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Original Article

# Prevalence of Obesity and its Associated Factors Among the 35-70-Year-Old Population of Bandare-Kong: A Cross-sectional Survey (Findings of the Persian Cohort Study)

**Sara Bahri[1], Masoumeh Kheirandish[1*], Shideh Rafati[2], Azim Nejatizadeh[3], Roghayeh Shahbazi[4], Ghazal Zoghi[1], Seyed Hossein Davoudi[5], Masoud Shareghi Brojeni[1], Ladan Hajiabdolrassouli[1]**

[1]Endocrinology and Metabolism Research Center, Hormozgan University of Medical Sciences, Bandar Abbas, Iran.
[2]Social Determinants in Health Promotion Research Center, Hormozgan University of Medical Sciences, Bandar Abbas, Iran.
[3]Molecular Medicine Research Center, Hormozgan Health Institute, Hormozgan University of Medical Sciences, Bandar Abbas, Iran.
[4]Cellular and Molecular Medicine Department, Faculty of Medicine, University of Ottawa, Ottawa, Canada.
[5]Department of Clinical Nutrition, School of Nutrition Sciences and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

***Correspondence to**
Masoumeh Kheirandish,
Email: kheirandishm@yahoo.com

**Abstract**

**Background:** Obesity is a major health problem in many countries such as Iran. This study aimed to evaluate the prevalence of overweight and obesity and their associated risk factors in Bandare-Kong, Hormozgan, Iran.

**Materials and Methods:** This cross-sectional survey included 3921 participants of the Bandare-Kong Cohort Study (BKNCD). Their baseline data were used for analysis. General obesity was defined as the body mass index (BMI) ≥ 30 kg/m$^2$ and overweight as 25≤BMI < 30. Central obesity was defined as waist circumference (WC) ≥ 95 cm.

**Results:** The prevalence of overweight, general, and central obesity was 39%, 24%, and 30.5%, respectively. Female gender (adjusted odds ratio [aOR] = 5.11, 95% confidence interval [CI]: 3.74-6.96 and aOR = 1.70, 95% CI: 1.34-2.16), hypertension (aOR = 2.43, 95% CI: 1.81-3.26 and aOR = 1.26, 95% CI: 1.04-1.52), and hypertriglyceridemia (aOR = 1.76, 95% CI: 1.31-2.38 and aOR = 1.26, 95% CI: 1.05-1.51) were significantly associated with both general and central obesity. Higher WC (aOR = 503.89, 95% CI: 331.76-765.32), higher calorie intake (aOR = 1.03, 95% CI: 1.02-1.04), and urban residency (aOR = 2.99, 95% CI: 2.06-4.32) were correlated with general obesity. BMI ≥ 25 kg/m$^2$ (aOR = 46.81, 95% CI: 35.53-61.67), higher fasting plasma glucose (aOR = 1.03, 95% CI: 1.01-1.04), older age (aOR = 1.03, 95% CI: 1.02-1.04) and being unemployed (aOR = 1.49, 95% CI: 1.18-1.89) were significantly associated with central obesity.

**Conclusion:** Overall, a significant correlation was found among female gender, hypertension, and hypertriglyceridemia with general and central obesity in this study. Given the high prevalence of obesity in this population, regional public health authorities should take appropriate measures to reduce these rates in order to prevent obesity-associated complications.

**Keywords:** Overweight, Central Obesity, PERSIAN Cohort Study

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## Introduction

Obesity, defined as the accumulation of excessive fat in the body, is a significant health issue. It is a risk factor for various chronic diseases such as diabetes, cardiovascular disorders, cancer, and metabolic syndrome. It is also considered a significant risk factor for the severity and mortality of coronavirus disease 2019 (COVID-19) after the emergence of this disease (1-3). Several anthropometric indices are used to assess obesity, including body mass index (BMI) and waist circumference (WC) (1). In addition, there are multiple predisposing factors for obesity, including race, gender, age, genetic factors, socioeconomic conditions, eating habits, and lifestyle (4-7).

