Gender differences and occupational factors in the risk of obesity in the Italian working population.

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Abstract

Background Obesity is a multifactorial condition and a major risk factor associated with several non-communicable diseases, as cardiovascular diseases, and with a higher risk of premature death and disability. Sex-specific factors play a key role and must be taken into consideration in studying occupational factors associated to the risk of obesity. The aim of this study was to investigate gender differences in Body Mass Index in a large cohort representative of Italian workers and, correlating this index with several demographic and occupational variables to verify differences due to the gender and work in the risk of obesity. Methods We utilized data from INSuLa, a cross-sectional nationally representative survey of the Italian workers population conducted in 2013 by the Italian Workers' Compensation Authority to investigate the health and safety at work. Analysis were run on a large sample of 8,000 Italian workers, aged from 16 to 64 years, representative of the Italian working population. Logistic regression models were carried out to assess gender differences in the association between occupational characteristics and Body Mass Index. We adjusted for age, education, variables related to health protection at work and chronic conditions and diseases. Results Findings showed several differences among males and females in the Body Mass Index due to exposure to several occupational factors, as occupational sector. Among the others, female shift workers were 1.32 times (95% CI = 1.11-1.57) more likely to be overweight or obese compared to normal workers, this association is maintained when controlling for confounders. A significant increase of 1.5-1.6 times in the likelihood of overweight or obesity was observed among women who worked 1-2 night shifts per week. Conclusions Gender-specific differences in studying occupational factors associated to the risk of obesity are useful in the view of characterizing the risk of obesity and contributing to the identification of workplace-targeted intervention strategies.

Background

The World Health Organization (WHO) defines obesity as a condition of "*abnormal or excessive fat accumulation in adipose tissue to the extent that health may be impaired*" (1, 2). This is a complicated, multifactorial condition that should be considered as a disease in its own right but, at the same time, it is a major risk factor associated with several noncommunicable diseases and with a higher risk of premature death and disability (2, 3-9). In the last decades, obesity (and overweight) prevalence has steadily grown at an alarming rate, so much so that nowadays we are openly talking about a pandemic of obesity (4, 10, 11). The most recent estimates provided by the Global Health Observatory data of the WHO indicate that nearly 2 billion adults worldwide are overweight and, of these, more than half a billion are obese (12). In this regard, the global prevalence of obesity is higher in women than in men in all continents, both among developed and developing countries (13-15).

The pathogenesis of obesity is substantially correlated to a long-term energy imbalance, between too many calories consumed and too few calories expended, that can result from a combination of overeating, reduced energy expenditure and physical inactivity (16). In turn, each of these parameters is strongly influenced by a myriad of demographic, social, cultural and occupational factors (14, 16). Many of such variables likely concur in increasing obesity in women. Nevertheless, there are some crucial aspects of the metabolic homeostasis that may affect the onset of obesity in a substantially different manner in the two sexes, since they are regulated differently in males and females (13). Fundamental sex differences include distribution and mobilization of adipose tissue storage, different insulin sensitivity and lipoprotein profiles and effects of gonadal hormones (17, 18). Therefore, sex-specific biological factors play a key role in the etiopathogenesis and must be taken into consideration in studying occupational factors associated to the risk of obesity. Then, it appears evident that individual physiology and behaviour may be also affected by socio-cultural influences and environmental determinants (14). In other words, sex-specific factors predispose to obesity, which in turn may develop in specific obesogenic settings. All these information gives us a fairly accurate picture of the incredible complexity of possible causal factors and their interplays ling behind obesity.

In this regard, workplaces should be considered in all respects as potential obesogenic environments since they can affect directly weight-related behaviours and lifestyles of workers and, at the same time, they expose them to occupational risk factors that can have a significant impact on the human body physiology (19-22). For example, scientific progress and technological innovation have greatly influenced the labour market leading to increased level of computerization, automation and mechanization (20, 23, 24). These changes have modified the types of working tasks in which workers are involved decreasing the strenuous activities, while increasing the sedentary jobs (25-27). Moreover, this trend is likely to be confirmed (if not even increased) in coming years by the advent of the so-called “fourth industrial revolution” or Industry 4.0 (28). In addition, it should be considered that adults of working age spend as much as 50% of their days (for a total of approximately 40 hours per week) at the workplace (29, 30). Therefore, considering that workers consume at least one of their daily meals at the worksite, the quality of food or the time and facilities offered by companies to this regard contribute importantly to daily energy balancing, also considering that spending most of waking hours at work inevitably decreases possibility to do leisure time physical activity (29).

