaches, we trust that our data are sufficiently robust to support our conclusions (21, 22). An additional challenge arises from the fact that, to the best of our knowledge, there is no standard methodology reported in the literature for evaluating the indirect cost of absenteeism due to obesity (7, 11, 12). Further, it is important to note that the salary values in this study were estimated based on the imputation of average worker wage data corresponding to the evaluation period of the EpiDoC and may therefore not be completely accurate. In addition, we assessed the cost of obesity with the HCA, which takes both an individual and societal perspective and has often been criticized for overestimating loss of productivity (19).

Despite these limitations, our study also has a number of key strengths. In particular, our data were obtained from a cohort representing the entire adult Portuguese population, and repeated measures can evaluate changes in outcomes over time. We also evaluated costs using obesity as the main predictor

variable, whereas most other studies evaluated costs related to obesity-related diseases, and not just obesity. For this reason, we expect that our study is less prone to confounding bias and thus, better able to determine associations between obesity and absenteeism, as well as to estimate its costs. Furthermore, our dataset containing information relating to days absent, chronic diseases, and lifestyle factors is quite robust for indirect cost estimates and allows for a comprehensive analysis of obesity-associated factors.

Conclusion

In this study, we analysed data from a large Portuguese population-based cohort and found that obesity is an independent risk factor for absenteeism that imposes a severe economic burden on society. Critically, future studies aimed at evaluating the cost-effectiveness and efficacy of specific interventions in the workplace for preventing obesity could yield key insights on the best methods and most effective policies for addressing this public health crisis and reducing obesity associated costs.

List Of Abbreviations

NUTS II	Nomenclature of Territorial Units for Statistics
BMI	Body Mass Index
EpiDoC	Epidemiology of Chronic Diseases Cohort
GDP	Gross Domestic Product
HCA	Human Capital Approach
INE	National Institute of Statistics
AF	Actualization Factor
CPI	Consumer Price Index
IRR	Incidence rate Ratio
OR	Odds Ratio
CI	Confidence Interval

Declarations

Ethics approval and consent to participate

The EpiDoC study was performed according to the principles established by the Declaration of Helsinki (World Medical Association, 2013), revised in 2013 in Fortaleza. Ethical approval was obtained by the National Committee for Data Protection and by the Ethics Committee of the Faculty of Medical Sciences

of the New University of Lisbon under the registration number 07-2011-CEFCM and 05-2012-CEFCM. Informed consent was obtained from all participants.

All methods were carried out in accordance with relevant guidelines and regulations as set out by Faculty of Medical Sciences of the New University of Lisbon Ethics Committee. Details on the ethical issues associated with the EpiDoC have been described elsewhere Rodrigues et al.¹⁵

Consent for publication

Not applicable.

Availability of data and materials

Data that supported this article is available on Dias SS, Rodrigues AM, Gregório MJ, de Sousa RD, Branco JC, Canhão H. Cohort Profile: The Epidemiology of Chronic Diseases Cohort (EpiDoC). *Int J Epidemiol*. 2018;47(6):1741-2j. <https://doi.org/10.1093/ije/dyy185>

Funding

This study was funded by Fundação para Ciência e Tecnologia, FCT, I. P. reference SFRH (PD/BD/135589/2018) and by ²Comprehensive Health Research Center (CHRC) (UIDP/04923/2020).

Authors' contributions

KD, JA, SD, MJG, HC, and AMR designed and conducted the study. SD, MJG, HC, and AMR performed data collection. KD, SD, and AMR analysed the data. KD, JA, SD, MJG, HC, and AMR interpreted the data. KD and AMR drafted the manuscript. KD, JA, SD, MJG, HC, and AMR revised the manuscript. KD takes responsibility for the integrity of the data analysis. All authors read and approved the final manuscript

Acknowledgements

We thank the Comprehensive Health Research Centre (CHRC) and the EpiDoC study group for their invaluable contributions and support in all phases of this study. We also would like to acknowledge the Fundação para Ciência e Tecnologia (FCT) for support this work.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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Tables

Due to technical limitations, table 1,2,3,4 is only available as a download in the Supplemental Files section.