Overweight and obesity are epidemiologic problems with an upward trend throughout the world. In the last three decades, not only has obesity been a significant public health concern in high socioeconomic countries, but it has also been a challenging issue for health systems in low-income and developing nations (6, 8) According to the Global Nutrition Report (2017), approximately two billion adults are overweight and obese worldwide.9 In recent years, obesity has also increased in Iran due to urbanization, nutrition transition to fast foods and

westernized diet, and sedentary lifestyle (10, 11).

Based on a meta-analysis published in 2009, the prevalence of obesity was 13.7% and 27.3% in Iranian men and women, respectively (10). Further, the findings of the Tehran Lipid and Glucose Study revealed that the prevalence of obesity increased from 21.3% to 34.1% over one decade (12). Furthermore, the prevalence of overweight and obesity was estimated at 62.3% among adults (11). Moreover, according to a recent meta-analysis in 2019, the prevalence of obesity in older Iranians (age > 50) was 21.4% (13) Other studies have shown that about 60% of Iranian adults are either overweight or obese. However, most of these studies have only analyzed the urban population in certain parts of Iran (11, 14), and some of them have assessed obesity in terms of BMI (15, 16). Based on a nationwide study in 2016, the prevalence of obesity was estimated at 11.7% in Hormozgan Province, located in the southern part of Iran (17); nevertheless, to the best of our knowledge, no recent study has so far investigated the prevalence of obesity among Iranians who live in the south coastal region of the country.

Iran comprises different ethnicities with diverse lifestyles, as well as cultural and sociodemographic characteristics, making their risk factors and exposures different. Therefore, in this study, data from the Bandare-Kong Cohort Study (PERSIAN Cohort Study) (18) were used to assess the prevalence of overweight and obesity and their associated risk factors among the native rural and urban populations of this southern coastal region of Iran.

## Materials and Methods

### *Participants and Data Source*

We analyzed the baseline data from the Bandare-Kong Cohort Study (BKNCD), a population-based cohort study, within the Prospective Epidemiological Research Studies in Iran (PERSIAN). The PERSIAN cohort study recruited individuals aged 35-70 from 18 areas of Iran (18).

In the BKNCD, 4063 individuals aged 35-70 years were recruited between November 17, 2016, and November 22, 2018, from Bandare-Kong, Hormozgan province, in the south of Iran through census sampling. Pregnant women, participants taking certain drugs such as anti-epileptics and immunosuppressants, and subjects with missing variables were excluded from the final analysis (Figure 1). All participants provided written informed consent.

Data on age, gender, residence, education, occupation, marital status, smoking status, diet, and physical activity were collected using interviews by trained staff through valid and reliable questionnaires designed to collect data in all PERSIAN cohort sites.

### *Variables Measurement and Definition*

#### *Variable Measurement*

The subjects' weight was measured while wearing minimum clothing and barefoot by means of a digital scale (to the nearest 0.5 kg). Height was measured while participants stood on the stadiometer barefoot. Additionally, the WC was calculated at the midpoint of the iliac crest and the last palpable rib's inferior margin in the mid-axillary line after several consecutive breaths. WC was measured twice for every subject, and the average of the two measurements was recorded accordingly. Hip circumference (HC) was computed at the maximum circumference of the buttocks. The same measuring tape was used for all participants. To calculate the waist-to-hip ratio (WHR), WC was divided by HC. Daily calorie intake was calculated by adding the energy of the ingested food, which was recorded using the Food Frequency questionnaire.