Then, it is not surprising that different research groups investigated the prevalence of overweight and obesity among several occupational groups and sectors in representative samples of working population, mainly evaluating the Body Mass Index (BMI) levels. This is a simple widely used index calculated using a person’s weight and height that, classifying underweight, overweight and obesity in adults, represents one of the most helpful tool to evaluate obesity prevalence within a population (2). For example, Caban et al. (31), assessing the BMI levels in 603,139 United States’ workers belonging to 41 occupational groups, observed higher obesity rates in workers employed as motor vehicle operators, police or firefighters and other protective service workers. A similar study, conducted in an Australian worker population (n=25,900), showed that the higher obesity percentages were detected in advanced clerical, intermediate production and transport workers and labourers (29). Comparable findings, showing high BMI levels and obesity prevalence especially in transportation, commercial and protective services, health care support, welfare work and retail, wholesale trade and office workers, were obtained by Proper and Hildebrand (30) and Birdsey and Sussel (19) in Dutch and US workers, respectively. Other studies have further deepened the level of investigation on this topic trying to establish correlations between the obesity prevalence and some specific occupational factors or work organization characteristics. In this regard, associations were found with working hours, shift work, hostile work environment, sedentary work and low physical job demand, company size (20, 21, 32-38).

Some findings of the aforementioned studies showed also gender divergence in the effects exerted by work-related factors on the obesity but, in most cases, these results are not thoroughly analyzed or discussed, so much so that several authors agree on the need to conduct more in-depth studies in order to clarify the causes behind the weight disparity between male and female workers (19, 29). This is an important and timely topic especially considering the increased participation of women into the labour force and the fact that female workers are increasingly entered in previously male-dominated professions and occupations (20). Therefore, this study aimed to investigate the BMI in a large cohort representative of Italian workers and, correlating this index with several demographic and work-related variables, to verify the possible presence of gender differences in the risk of obesity.

Methods

Study population and survey procedure

This study was based on data from INSuLa, a cross-sectional nationally representative survey of the Italian workers population conducted in 2013 by the Italian Workers' Compensation Authority (INAIL) to investigate the health and safety at work. INSuLa counts 8,000 Italian workers representative of the entire national workforce aged from 16 to 64 years excluding self-employed, military and civil protection personnel. Sampling was done starting from the national workforce identified by the 2012 national Labour Force Survey, which provided information to define the universe and stratify the sample based on region, workers gender and age, type of contract, occupational level and occupational sector, thanks to the collaboration of the Italian Institute for Statistics (ISTAT).

The survey was conducted in the period from July to December 2013 and data were collected through structured interviews, using the Computer-assisted telephone interviewing (CATI) method, by trained interviewers from TNS Italia. A random procedure was applied to contact eligible persons via telephone (mobile and landline) and participants were selected proportionally based on the sampling strategy up to reach the sample characteristics. The standardized questionnaire developed to conduct the interviews was based on findings of a literature review and a benchmarking analysis of the most prominent European surveys in the field. It includes several questions aiming to investigate the main aspects linked to health and safety at work in terms of working conditions, risk exposure and perceptions, health status and outcomes, management and prevention, occupational health and safety professionals and legal aspects. Variables used in this study included main demographic and occupational variables traditionally linked to the BMI and the self-reported height and weight for computing the BMI.

Demographic variables and health related characteristics

Information collected by the participants included gender, age in years and education (<high school graduate, high school graduate, graduate and post graduate). Some information related to health conditions were collected asking to the participants the presence/absence of some diseases and/or chronic conditions generally linked to overweight conditions as musculoskeletal, respiratory, gastrointestinal, cardiovascular diseases and insomnia. Participants were also asked to report their height in cm and weight in kg from which their BMI was defined as weight in kilograms divided by the square of the height in metres (kg/m2). To analyse and interpret data we referred to the WHO's ranges for the BMI, namely underweight (BMI$\leq$ 18.5), normal weight (BMI $\leq$24.9 kg/m^2), overweight (BMI $\geq$ 25 kg/m^2) and obesity (BMI $\geq$ 30 kg/m^2)

