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The Prevalence of Normal-Weight Obesity and Its Possible Related Dietary Factors: A Cross-Sectional Study of University Employees of Shiraz, Iran

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ABSTRACT

Background: Normal-weight obesity (NWO), defined as normal body mass index (BMI) but high body fat, is related to chronic health conditions. This study aims to assess the prevalence of NWO and some possible relationships with dietary factors in an Iranian population. **Methods:** A cross-sectional study was conducted on the participants of the Employees Health Cohort Study, Shiraz, Iran. Based on the anthropometric assessments, participants were categorized into three groups: Normal-weight non-obese, NWO, and Overweight/Obese. NWO was defined as having a normal BMI but high body fat. Body fat was assessed by bioelectrical impedance analysis. Then, a 116-item semi-quantitative Food Frequency Questionnaire (FFQ) was used to obtain food intake. Dietary factors included energy intake, macro-nutrients intake, frequency of meals, fried and grilled foods' consumption, and salt intake. **Results:** Overall, 1038 participants (513 men and 525 women) were studied with a mean age of 41.04±6.98. 35.9% had normal weight and 63.0% were overweight or obese according to BMI criteria. Based on WHO criteria, the prevalence of NWO was 21.68% and 26.63% among men and women, respectively. Women were more likely to have excess body fat compared with men (P<0.001). Moreover, no significant relationship was observed between any dietary factor and NWO. **Conclusions:** NWO was prevalent among university employees, and no relationship was observed between dietary factors and NWO. Considering the high cardio-metabolic risk of this condition, it needs further attention.

Keywords: *Normal-weight obesity; Obesity; Body fat; Dietary behaviors.*

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Introduction

Obesity has been a global health concern for several decades. This overwhelming condition is the underlying cause of various negative outcomes such as hypertension, type-2 diabetes, heart disease, cancer, non-alcoholic fatty liver, depression, and rheumatoid arthritis (Agha and Agha, 2017). Therefore, assessing and controlling this issue is considered a priority in

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health plans (Sacks *et al.*, 2020).

Body Mass Index (BMI), due to its convenience, is the most common and applicable measure to categorize weight status and identify the over-weight and obese (Berthoud and Klein, 2017). However, BMI has notable drawbacks; particularly, it is not useful for identifying excess body fat as the true meaning of obesity (Jan and Weir, 2019). It should be noted that body fat is a substantial indicator of health status, with regard to both its amount and specific site accumulation (Jan and Weir, 2019). High body fat has been significantly related to type-2 diabetes, hypertension, and other cardio-metabolic complications (Chen *et al.*, 2019a).

Normal Weight Obesity (NWO), a relatively new term, is a status that describes an excess body fat with a normal BMI (Oliveros *et al.*, 2014). Therefore, as this phenomenon is taking into account both fat mass and BMI, it could more properly reveal neglected susceptibility to chronic diseases (Pacheco *et al.*, 2016). Previous studies indicated that high percentage and abnormal distribution of fat and central obesity in NWO are associated with undesired metabolic consequences such as insulin resistance, hypertension, hyperglycemia, dyslipidemia, metabolic syndrome, and cardiovascular diseases (De Lorenzo *et al.*, 2013, Oliveros *et al.*, 2014, Wijayatunga and Dhurandhar, 2021).

Of lifestyle factors related to high body fat, diet plays a major role (Chen *et al.*, 2019b). Both diet ingredients and dietary behaviors may affect fat accumulation and therefore contribute to metabolic health. The relationship between a few healthy or unhealthy dietary parameters and NWO has been demonstrated in previous studies but macronutrients analyses have not yielded a consistent association with NWO (Männistö *et al.*, 2013, Schrijvers *et al.*, 2016).

As different criteria are used to estimate the prevalence of NWO, considerable differences exist among different studies. Moreover, geographic, demographic, and ethnic factors seem to be the other causes of these differences (Pacheco *et al.*, 2016, Wijayatunga and Dhurandhar, 2021). To the best of the authors' knowledge, no study has been conducted to estimate NWO prevalence among Iranian employees' population. Thus, the aim of the present study is to evaluate the prevalence of NWO among employees of Shiraz University of Medical Sciences and examine the possible relationships with some dietary factors.

Materials and Methods

Design and population

The present cross-sectional study was reported based on Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline (Elm *et al.*, 2007). This study was conducted on baseline data of the Employees' Health Cohort Study (EHCS) at Shiraz University of Medical Sciences (SUMS), Shiraz, Iran.