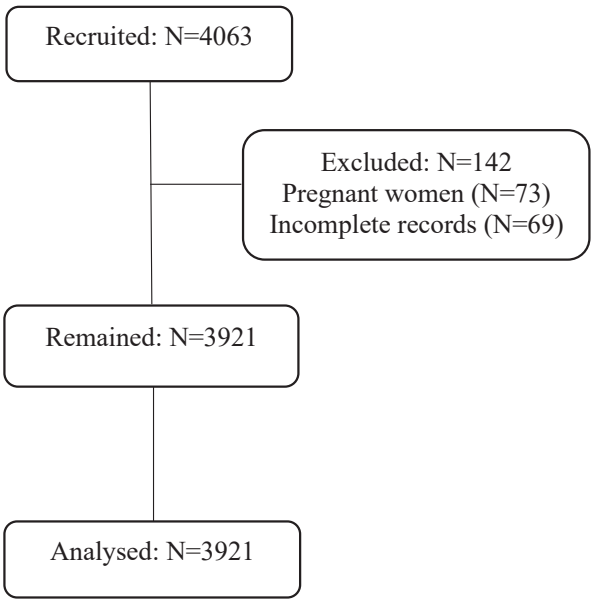


**Figure 1.** Details of patient recruitment, exclusion, and analysis

Weight was divided by the square of height to estimate the BMI. A standard sphygmomanometer was employed to measure systolic blood pressure (SBP) and diastolic blood pressure (DBP) in the chair-seated position after 15 minutes of rest, and the arm was supported at heart level. The mean of two successive measurements was recorded, and blood samples were collected after 8 hours of overnight fasting. The glucose oxidase method was applied to measure fasting plasma glucose (FPG) levels. Furthermore, venous blood samples were taken to evaluate total cholesterol (TC), triglyceride (TG), low-density lipoprotein (LDL), and high-density lipoprotein (HDL) levels after 12 hours of overnight fasting. The enzymatic method was utilized for lipid measurements.

#### *Variables Definition*

Based on the World Health Organization guidelines, overweight and general obesity are defined as $25 \leq BMI < 30$ and $BMI \geq 30$ kg/m$^2$, respectively (19). Central obesity, by definition, was $WC \geq 95$ cm for both men and women (20) The cigarette smoking status was based on self-

reported data. Current cigarette smoking was attributed to participants who currently smoke cigarettes and have smoked a minimum of 100 cigarettes in their lifetime. Former smokers were those who had smoked a minimum of 100 cigarettes in their lifetime but have not smoked within the past six months (21) Hypertension (HTN) was defined as SBP ≥ 140 mm Hg and/or DBP ≥ 90 mmHg. Hypertriglyceridemia was described as TG ≥ 150 mg/dL. The wealth index score (WIS) was separately determined by the multiple correspondence analysis of the variables. Participants were divided into poor, average, and rich categories based on their occupation, type of residence, ownership, and size of houses, and other properties, including ownership and type of cars, ownership of a cell phone, a personal computer, or a laptop, and access to the freezer and washing machine. In addition, the other variables included access to a dishwasher, computer, internet, motorcycle, vacuum cleaner, and TV, type of TV (no color TV or regular color TV vs. plasma color TV), type of cell phone, instruments of the welfare state, and lifetime international trips. According to their total asset score, individuals were ranked and then categorized into rich, average, and poor tertiles (22). Regarding the physical activity level (PAL), the self-reported daily activities of participants were recorded, including work, exercise, and leisure time activities. Then, PAL was measured using the metabolic equivalent of tasks (METs) of the daily activities. Based on the mean METs, participants were classified into low (< 36 METs/h/d), moderate (36-44.9 METs/hour/day), or vigorous (≥ 45 METs/h/d) PAL groups (23) As for occupation, homemakers were considered unemployed.