Work related variables

Some occupational characteristics reported by the participants were included into this study to investigate some possible effects on BMI. The occupational sector based on the nine categories from the National industrial classification of all economic activities (ATECO), the occupational position (top and middle manager, white collar, blue collar, apprentice or other), the type of contract (permanent, fixed-term or temporary), shift work (yes/no), night work (no, 1 to 2 times a week, more than 2 times a week), working hours (usual number of hours worked per week in the last 6 months); the firm size (4 categories 1 to 9 employees, 10-49 employees, 50-249 employees and more than 250 employees). Moreover, some information related to health and safety protection at work were considered as being included in health surveillance (yes/no), the exposure to Video Display Terminal (VDT; yes/no) and the work-related stress risk (yes/no). Such work risks were included in this study for the recognized link to the risk of overweight and obesity. In particular, as regard to the exposure to VDT the purpose was included as an indicator of sedentary work related both to the musculoskeletal discomfort and increased possibility of sedentary behaviour and reduced physical activity.

Statistical analysis

Although the distribution of the participants was almost balanced, a weighting was applied in carrying out data analysis to reach the exact proportions and reflect the population at the time of the survey, taking into account the probability of being sampled and the differential response across the population. Body mass index (BMI) was computed by dividing weight in kilograms by height in meters squared. Descriptive statistics for mean BMI (sd) and prevalence of population overweight (BMI $\geq$ 25 kg/m^2) and obesity (BMI $\geq$ 30 kg/m^2) were tabulated by all the demographic and occupational variables included in the study and dived for gender. Logistic regression models were carried out to assess associations between occupational characteristics and BMI. The BMI measure was used as a dichotomous variable considering the overweight (BMI $\geq$ 25.0 kg/m^2) as cut-off. Occupational characteristics were entered as dummy variables and each category with the lowest mean of BMI, respectively for men and women, designated as the reference in all cases for ease of comparability. We adjusted for age, education, variables related to health and safety protection at work (health surveillance, risk to VDT and work-related stress risk) and chronic conditions and diseases. Analysis was conducted in six steps: Model 1 not adjusted, Model 2 adjusted for age, Model 3 adjusted for age and education level, Model 4 adjusted for age and education level, exposure to VDT and health surveillance, Model 5 adjusted for age and education level, exposure to VDT, health surveillance and exposure to work-related stress risk, Model 6 adjusted for age and education level, exposure to VDT, health surveillance, exposure to work-related stress risk and diseases and chronic conditions. Analyses were stratified by gender. The calculated p values were considered significant at $p<0.05$ and confidence interval (CI) at 95% was estimate. All analyses were carried out using the IBM SPSS Statistics version 21.

Results

Table 1 summarized the sample by presenting the means for continuous variable and showing the percentage for categorical variable of socio-demographic and occupational features in relation to the BMI levels. Descriptives related to the BMI were compared for gender. Mean age of respondents is 42.7 (±9.9) years, 53.8% are men, and 49.3% has a high school education level. As regard to the occupational characteristics, 23.2% of the sample is employed in the manufacturing/industry sector, followed by 17.7% in Commerce and 14.9% in Education and Public administration and 11.7% in other sectors. As regard to the occupational position, 46.8% of respondents are blue collars, 41% white collars, 8.9% top/middle managers; almost 85% of the sample has a permanent job/work contract. Thirty-three percent of respondents are shift workers; 5.2% works 1 to 2 night shifts during the last week of work, while only 3.3% works more than two night shifts. Sixty-three percent of the sample has worked between 35 and 40 hours per week over the six months preceding the survey; almost 38% works in a company with ≥250 employees. With regard to health and safety protection at work, 67.8% of the respondents receives health surveillance since exposed to a risk for health and safety at work, 90.1% reported exposure to VDT, while 55.4% exposure to work-related stress risks (sociodemographic and occupational characteristics of the sample are reported as supplemental materials).

Table 1 shows the descriptive statistics for BMI and prevalence of overweight and obesity by socio-demographic, occupational and health-related characteristics. First, we noted the BMI's mean of the Italian workers was 25.1 kg/m^2 with 38.1% being overweight and 8.6% being obese (data not shown in Table 1). Men had a significant higher BMI's mean (26.4 kg/m^2) than women (23.6 kg/m^2) and higher values were seen at increasing age for both sexes. As regard to educational level, for both males and females, a gradient was seen from the lowest to the highest educational attainment, where mean BMI progressively increased from those with a lower level of education. Regarding the occupational sector, the BMI of male workers exceeded the normal range in all sectors, with higher levels in healthcare (27.1 kg/m^2; 56.2% overweight and 16.0% obesity). Females working in agriculture had the highest BMI (25.0 kg/m^2; prevalence of overweight: 36.4%).