EHCS-SUMS is an ongoing prospective cohort study started in 2017 as a subset of Prospective Epidemiological Research Studies in IRAN (PERSIAN) cohort and gathers health-related data from the employees' population, aged 25-64. Participants were all eligible employees who visited EHCS center in Motahari clinic, Shiraz, Iran from summer to winter in 2017 for the first phase of EHCS. Data gathering was in line with the published guidelines and procedures used by the PERSIAN cohort (Poustchi *et al.*, 2018). All the cohort staff were trained and informed about the specific tools and methodologies.

Data gathering

Demographic characteristics of the participants including age, sex, educational level, and marital status were obtained using structured questionnaires. Weight was measured in the lightest possible clothing by a digital scale to the nearest 0.1 kg when participants were standing on the center of the scale. Height was measured with no shoes or hat, standing straight along the wall when heels, shoulders, and the back of the head were touching the wall, by a stadiometer to the nearest 0.1 cm. BMI was calculated using the standard formula (weight (kg)/(height (m))^2). A non-elastic measuring tape was used to measure waist circumference in the middle of the distance between the lowest rib and the iliac crest. The

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percentage of body fat (PBF) was assessed by bioelectrical impedance analysis using bioelectrical impedance analyzer (InBody 770©; Biospace, Seoul, South Korea).

A reliable and valid Food Frequency Questionnaire (FFQ) with 116 items was used to assess dietary intake of the participants (Malekshah *et al.*, 2006). Participants were interviewed to report the frequency and amount of the consumption of each food item on daily, weekly, monthly, and yearly levels in the past year. Then, the participants' consumption of macronutrients was estimated from the results of FFQ using Nutritionist IV software (Hearst Corp., San Bruno, CA) and the United States Department of Agriculture (USDA) food composition database (Gebhardt *et al.*, 2006). The number of meals per day, fried foods and grilled foods consumption, and subjective salt intake were also recorded on a structured questionnaire which was previously validated (Poustchi *et al.*, 2018).

Normal-weight obesity assessment

NWO was defined by different criteria, and its prevalence was assessed separately according to each definition. Individuals were considered to have NWO if their BMI was 18.5 to 24.9 kg/m^2 and met one of the following cut-off points, based on the different definitions:

1. PBF ≥ 29.1% for men and ≥37.2% for women according to a study by Zhu et al, using NHANES III data (NHANES-PBF) (Zhu *et al.*, 2003).
2. PBF ≥25% for men and ≥35% for women according to WHO special committee on obesity (WHO-PBF) (Eveleth, 1996).
3. PBF in the highest quartile of the population.
4. PBF in the highest tertile of the population.
5. Waist circumference (WC) ≥ 94 cm for men and ≥80 cm for women according to WHO special committee on obesity (WHO-WC) (World Health Organization, 2011).
6. WC ≥ 95 cm for both genders according to Iran national committee on obesity (Iran-WC) (Azizi *et al.*, 2010).

To assess the possible relationships between NWO and dietary factors, WHO-PBF was adopted to categorize the participants into 3 groups: normal weight non-obese (NWNO), NWO, and overweight or obese (OW/O). NWNO consisted of individuals with normal BMI and normal PBF, and OW/O was equal to BMI ≥25 kg/m^2, independent of body fat status.

Ethical considerations

The present study was approved by the ethics committee of Shiraz University of Medical Sciences (Code: IR.SUMS.REC.1399.498). All the participants were informed about the aim and procedure of the study and signed the written informed consent form to participate in the cohort study. For participants who could not read the consent form, the document was orally presented to them or their legally authorized representative, in the presence of an independent witness, and was subsequently signed. All the methods and procedures were performed in accordance with the published guidelines and regulations required by the ethics committee of Shiraz University of Medical Sciences.

Data analysis

SPSS software version 21.0 (SPSS Inc., Chicago, IL, USA) was used to analyze data. The qualitative and quantitative data were described by frequency (percentage) and mean ± standard deviation (SD), respectively. The prevalence rates of NWO according to various criteria were estimated using descriptive analyses. Independent sample t-test and Chi-square test were performed to assess differences in quantitative and qualitative variables between genders, respectively. Chi-square test was also used to examine the relationship between study groups and dietary habits. After that, ANOVA and ANCOVA tests were used to compare means and SDs of energy and macronutrient consumption among groups. P-value ≤ 0.05 was considered significant in all analyses.