### *Statistical Analysis*

Continuous variables with normal distribution were described by means and standard deviations. Independent *t* test and analysis of variance test were used to compare the mean continuous variables between groups. Categorical variables were described by frequencies and percentages. The chi-square test was applied to compare categorical variables between groups. The binary logistic regression model was employed to determine the associations with central obesity, and the multinomial regression analysis was used to determine the associations between overweight and general obesity. All the potential variables with *P* values ≤0.2 in univariable regression were simultaneously included in the multivariable logistic regression model using the "Wald" method. For instance, obesity (central or general) and normal groups were coded 1 and 0, respectively. Therefore, the odds of central and general obesity were reported compared to their normal counterparts. *P* values < 0.05 were considered statistically significant. In addition, the prevalence was standardized to the population of Hormozgan province by the direct standardization method to overcome the confounding effect of age and gender. All analyses were performed using the Statistical Package for the Social Sciences (SPSS) software (version 25.0, Armonk, NY: IBM Corp., USA).

## Results

Data from 3921 individuals were analyzed in the current study. Of these, 56.8% were females. The mean age of the participants was 45.30 ± 9.38 years. Table 1 presents the prevalence of general and central obesity. Based on the results, 1534 (39.1%) and 951 (24%) individuals were overweight and obese, respectively, and 1761 (45.1%) of them had central obesity. Both general and central obesity were significantly higher in women compared to men (*P* < 0.001).

Table 2 provides the crude and age-standardized prevalence of general and central obesity by gender. The prevalence of general and central obesity was almost twice in women compared to men (30.4% vs. 16.7% and 52.1% vs. 34%, respectively), while the prevalence of overweight was slightly higher in men.

Table 3 summarizes data on the comparison of general characteristics between men and women by the BMI. Obese women were older (*P* = 0.003) and had higher WC and HDL levels (*P* < 0.001), while obese men had higher levels of SBP (*P* = 0.010) and DBP (*P* < 0.001), TG (*P* < 0.001), and physical activity (*P* < 0.001). There

**Table 1.** Prevalence of general and central obesity in men and women of Bandare-Kong Cohort Study (n = 3921)

| Variables | | | Total | Men N (%) | Women N (%) | *P* value† |
|---|---|---|---|---|---|---|
| BMI | Underweight | | 107(2.7) | 60(3.5) | 47(2.1) | 0.209 |
| | Normal | | 1329(33.9) | 698(41.2) | 631(28.3) | 0.066 |
| | Overweight | | 1534(39.1) | 664(39.2) | 870(39.1) | <0.001 |
| | Obese | Mild | 702(17.9) | 226(13.3) | 476(21.4) | <0.001 |
| | | Moderate | 195(5.0) | 36(2.1) | 159(7.1) | <0.001 |
| | | Morbid | 54(1.4) | 10(0.6) | 44(2.0) | <0.001 |
| Central obesity* | No | | 2153(54.9) | 1121(66.2) | 1032(46.3) | <0.001 |
| | Yes | | 1768(45.1) | 573(33.8) | 1195(53.7) | <0.001 |

BMI, body mass index; WC, waist circumference;
*Central obesity has been defined by Iranian cut off waist circumference ≥ 95 cm
†Analyzed by the Chi-square test.

**Table 2.** The crude and age-standardized prevalence (ASP) of general and central obesity by gender in Bandare-Kong Cohort Study (n = 3921)

| Obesity Categories | Total Population | | Men | | Women | |
|---|---|---|---|---|---|---|
| | Crude | ASP (95% CI) | Crude | ASP(95% CI) | Crude | ASP(95% CI) |
| Overweight (25≤BMI < 30 Kg/m²) | 39.1(37.6-40.7) | 38.8(37.3-40.4) | 39.1(36.9-41.6) | 39.2(36.8-41.6) | 39.7(37.0-41.1) | 38.5(36.5-40.6) |
| Obesity (BMI ≥ 30 Kg/m²) | 24.2(22.8-25.6) | 24.5(23.2-25.9) | 16.0(14.3-17.8) | 16.7(14.9-18.5) | 30.4(28.5-32.4) | 30.4(28.4-32.3) |
| Central Obesity (WC ≥ 95 cm) | 45.1(43.4-46.5) | 44.4(42.8-46.0) | 33.8(31.5-36.1) | 34.0(31.7-36.3) | 53.7(51.5-55.7) | 52.1(50.1-54.2) |