A gradient was seen from the top/middle management to the blue collar position in both sexes, with the latter having the highest mean BMI (26.5 men and 24.1 kg/m^2 women). However, a statistically significant difference was found only for females workers. Female shift workers show a significant higher BMI, while statistically significant differences were observed for working hours among men. No statistically significant differences were found for the type of contract, night shift and firm size.

Findings of the multivariate logistic regression modelling are showed from Tables 2 to 5. The most significant findings are presented as following in this section.

Men working in healthcare sector had significantly greater Odds Ratio (OR = 1.56, 95% CI = 1.02-2.37) of being overweight or obese, but this association lost significance after adjusting for confounders. Women working in agriculture and in other public and personal services were significantly associated with higher odds (4.4 and 2.8, respectively) of being overweight or obese, in both unadjusted and adjusted models. Furthermore, adjustment for age and educational level (Model 3) increased odds in transportation and healthcare sectors.

Male workers having a permanent job contract (Table 3) resulted in a significantly higher likelihood of overweight or obesity (OR = 1.52, 95% CI = 1.23-1.88) compared with those with a temporary one (Model 1), but the model is not significant after adjusting for age and educational level. A statistical significance is found again by adjusting for exposure to VDT and health surveillance (Model 4). On the contrary, women having a permanent job contract were significantly associated with lower odds of overweight or obesity compared to those having a temporary job contract, after adjusting for confounders.

Shift work showed interesting findings (Table 4). After adjusting for age, men shift workers had a significant increase by 1.25 times (95% CI = 1.06-1.46) in the likelihood of being overweight or obese. This association disappeared including exposure to work-related stress risk and chronic conditions as confounders. A negative association with overweight or obesity was observed also among female shift workers. In particular, female shift workers were 1.32 times (95% CI = 1.11-1.57) more likely to be overweight or obese compared to normal workers, and this association is maintained when controlling for confounders. When focusing on night shift (Table 5), a significant increase of 1.5-1.6 times in the likelihood of overweight or obesity was observed among women who worked 1-2 night shifts per week compared to day shifts.

No significant associations with overweight or obesity were found for occupational position, working hours and firm size.

Discussion

Findings of the present study indicated that the risk of developing an excessive fat accumulation in adipose tissue might be a consequence of exposure to several occupational or work-related factors and it is profoundly different for male and female workers. Previous studies observed that gender differences, regarding BMI levels and obesity prevalence, could be detected within the same occupational group or with reference to specific occupational variables (19, 29, 30). Although these data have been explained by calling into question in turn demographic, socio-economic, and cultural or lifestyle factors, the common conclusion in these studies was to deepen the research on this topic. In this context, we cannot obviously exclude the possibility that our results related to gender differences may be due to the contribution of determinants other than those considered in this study. However, the observation that in the adjusted analysis male and female workers showed a different susceptibility to obesity, even after having taken into account some key variables (i.e. age, educational level, sedentariness of work, psychosocial stressors and chronic diseases) suggests that, at least for some occupational factors, the role played by sex-specific differences is significant.

Therefore, assuming that this hypothesis is valid and considering workplaces as optimal and privileged adult settings where it is possible to plan, apply, and implement appropriate interventions to prevent and treat obesity, in our opinion these measures should certainly include, but at the same time not be limited to, healthy lifestyle behaviours promotion. Indeed, doing a regular physical activity and/or having a healthy and balanced diet are general recommendations that are always valid for all people (or workers) regardless of sex, demographic and socio-cultural variables and type or characteristics of the work being performed. Therefore, if we really want to take advantage of the workplaces to have available more strategies that are effective to win the battle against obesity, we have to begin to consider that this condition is not just a consequence of a personal choice, but rather it is caused by a complex interplay between an individual and the environment in which he lives (14). In this regard, to properly address this issue we need more qualitative and quantitative data to try answering some unsolved questions. For example, in this regard, what are the occupational groups or workers' categories that are at increased risk of obesity? Furthermore, are there other occupational risk factors besides sedentary work and diet that can be associated with obesity? Are they potentially modifiable factors? Moreover, considering the increase of women in the labour force and their increasingly involvement in roles and activities that were traditionally male focused, is it possible that some gender differences in work-related factors does exit potentially associated with obesity? Findings of our study provide helpful indications to address some aspects of the aforementioned questions. First of all, evaluating the main socio-demographic characteristics of the sample (sex, age and educational level) higher BMI values and overweight or obesity prevalence were observed in male workers, at increasing age and in subjects with a lower education (Table 1). These results are in accordance to the previous evidence, thus confirming that these variables are correlated with obesity (19-21, 29, 30, 37). Therefore, these socio-demographic determinants should be taken into account when trying to establish correlations between BMI and occupational groups or work-related factors, since they may be responsible for some variance in BMI levels (30).