Results

One thousand thirty-eight participants (513 males and 525 females) were included in the study, with the age range of 26-64 and mean age of 41.04±6.98 years. 42 participants with missing data of PBF were excluded from the phase of

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determining the prevalence by respective criteria and also from further analyses.

Demographic and dietary characteristics of the participants are shown in **Table 1**. Significant differences were found between genders for the number of meals per day (*P*=0.039), food salt content (*P*=0.041), grilled foods' consumption (*P*=0.004), fried foods' consumption (*P*=0.033), energy intake (*P*<0.001) and all the three macronutrients (*P*<0.05).

Table 1. Demographic and dietary characteristics of the participants.

Variables	Total (n=1038)	Men (n=513)	Women (n=525)	P-value
Age (years)	41.04 ± 6.98[a]	41.14 ± 7.04	40.94 ± 6.92	0.639[c]
Energy intake (kcal/d)	2812.72 ± 966.88	3067.47 ± 1045.23	2563.86 ± 810.60	<0.001[c]
Protein intake (g/d)	91.93 ± 33.72	101.50 ± 36.03	82.59 ± 28.37	<0.001[c]
Carbohydrate intake (g/d)	408.70 ± 163.80	456.95 ± 177.20	361.57 ± 133.85	<0.001[c]
Fat intake (g/d)	98.97 ± 37.67	101.37 ± 38.21	96.62 ± 37.02	0.043[c]
Education level				
Elementary	102 (9.8)[b]	79 (15.4)	23 (4.4)	<0.001[d]
High school diploma	195 (18.8)	119 (23.2)	76 (14.5)	
Graduate	490 (47.2)	205 (40.0)	285 (54.3)	
Post- graduate	247 (23.8)	107 (20.9)	140 (26.7)	
Meals number per day				
<3	41 (4.0)	17 (3.3)	24 (4.6)	0.039[d]
3	151 (14.6)	87 (17.0)	64 (12.2)	
4	379 (36.5)	199 (38.8)	180 (34.4)	
5-6	428 (41.3)	193 (37.6)	235 (44.8)	
6<	38 (3.7)	17 (3.3)	21 (4.0)	
Salt consumption				
No	736 (71.0)	365 (71.2)	371 (70.8)	0.330[d]
Some	168 (16.2)	89 (17.3)	79 (15.1)	
Yes	133 (12.8)	59 (11.5)	74 (14.1)	
Food salt content				
Low	429 (41.4)	232 (45.2)	197 (37.6)	0.041[d]
Medium	553 (53.3)	257 (50.1)	296 (56.5)	
High	55 (5.3)	24 (4.7)	31 (5.9)	
Grilled food				
Never	27 (2.6)	12 (2.3)	15 (2.9)	0.004[d]
<1/month	213 (20.5)	83 (16.2)	130 (24.8)	
1-3/month	546 (52.7)	275 (53.6)	271 (51.7)	
1-3/week	249 (24.0)	142 (27.7)	107 (20.4)	
Daily	2 (0.2)	1 (0.2)	1 (0.2)	
Fried food				
Never	12 (1.2)	5 (1.0)	7 (1.3)	0.033[d]
<1/month	38 (3.7)	11 (2.1)	27 (5.2)	
1-3/month	241 (23.2)	109 (21.2)	132 (25.2)	
1-3/week	670 (64.6)	350 (68.2)	320 (61.1)	
Daily	76 (7.3)	38 (7.4)	38 (7.3)	

[a]: Mean ± SD; [b]: n (%); [c]: Independent sample t-test; [d]: Chi-square test.

Anthropometric indices

The mean BMI among the participants was 26.52±4.06 kg/m^2. Overall, 35.9% had normal weight and 63.0% were overweight or obese according to BMI criteria. BMI was not significantly different between genders.

According to WHO-PBF criteria, high PBF was found in 69.7% of the participants. Moreover, women were more afflicted with high body fat, i.e. above cut-off points than men (*P*=0.001) with respect to WHO-PBF criteria (Eveleth, 1996). **Table 2** summarizes anthropometric status and PBF of the participants.