ASP estimated by direct standardization.
WC, waist circumference; BMI, body mass index; CI, confidence interval
*Central obesity has been defined by Iranian cut off WC ≥ 95 cm

were no significant differences between obese men and women in terms of FPG, TC, LDL, and daily calorie intake. Irrespective of gender, obese individuals were older, had higher WC (P < 0.001), higher blood pressure ($P < 0.001$), higher levels of TG, TC, LDL ($P < 0.001$), and FPG ($P = 0.002$), and lower HDL levels ($P = 0.001$). The prevalence of obesity was higher in the urban residents ($P = 0.005$), the unemployed, and those with lower physical activities, while its prevalence was lower in singles, smokers, and those with average WIS ($P < 0.001$). There was no statistically significant difference in the education level among normal, overweight, and obese groups. Table 4 presents the comparison of general characteristics between men and women by central obesity. Women with central obesity were older than their male counterparts ($P < 0.005$) and had higher BMI ($P < 0.001$), higher levels of HDL ($P < 0.001$), FPG ($P = 0.002$), and TC ($P = 0.014$). Regardless of gender, persons with higher WC were older ($P < 0.001$), had higher BMIs ($P < 0.001$), blood pressure ($P < 0.001$), FPG ($P < 0.001$), TG ($P < 0.001$), TC ($P < 0.001$), and LDL ($P = 0.011$), while they had a lower level of HDL ($P < 0.001$). Singles ($P = 0.008$), smokers, the unemployed, those with average WIS, and individuals with vigorous PAL had lower WC ($P < 0.001$). No significant difference was found in the mean of daily calorie intake between groups.

Table 5 provides the multinomial logistic regression analysis of overweight and general obesity after adjustment for gender, age, marital status, place of residence, education, WIS, occupation, hypertension, FPG, hypertriglyceridemia, hypercholesterolemia, HDL, LDL, smoking status, physical activity, and daily calorie intake. The results revealed no significant correlation between FPG, marital status, and education with obesity and overweight. Women had higher odds of overweight and obesity (adjusted odds ratio [aOR] = 1.91, 95% confidence interval [CI]: 1.42-2.55 and aOR = 5.11, 95% CI: 3.74-6.96, respectively, $P < 0.001$). The odds of overweight and obesity significantly decreased with advancing age (aOR = 0.97, 95% CI: 0.95-0.98 and aOR = 0.93, 95% CI: 0.91-0.94, respectively, $P < 0.001$). Hypertension and hypertriglyceridemia were significantly correlated with both overweight and obesity ($P < 0.001$). Urban residents also had greater odds of general obesity (aOR = 2.99, 95% CI: 2.06-4.32, $P < 0.001$). Current smoking (aOR = 0.57, 95% CI: 0.34-0.96, $P = 0.035$) and vigorous PAL (aOR = 0.59, 95% CI: 0.39-0.91, $P = 0.019$) were negatively associated with general obesity, while daily calorie intake (aOR = 1.03, 95% CI: 1.02-1.04, $P < 0.001$) was positively associated with general obesity.

Table 6 presents the risk of central obesity after adjustment for the above-mentioned factors. Based on the findings, a significant positive correlation was observed between central obesity with age ($P < 0.001$) and FPG levels ($P = 0.025$). Greater odds of abdominal obesity were observed in females (aOR = 1.70, 95% CI: 1.34-2.16, $P < 0.001$) and unemployed individuals (aOR = 1.49, 95% CI: 1.18-1.89, $P = 0.001$), while urban residents had lower odds of central obesity (aOR = 0.58, 95% CI: 0.45-0.76, $P < 0.001$). Hypertension and hypertriglyceridemia were significantly related to central obesity ($P = 0.018$ and $P = 0.010$, respectively).