The analysis of BMI according to different occupational sectors, revealed that male workers involved in healthcare and social assistance had the highest prevalence of overweight and obesity, whereas their female counterpart showed higher prevalence values in agriculture, fishing and hunting (overweight) and in construction, healthcare and social assistance (obesity) (Table 2). Overall, these data are consistent with the findings of previous studies further confirming that occupations that required sedentary behaviours or implied low levels of physical activity are characterized by increased levels of overweight and obesity prevalence (although this association is weaker in female workers) (20, 29, 30, 37). Nevertheless, some important differences should be pointed out since, differently by our results, several research groups observed higher prevalence rates in transportation and warehousing workers (19, 29-31, 37) and lower levels in the healthcare sector (31, 37). In our study, using the ATECO classification, transportation and warehousing workers are included in the same group of information and communication as well as workers included in the healthcare and social assistance sector carry out different job activities (i.e. healthcare practitioners and technical, healthcare support and protective services), whereas were considered individually in other studies (31, 37). Therefore, it is quite likely that these conflicting results are due to differences in classification of several occupational sectors although it is not possible to rule out an influence of socio-demographic and cultural factors (30).

With regard to these socio-demographic characteristics, we have also conducted an adjusted analysis in order to explore to what extent the BMI values (and the related overweight/obesity prevalence) observed in the several occupational groups were affected by differences both in the distribution of these variables and other work-related factors (Table 2). Findings confirmed that, for female workers, these determinants could have a significant impact in changing the OR in specific occupational groups. On the other hand, few occupational categories (i.e. agriculture, fishing and hunting and other public and personal services) were associated in a statistically significant manner with increased OR even after adjustment, thus suggesting that other work-related factors, specific for these occupational groups and not captured or assessed in the present study, can contribute to overweight and obesity. Moreover, the differences of occupational effect by gender point out that sex-specific factors other than socio-demographic and work-related determinants may influence the likelihood of overweight and obesity. Therefore, additional research on this topic investigating the reasons of weight disparity between male and female workers in different job categories is desirable and suggested (19, 30).

Besides knowing the obesity prevalence rates in the different workers' categories, however, it is also important to understand the reasons that determine them, and that is, in other words to identify the work-related factors (in addition to sedentary work, low physical job demand, worksite nutrition) that could possibly be associated with obesity. In this regard, a high risk of developing an overweight/obesity condition was observed in subjects who worked long hours (34, 39), similarly a working time ≥ 35 and > 40 or > 50 hours per week was significantly associated with increased BMI values in men (40) and with obesity in workers of both sexes (21, 37), whereas Kim et al., (35) found an association between this condition and long working hours only in female workers. In our study, no statistically significant association has been found between long working hours and overweight or obesity, even if female workers who worked > 40 and ≥ 55 hours/week showed the highest overweight and obesity prevalence, respectively. On the contrary, surprisingly in male workers the highest level of obesity was observed in the group that had the lowest working hours.