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Table 2. Anthropometric status of the participants

	Total (n=1038)	Men (n=513)	Women (n=525)	P-value
Weight (kg)	73.30 ± 14.24[a]	73.27 ± 13.82	73.32 ± 14.65	0.858[c]
Height (cm)	165.95 ± 9.60	166.26 ± 9.50	165.66 ± 9.70	0.268[c]
Waist circumference (cm)	94.39 ± 9.84	94.29 ± 9.64	94.49 ± 10.03	0.865[c]
Body mass index (kg/m^2)	26.52 ± 4.06	26.44± 4.01	26.60 ± 4.11	0.773[c]
Weight status				
Normal Weight	373 (35.9)[b]	181 (35.3)	192 (36.6)	0.660[d]
Underweight	11 (1.1)	6 (1.2)	5 (1.0)	
Overweight	484 (46.6)	247 (48.1)	235 (44.8)	
Obese	170 (16.4)	78 (15.2)	91 (17.3)	
Percentage of body fat (%)				
All ages				
Mean ± SD	33.33 ± 8.32	27.54 ± 6.30	38.91 ± 5.85	<0.001[c]
Normal	302 (30.3)	172 (35.2)	130 (25.6)	0.001[d]
High[e]	694 (69.7)	317 (64.8)	377 (74.4)	
Age<40 (n=461)				
Mean ± SD	32.57 ± 8.18	27.04 ± 6.24	37.66 ± 6.22	<0.001[c]
Normal	172 (37.3)	92 (41.6)	80 (33.3)	0.066[d]
High	289 (62.7)	129 (58.4)	160 (66.7)	
Age≥40 (n=524)				
Mean ± SD	33.97 ± 8.41	27.89 ± 6.35	40.04 ± 5.23	<0.001[c]
Normal	119 (22.7)	77 (29.4)	42 (16.0)	<0.001[d]
High	405 (77.3)	185 (70.6)	220 (84.0)	

[a]: Mean ± SD; [b]: n (%); [c]: Independent sample t-test; [d]: Chi-square test; [e]: Percentage of Body Fat ≥ 25% for men and ≥35% for women according to WHO special committee on obesity (WHO-PBF).

Normal-weight obesity prevalence

The prevalence of NWO is presented in **Table 3** based on NHANES-PBF, WHO-PBF, PBF tertile and quartile, WHO-WC, and Iran-WC. Based on the cut-off values of WHO-PBF, 241 (24.19%) participants had NWO. NWO prevalence was not significantly different between genders, but it was higher among female participants (21.68% and 26.63%, for males and females, respectively; *P*=0.071). In individuals with normal BMI, 58.56% of men and 70.31% of women had NWO. Concerning the two other anthropometric categories, 123 (12.49%) and 621 (63.04%) participants belonged to NWNO and OW/O groups, respectively. The remaining participants (n=11) were considered underweight.

Table 3. Prevalence of normal weight obesity based on defined criteria.

	Total (n=996)	Men (n=489)	Women (n=507)
WHO percentage of body fat[b]	241 (24.19)[a]	106 (21.68)	135 (26.63)
NHANES percentage of body fat[c]	173 (17.37)	70 (14.31)	103 (20.31)
Percentage of body fat, highest quartile	77 (7.73)	40 (8.18)	37 (7.29)
Percentage of body Fat, highest tertile	106 (10.64)	54 (11.04)	52 (10.25)
WHO waist circumference[d]	189 (18.21)	20 (3.90)	169 (32.19)
Iran waist circumference[e]	113 (10.89)	56 (10.92)	57 (10.85)

[a]: n (%); [b]: Percentage of body fat ≥ 25 for men and ≥ 35 for women; [c]: Percentage of body fat ≥ 29.1 for men and ≥ 37.2 for women; [d]: waist circumference ≥ 94 cm for men and ≥ 80 for women; [e]: waist circumference ≥ 95 cm for both genders; WHO: World Health Organization, NHANES: National Health and Nutrition Examination Survey.

Relationship with dietary factors

After the exclusion of underweight individuals (BMI less than 18.5), the data from 985 participants were categorized into the three groups of NWNO, NWO, and OW/O. No significant differences were observed for dietary behaviors, such as meals per day (*P*>0.05 for both genders) or fried food consumption (*P*>0.05 for both genders)

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between groups. Moreover, there were no significant differences among groups in energy and macronutrient consumption (P>0.05 for all).

Discussion

In the present study, the prevalence of NWO was determined in the population of SUMS employees. The highest prevalence was observed when considering NWO with the PBF cut-offs proposed by WHO. On the other hand, the lowest prevalence was the one based on the highest quartile of PBF, which **has** not been widely used before.