## Discussion

This population-based study provided an opportunity to evaluate the prevalence of general and central obesity, as well as their associated risk factors in the urban and rural populations of the southern coastal region of Iran.

Regarding general obesity, approximately 65.5% of the participants were overweight or obese, and almost 50% of the population had central obesity. Among women, 35% and 53% had general and abdominal obesity, respectively. Similar to other studies, both types of obesity were higher in women (11, 14). The prevalence of general obesity was comparable with other studies in Iran (11, 14); however, a lower prevalence of central obesity was found in the current study compared to another study conducted in Iran (14), which can be attributed to genetic factors and different dietary patterns. Interestingly, in a recent study on 5000 adults in Hormozgan province, the same province as the current study, 31.8% of the study population were also overweight and only 15.2% were obese (24). These rates, especially obesity, were higher in our study. The justification for this discrepancy can be the difference in the age of the studied populations. Farshidi et al evaluated individuals above 18 years of age, while we assessed those in the age range of 35-70 years (24).

By estimating crude and age-standardized prevalences, we found a higher prevalence of abdominal obesity, particularly among women. Previous studies have also reported a higher prevalence of general and abdominal obesity in females (10, 11, 14, 24), potentially due to

**Table 3.** General characteristics of the study population by the presence of obesity based on BMI in men and women of Bandare-Kong Cohort Study (n=3921)