Interestingly, we found that shift workers have higher prevalence rates for overweight and obesity and this difference was statistically significant for female workers. In this regard, Luckhaupt et al., (37) and Di Milia and Mummery (34) obtained similar results showing an increasing prevalence of obesity and BMI levels in shift workers performing night or rotating shifts compared to day or evening shift workers. The increased odd of being overweight/obese in female workers persisted after adjustment for socio-demographic characteristics, variables related to health and safety protection and chronic diseases (Table 4) and a similar trend was observed also taking into account the exposure to night shifts (1 or 2 times per week) (Table 5). However, male shift workers were associated with an increased OR only when considering age, educational level or health surveillance and no statistically significant association was detected with regard to night shift work (Tables 4 and 5). Overall, these findings seem to suggest that the association among shift, night work and obesity is influenced by gender-specific variables. It has been suggested that inadequate or difficult working conditions can trigger a stress response that in turn may enhance the risk of obesity (41). Indeed, when a person experiences a stress condition the production of hormonal factors (especially of adipokine that are strongly linked to appetite and fat storage) changes substantially (42-44). Considering that, key sex differences in fat storage in men and women include differential insulin sensitivity and adipokine production it is plausible to hypothesize that the gender-specific differences observed in our study are due to this sex asymmetry (13, 17, 18).

Then, assuming the possibility that stressors can play a role in promoting weight gain, few studies have investigated the possible association between several psychosocial working conditions and obesity (20, 37). In this regard, a correlation was observed between hostile work environment and, to a lesser extent, job insecurity (37), whereas in the study carried out by Choi et al., (20) job demand, supervisor and/or co-worker support were not associated with increased obesity prevalence and only low job control in female workers showed a statistically significant difference. Our data are similar to those provided by Choi et al., (20) as no association has been established between male and female workers' exposure to work-related stress and prevalence rates for overweight and obesity. Furthermore, we studied also the type of contract (permanent or temporary) as a possible work-related stress factor since, having a temporary contract, is for workers a major source of concern about becoming unemployed. This variable was taken into consideration also by Luckhaupt et al, (37) who, while observing a greater prevalence of obesity in temporary workers compared to permanent ones, failed to identify a statistically significant association between work arrangement and obesity. Similarly, in the current study, no overall differences were found as regard to the type of contract. However, it should be noted that the analysis with the logistic regression models provided interesting findings highlighting, important differences between male and female workers (Table 3). Indeed, among females it seems that having a permanent contract is a protective factor against the risk of developing an obesity condition whereas this variable is instead associated with greater OR in men. Providing an explanation for these conflicting results is quite challenging since, several other factors of social, cultural and work-related nature (that have not been evaluated in our work) could be responsible for the differences obtained. Nevertheless, once again, the observation of a divergence of results by gender would suggest the need to focus attention primarily on the role played by biological/physiological gender differences in favouring or combating obesity in workplaces. That is, further research should verify whether exposure to specific occupational risk factors (i.e. long working hours, shift and night work, psychosocial stressors) is able to influence (and how) the expression of the aforementioned biological and physiological characteristics or of the functioning of some organ systems (e.g. the endocrine system) that could therefore determine a different propensity to obesity in male and female workers due to its significant impact on metabolism and adipose tissue storage.

Finally, our data showed a statistically significant association between overweight and obesity prevalence and several chronic conditions such as musculoskeletal, respiratory and cardiovascular diseases both in male and female workers (Table 1). These results further underline the importance of preventing and adequately treating obesity as excess weight gain is an important risk factor for several non- communicable diseases.

Strengths, limitations and future perspectives

Some strengths of this manuscript might be found. First, this addresses a large sample of Italian workers representative of the Italian working population, filling the gap of the lacking of studies on occupational factors and risk of obesity in the Italian context. Having studies on national representative samples represents a value add when investigating on aspects related to overweight and obesity, since there is huge evidence of external socio-cultural factors, such as diet culture, acceptable lifestyles, behavioural patterns affecting a person's weight. Secondly, we included several occupational factors in the risk of obesity by adjusting for main confounders. Even if there are studies considering occupational aspects, they mostly refer to specific occupational populations and sectors. Moreover, we consider a large set of occupational variables including the ones generally less investigated (e.g. work shift, night work, type of contract) in relation to the obesity, and relevant under the perspective of gender differences. Finally, this study does not limit to control for gender, but takes into consideration gender-specific differences in studying occupational factors associated to the risk of obesity in order to characterize better the risk of obesity categories and contribute in the identification of workplace-targeted intervention strategies.

Some limitations may be addressed too in the view of future improvements. First, the cross-sectional design that allows us to describe associations but not causation. In other words, we are not able to draw causal inferences about the effect of the different variables on overweight and obesity since we cannot define the directionality of the associations observed. Nevertheless, data were collected as part of a national project, a well-established worker-population survey named INSuLa, on a representative sample including reliable information on several socio-demographic variables and working conditions. This survey is becoming a monitoring system allowing to appreciate changes over time. Moreover, thanks to this study, we collected by data some suggestions to integrate measures in the next waves. To this regard, aspects related to the attitudes and behaviours related to meal during the work time and physical activity will be considered in the future and linked to the BMI.