WC and the related parameters such as waist-hip ratio or waist-height ratio are not precise for diagnosing NWO (Franco *et al.*, 2016). Therefore, in present study, body fat cut-off points suggested by WHO were used to analyze the possible relationships. Nevertheless, various cut-offs have been used around the world (Franco *et al.*, 2016); and further investigation is required to develop more proper cut-off points for PBF in Iranian population.

Considerable discrepancies were found in the reports regarding the prevalence of NWO (Franco *et al.*, 2016). The present study found a high prevalence of NWO among university employees when compared to other investigations. It should be noted that the population of this study supposedly had a relatively higher rate of sedentary occupations, which can be a possible reason for the observed prevalence of NWO.

A study by Tayefi *et al*. in Mashhad reported a 38.5% prevalence of high PBF among normal-weight participants (Tayefi *et al.*, 2019). They assigned the cut-off point of PBF >30 for women, which was more sensitive than the present study, although for men the cut-offs were identical. To explain the lower prevalence found by that study, the sample characteristics should be noted. Their sample was composed of citizens from three different regions of the city, selected by a stratified cluster random sampling method. The lower proportion of educated participants in their study (Ghayour-Mobarhan *et al.*, 2015), and possibly lower rate of sedentary office work compared to our sample, could be some factors explaining their lower prevalence of NWO. The lower means of BMI (22.92 *vs.* 26.52 kg/m^2) and WC (85.09 *vs.* 94.39 cm) in their study compared to the current study was also suggestive of the mentioned demographic variance.

The studies determining the prevalence of NWO in other Asian countries were limited. A representative study of the Chinese population used a BMI range of 18.5-23.9 kg/m^2 and cut-off points of PBF ≥24% for males and ≥33% for females to recognize NWO participants. The results estimated a prevalence rate of 7.46%. In this study, the definition of NWO, i.e. BMI of 18.5-24.9 kg/m^2 and PBF ≥25 for men and ≥35 for women, was close to their criterion but yielded a prevalence rate of 24.19% among the whole sample, which was much higher than the corresponding number in their results (Jia *et al.*, 2018). The higher prevalence in this may be related to the office job, which could contribute to obesity (Hall, 2018, Jong *et al.*, 2018). A cross-sectional study involving women in Malaysia, a developing country, estimated that the prevalence of NWO was 19.8% (Moy and Loh, 2015). The researchers considered a participant to have NWO if she had a BMI between 18.5 and 22.9 kg/m^2 and a PBF in the highest tertile (>28.52%). By comparing the highest tertile between this study and the above-mentioned research, it was found that the sample in this study had a much higher body fat. To better interpret these findings, the difference between BMI ranges of the two studies should be highlighted (≥23 kg/m^2 *vs.* ≥25 kg/m^2 as overweight). A higher rate of NWO was found in India by Kapoor *et al*. using the cut-offs of PBF ≥ 20.6% in men and ≥ 33.4% in women (Kapoor *et al.*, 2020). It should be noted that they studied individuals with a high risk of diabetes who aged between 30 and 60. These characteristics could explain the high prevalence.

Another study in India estimated a prevalence of 16.1% among young adults (Hadaye *et al.*, 2020). Researchers defined high body fat as PBF >17.6% and >31.6% for males and females, respectively. Although they used more liberal criteria for NWO,

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the participants' young age, i.e. being 18-24, and also sampling from a medical college which could indicate higher health literacy, may partly justify the lower prevalence of this health condition.

With regard to the results of the studies, selecting an appropriate borderline for body fat is very challenging. A study on the data of The Korea National Health and Nutrition Examination Survey proposed a definition of obesity as more than 26% and 36% body fat for men and women respectively (Kim *et al.*, 2013). The authors explained that these cut-off points demonstrated obesity-related cardiovascular risk factors among Korean participants. It should be noted that the study defined normal weight as a BMI of between 18.5 and 22.9 kg/m^2 for Asian adults. Their estimates of appropriate body fat borderlines were in close proximity to those proposed by Li *et al*. for Mongolian adults (Li *et al.*, 2017) and also to the WHO definition that was used in this study.

The present investigation showed no significant differences in energy or macronutrient intake among the study groups, not even between NWNO and OW/O. Accordingly, a population-based study in Finland did not find any significant differences regarding the intake of macronutrients among the corresponding groups except the consumption of protein (% of energy) by women, which was higher in overweight than NWO or lean peers (Männistö *et al.*, 2013).

Contrary to these findings, a case-control study on male students in Iran revealed that both NWO and overweight or obese groups had higher calorie intake than the normal-weight group (P<0.01) (Amani *et al.*, 2019). This study also showed lower fiber consumption in the NWO group compared to the normal-weight individuals.