| | BMI | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | | *P* value* | Overweight | | *P* value* | Obese | | *P* value* | Final P-value |
| | Men | Women | | Men | Women | | Men | Women | | |
| | Mean(SD) | | | | | | | | | |
| Age (years) | 49.18(9.6) | 48.33(10.1) | 0.103 | 48.32(9.62) | 48.59(8.7) | 0.584 | 45.92(8.7) | 47.83(8.8) | 0.003 | <0.001 |
| WC (cm) | 81.72(7.5) | 84.74(7.3) | <0.001 | 94.14(5.40) | 96.11(6.2) | <0.001 | 105.59(7.9) | 108.18(8.8) | <0.001 | <0.001 |
| SBP (mmHg) | 117.80(16.4) | 112.91(18.04) | <0.001 | 122.09(16.62) | 117.90(18.0) | <0.001 | 124.06(15.2) | 121.01(17.2) | 0.010 | <0.001 |
| DBP (mmHg) | 76.52(9.9) | 73.30(11.2) | <0.001 | 79.49(9.81) | 76.21(10.1) | <0.001 | 80.79(9.2) | 78.04(9.8) | <0.001 | <0.001 |
| FPG ( mg/dl) | 102.82(37.2) | 107.54(49.2) | 0.039 | 107.14(37.88) | 112.60(48.9) | 0.014 | 109.87(39.4) | 109.44(40.2) | 0.381 | 0.002 |
| TC ( mg/dl) | 195.47(38.1) | 200.11(42.9) | 0.031 | 200.59(47.44) | 207.12(42.6) | 0.005 | 204.99(39.2) | 206.31(41.2) | 0.645 | <0.001 |
| TG ( mg/dl) | 128.72(81.7) | 107.30(59.3) | <0.001 | 161.05(129.8) | 133.68(73.7) | <0.001 | 175.81(98.6) | 138.72(66.4) | <0.001 | <0.001 |
| HDL ( mg/dl) | 46.21(9.7) | 52.28(11.4) | <0.001 | 43.15(8.94) | 49.81(10.7) | <0.001 | 42.85(9.7) | 49.18(10.1) | <0.001 | 0.001 |
| LDL ( mg/dl) | 124.10(32.2) | 126.48(35.3) | 0.184 | 125.87(34.31) | 130.99(36.02) | 0.005 | 128.17(33.1) | 129.53(34.9) | 0.587 | <0.001 |
| Education (years) | 6.26(4.6) | 5.05(4.9) | <0.001 | 7.80(4.89) | 4.63(4.4) | <0.001 | 8.78(4.9) | 4.47(3.9) | <0.001 | 0.148 |
| Daily Energy Intake (Kcal) | 3167.55(911.9) | 2447.88(711.4) | <0.001 | 3379.76(1006.7) | 2613.24(739.8) | <0.001 | 3547.99(1060.5) | 2668.35(794.8) | 0.067 | 0.002 |
| | Proportion N (%) | | | | | | | | | |
| Physical activity (METS) | | | <0.001† | | | 0.001† | | | <0.001† | <0.001 |
| Low (24-36.5) | 185(24.8) | 140(20.8) | | 179(27.4) | 220(25.6) | | 93(34.4) | 193(29.1) | | |
| Moderate (36.6-44.9) | 376(50.3) | 439(65.3) | | 364(55.7) | 546(63.6) | | 143(53.0) | 420(63.3) | | |
| Vigorous (≥45) | 186(24.9) | 93(13.8) | | 111(17.0) | 92(10.7) | | 34(12.6) | 51(7.7) | | |
| Place of residence | | | 0.744† | | | 0.167† | | | <0.001† | 0.005 |
| Urban | 631(83.2) | 560(82.6) | | 579(87.2) | 737(84.7) | | 253(93.0) | 580(85.4) | | |
| Rural | 127(16.8) | 118(17.4) | | 85(12.8) | 133(15.3) | | 19(7.0) | 99(14.6) | | |
| Marital status | | | <0.001† | | | <0.001† | | | <0.001† | <0.001 |
| Single | 14(1.8) | 37(5.5) | | 3(0.5) | 17(2.0) | | 4(1.5) | 18(2.6) | | |
| Married | 737(97.2) | 543(80.1) | | 654(98.4) | 728(83.7) | | 265(97.4) | 581(85.6) | | |
| Widowed + Divorced | 7(1.0) | 98(14.5) | | 7(1.1) | 125(14.3) | | 3(1.1) | 80(11.8) | | |
| Occupation | | | <0.001† | | | <0.001† | | | <0.001† | <0.001 |
| Employed | 628(82.8) | 577(85.1) | | 552(83.1) | 146(16.8) | | 234(86.0) | 93(13.7) | | |
| Unemployed | 130(17.2) | 101(14.9) | | 112(16.9) | 724(83.2) | | 38(14.0) | 586(86.3) | | |
| Smoking status | | | <0.001† | | | <0.001† | | | <0.001† | <0.001 |
| Never | 470(62.2) | 653(99.7) | | 463(69.9) | 854(99.5) | | 192(70.6) | 668(99.7) | | |
| Current | 188(24.9) | 0(0.0) | | 114(17.2) | 4(0.5) | | 43(15.8) | 2(0.3) | | |
| Former | 98(13.0) | 2(0.3) | | 85(12.8) | 0(0.0) | | 37(13.6) | 0(0.0) | | |
| WIS | | | <0.005† | | | <0.001† | | | <0.001† | <0.001 |
| Poor | 312(41.2) | 335(49.4) | | 187(28.2) | 375(43.1) | | 79(29.0) | 315(46.5) | | |
| Average | 153(20.2) | 130(19.2) | | 144(21.7) | 139(16.0) | | 47(17.3) | 140(20.6) | | |
| Rich | 292(38.6) | 213(31.4) | | 333(50.2) | 356(40.9) | | 146(53.7) | 223(32.9) | | |

WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; FPG, fasting plasma glucose; TC, total cholesterol; TG, triglyceride; HDL, high-density lipoprotein; LDL, low-density lipoprotein; WIS, wealth index score.
*Analyzed by independent t-test.
†Analyzed by Chi-square test.