Figures

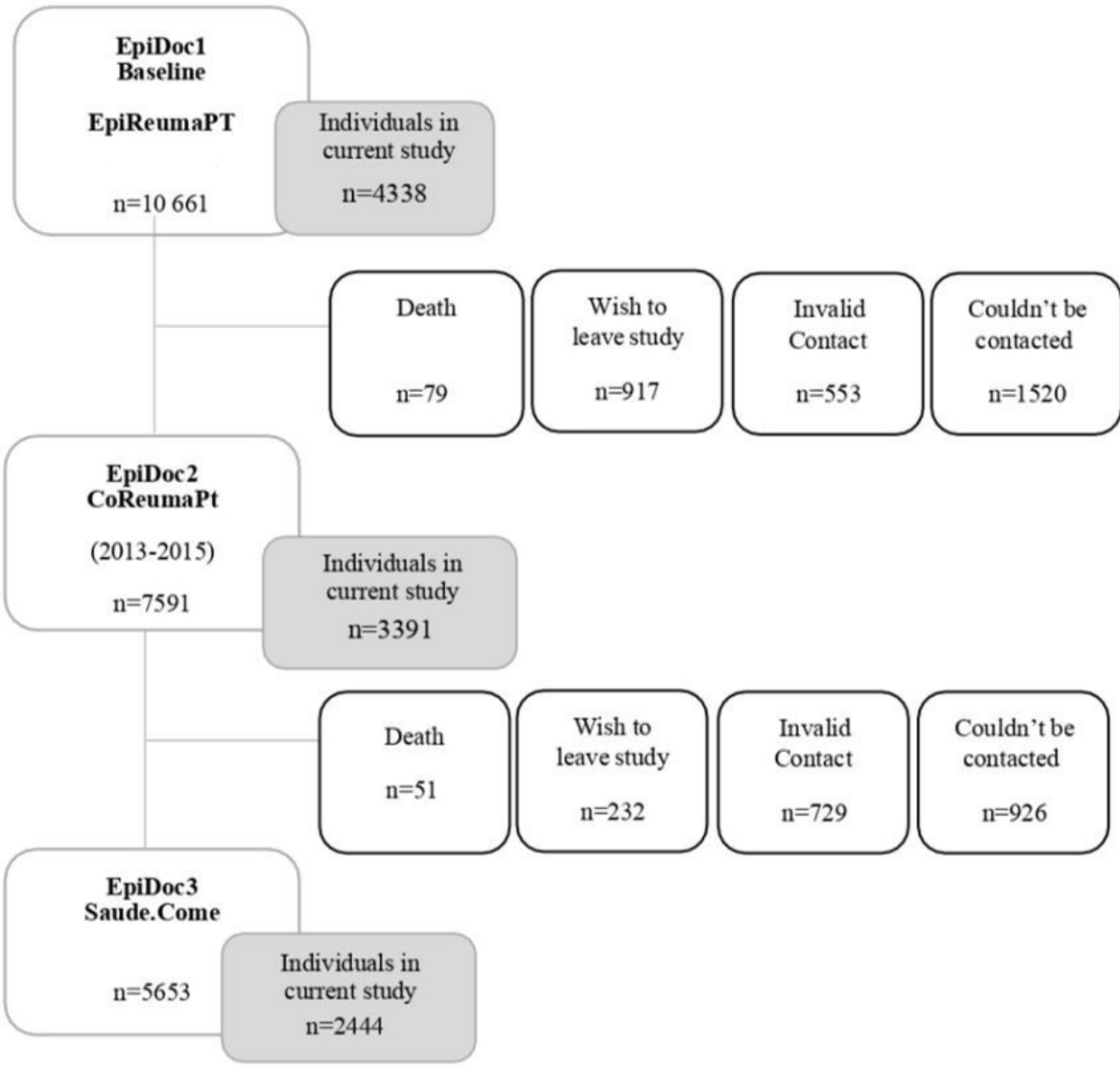


Figure 1

Flowchart describing the population eligible of the study

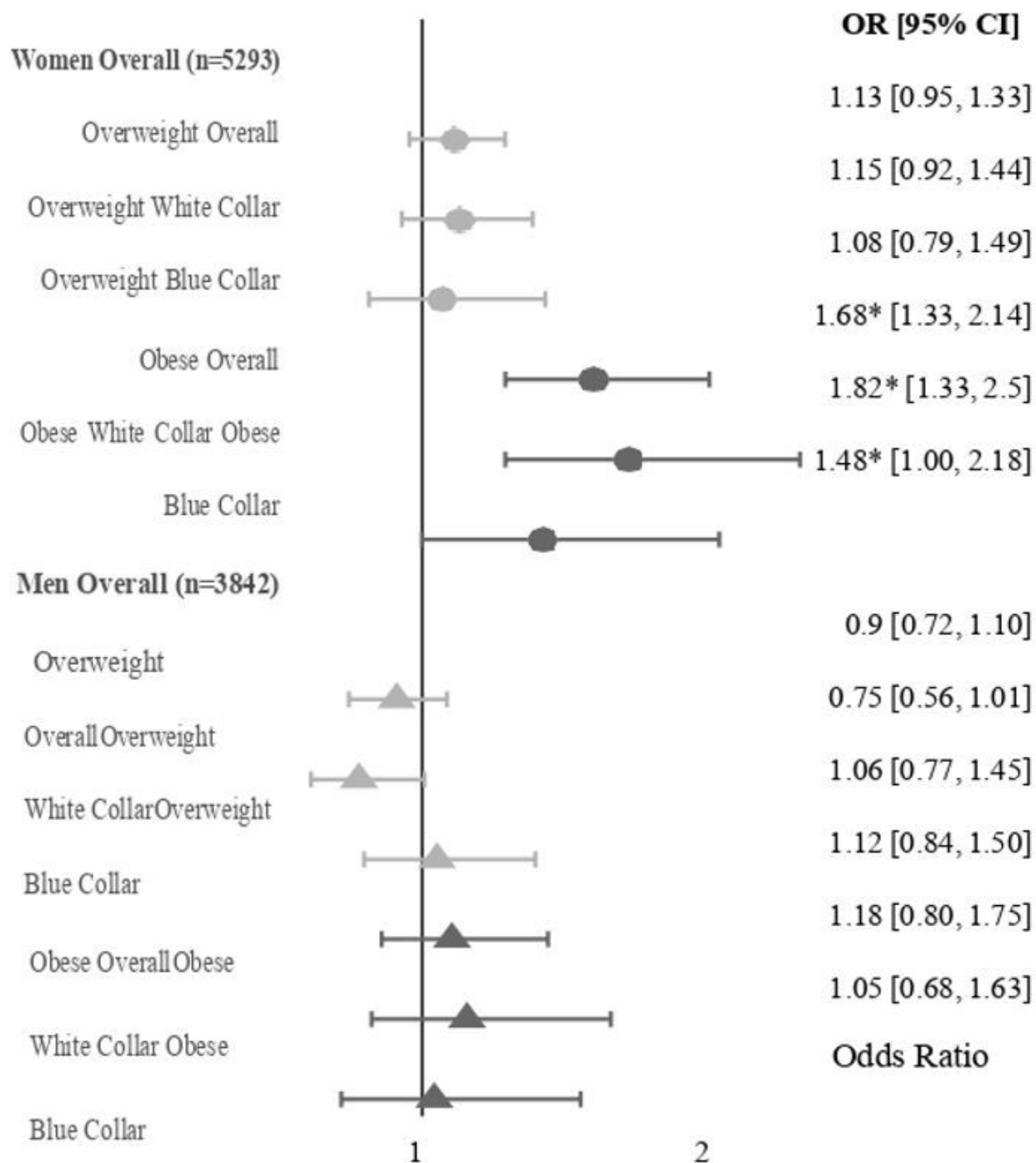


Figure 2

Probability of Missing Work, by Body Mass Index, Gender and Type of Work Reference category (IMC \geq 18,5 to \leq 24.9 kg/m²); * p < 0.10, ** p < 0.05, *** p < 0.01

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Table1.pdf](#)
- [Table2.pdf](#)
- [Table3.pdf](#)
- [Table4.pdf](#)