As second limitation is related to the self- report nature of the body weight and height measure. Consequently, BMI calculations are subject to error and our findings might be potentially vulnerable of reporting bias. As it is noting people have a tendency to overestimate their height and, at the same time, to underestimate their weight and this self-report bias is higher among overweight and obese individuals

(45, 46). However, in this regard, it has been observed that in adult subjects measured and perceived BMI values are strongly correlated (47) and a limited number of studies, evaluating the differences between self-reported and measured anthropometrics in selected working categories, provided evidence that self-reported weight and height information is a reliable tool to assess BMI in large population worker samples (48-50). Future studies might provide investigation on validity of self-report vs measured BMI in specific Italian occupational groups and considering some sociodemographic differences (as gender, age, educational level).

Conclusions

Previous studies, investigating the relationship between work and obesity, found that BMI levels of workers may be significantly associated with some work-related factors and have also observed different obesity prevalence among various occupational groups and/or sectors. Basing on these results, several authors have rightly suggested the possibility of implementing specific measures to counteract obesity in the workplaces. These workplace-targeted intervention strategies should be particularly aimed at workers belonging to job categories that are at higher risk of obesity or exposed to occupational factors that have been identified as possible elements favouring the onset of this disease. Unfortunately, the effectiveness of such interventions remains currently unclear and uncertain. From a public health perspective, although some encouraging signs of improvement have been observed, the identification and promotion of updated policies are yet under considered (including food pack labelling, public campaigns to increase people awareness and health promotion, pricing and fiscal measures and changes in portion sizes), particularly in the light of reducing obesity prevalence (51-54). Indeed, no single country was able to obtain a significant and sustained decrease in obesity prevalence because of the application of comprehensive and multidisciplinary policies (4, 11, 55).

In this context, the information reported in the current study add some interesting findings to the current state of knowledge on this topic suggesting that the issue of gender differences should be adequately taken into account in the evaluation of the complex and multifaceted interactions between obesity and worker, work environment and/or working activities. This perspective opens up interesting scenarios concerning the possible design and application of innovative strategies to tackle obesity both in workplaces and in other living settings. In our opinion, the cornerstone of an efficient obesity prevention system should include a gender-tailored communication strategy. In this regard, we agree with Kanter and Caballero (56) about the fact that the same information (on obesity prevention) provided both to male and female workers, if conveyed in a gender-specific manner could achieve much better results.

Abbreviations

WHO - World Health Organization

BMI- Body Mass Index

INAIL- Italian workers compensation Authority

ISTAT - Italian Institute for Statistics

CATI - Computer-Assisted Telephone Interviewing

ATECO – Economic Activities

VDT - Video Display Terminal

OR - Odds Ratio

CI- Confidence Interval

Declarations

Ethics approval and consent to participate

We analysed secondary data provided by the INSuLa survey, developed in 2014 by the INAIL (Italian Workers' Compensation Authority) into the triennial research plan 2013–2015 and on the basis of a project commissioned by the Italian Ministry of Health. Survey was commissioned and approved by the Ministry of Health's Scientific Committee and ratified by the INAIL's Scientific Committee that approved the study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Verbal informed consent was obtained from all participants included in the study in accordance with the procedure of the Computer Assistance Telephone Interview.

Availability of data and materials

Data used into the study are from INSuLa survey developed by INAIL and has been made available to authors by their Institute for developing secondary analysis, in accordance with the INAIL's research aims.

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Competing interests

The authors declare that they have no competing interests.

Authors' Contributions

LF and CDT are equally contributing first authors since they contributed to all sections of the paper; particularly LF took care of the theoretical framework, literature review and to the Discussion, CDT took care to the Methods, to the definition of the data analytical strategy and to the Discussion. GA contributed to the literature review and interpretation of data. She took care of the writing of the Results sections. MP contributed in the interpretation of data and provided comments to the work. SI contributed to the conception and design of this study and interpretation of data, and he took care of critically revising the work. All authors read and approved the manuscript.

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Consent for publication

Not applicable.

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