With respect to dietary behaviors, Hadaye *et al*. showed significant differences between NWO and NWNO groups regarding food habits; such as snacks, skipping breakfast, intake of fish, protein, high-fiber cereals, and also restaurant visits (Hadaye *et al.*, 2020). To address the specific dietary behaviors assessed in the present study, Holmback *et al*. observed that higher frequency of meals was associated with lower central obesity in men, but not in women (Holmbäck *et al.*, 2010). However, the authors noted that some other confounding factors were not adjusted and the results may only suggest a tendency toward healthier meal patterns in participants with an active lifestyle, thus contributing to reduced body fatness. In addition, the distinction between the methods, central obesity determined by WC, and NWO diagnosed by both BMI and PBF should be mentioned to partly clarify the dissimilarity of results.

Salt consumption, as another factor, is a crucial part of dietary behaviors. A cross-sectional study performed on NHANES data indicated that higher consumption of sodium was positively associated with both body fat and central obesity (Zhang *et al.*, 2018). Indeed, every 1 gram increment of sodium intake per day was linked to a 0.44% increase in total fat percentage and in central obesity risk by 24%. Similar findings were presented in other studies (Ma *et al.*, 2015, Yoon and Oh, 2013). Generally, foods high in sodium are also high in fat and may exacerbate overeating behaviors which could result in weight gain (Zhang *et al.*, 2018). In contrast, the present study used only subjective assessment of salt intake, not sodium, and could not find a significant relationship. Considering the subjective method of assessment, the participant's responses in this study may be biased due to their conception of "high" and "low" amounts of salt.

Regarding fried and grilled food consumption, the current study did not reveal any relationship with NWO. Nevertheless, in a cohort study of relatively young adults, central adiposity was significantly associated with frequent fried food consumption (Sayon-Orea *et al.*, 2014). Likewise, another study found a positive relationship between fried food intake and central obesity only among the participants in the "highest quintile of energy intake from fried food" (Guallar-Castillón *et al.*, 2007). Undoubtedly, as fried foods usually absorb some oil and are palatable (Gadiraju *et al.*, 2015), their consumption could lead to higher energy intake and an increase in weight and body fatness.

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Two probabilities further explain the lack of relationship in this study; they are the effects of ethnicity and physical activity on body weight or fat status. Ethnic differences not only affect the prevalence of the condition (Wijayatunga and Dhurandhar, 2021) but also may cause discrepancies in the related factors (Wang *et al.*, 2021). Physical activity was not assessed in this study. Similarly, some studies had shown that higher consumption of energy was not necessarily associated with higher BMI and body fat, but were inversely associated with physical activity and metabolic rate (Miller *et al.*, 1990). Although many other studies agreed that higher calorie consumption was associated with obesity (Romieu *et al.*, 2017, Stubbs and Lee, 2004), additional investigation was required to enlighten these ambiguities.

With regard to limitations, it should be noted that low physical activity was a very probable contributing factor to high body fat, but in this study, the authors did not have access to the physical activity data. Also, the results from this sample cannot be generalized to the general population due to office work, health literacy, and other life aspects of employees in comparison to the whole city population.

To the best of the authors' knowledge, this was the first study to report NWO prevalence in Iranian employee's population. One strength of this study was the estimation of NWO prevalence by various criteria, which can help future researchers compare the results and adopt the most favorable one for their investigations.

Conclusions

NWO was prevalent among university employees. Women were more afflicted with excess body fat than men, according to gender-specific criteria. However, no significant relationship was found between dietary factors and NWO. As this health condition is related to many negative outcomes and maybe a better predictor of chronic diseases than only BMI, it needs further attention. Additionally, this population seems particularly vulnerable to NWO and may require lifestyle recommendations to control weight and fat mass.

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Authors' contributions

Eftekhari MH and Kohanmoo A designed the research. Masoumi Jamshidi S and Kohanmoo A conducted it. Kohanmoo A and Mohsenpour MA analyzed data and interpreted the results. Kohanmoo A, Mohsenpour MA and Jamshidi S wrote the paper. Mohsenpour MA, Jamshidi S and Eftekhari MH substantially revised the manuscript. Kohanmoo A had primary responsibility for the final content. Eftekhari MH and Masoumi SJ supervised the entire study process. All the authors read and approved the final manuscript.

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Conflict of interests

The authors declared no conflict of interests.

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