**Table 4.** General characteristics of the study population by the presence of central obesity in men and women of Bandare-Kong Cohort Study (n=3921)

| | WC | | | | | | |
|---|---|---|---|---|---|---|---|
| | Normal | | | High | | | |
| | Men | Women | *P* value* | Men | Women | *P* value* | Final *P* value* |
| | Mean(SD) | | | | | | |
| Age (years) | 48.47(9.53) | 47.01(9.35) | <0.001 | 48.02(9.60) | 49.37(9.04) | 0.005 | <0.001 |
| BMI (kg/m2) | 23.59(2.99) | 24.04(3.33) | 0.001 | 30.05(3.61) | 31.03(4.30) | 0.001 | <0.001 |
| SBP (mmHg) | 118.87(16.31) | 113.43(17.27) | <0.001 | 123.64(16.35) | 120.70(18.05) | 0.001 | <0.001 |
| DBP (mmHg) | 77.31(9.95) | 73.76(10.77) | <0.001 | 80.45(9.59) | 77.72(10.00) | <0.001 | <0.001 |
| FPG ( mg/dl) | 104.17(37.59) | 104.37(43.02) | 0.910 | 108.52(38.43) | 115.04(48.92) | 0.002 | <0.001 |
| TC ( mg/dl) | 197.54(42.92) | 202.00 (42.49) | 0.016 | 201.87(40.98) | 207.10(42.17) | 0.014 | <0.001 |
| TG ( mg/dl) | 140.40(111.73) | 112.15(60.10) | <0.001 | 167.70(95.79) | 140.16(72.88) | <0.001 | <0.001 |
| HDL ( mg/dl) | 45.31(9.45) | 51.59(11.19) | <0.001 | 42.84(9.62) | 49.32(10.40) | <0.001 | <0.001 |
| LDL ( mg/dl) | 124.67(32.54) | 128.02(35.20) | 0.023 | 126.97(34.43) | 130.16(35.78) | 0.072 | 0.011 |
| Education (years) | 6.87(4.71) | 5.41(4.84) | <0.001 | 8.05(5.09) | 4.1(3.97) | <0.001 | <0.001 |
| Daily energy intake (kcal) | 3245.75(956.53) | 2538(724.58) | <0.001 | 3440.89(1019.61) | 2615.53(776.58) | <0.001 | 0.430 |
| | Proportion N (%) | | | | | | |
| Place of residence | | | 0.134† | | | <0.001† | 0.007† |
| Urban | 953(85.0) | 901(87.3) | | 510(89.0) | 976(81.7) | | |
| Rural | 168(15.0) | 131(12.7) | | 63(11.0) | 219(18.3) | | |
| Marital status | | | <0.001† | | | <0.001† | 0.008† |
| Single | 17(1.5) | 43(4.2) | | 4(0.7) | 29(2.4) | | |
| Married | 1092(97.4) | 847(82.1) | | 564(98.4) | 1005(84.1) | | |
| Widowed +Divorced | 12(1.1) | 142(13.8) | | 5(0.9) | 161(13.5) | | |
| Physical activity(Mets) | | | <0.001† | | | <0.001† | <0.001† |
| low | 265(24.1) | 216(21.2) | | 191(33.7) | 337(28.7) | | |
| moderate | 577(52.4) | 663(65) | | 305(53.8) | 742(63.2) | | |
| vigorous | 259(23.5) | 141(13.8) | | 71(12.5) | 95(8.1) | | |
| Occupation | | | <0.001† | | | <0.001† | <0.001† |
| Employed | 940(83.9) | 201(19.5) | | 474(82.7) | 139(11.6) | | |
| Unemployed | 181(16.1) | 831(80.5) | | 99(17.3) | 1056(88.4) | | |
| Smoking status | | | <0.001† | | | <0.001† | <0.001† |
| Never | 728(65.2) | 1005(99.8) | | 396(69.2) | 1170(99.5) | | |
| Current | 250(22.4) | 1(0.1) | | 95(16.6) | 5(0.4) | | |
| Former | 139(12.4) | 1(0.1) | | 81(14.2) | 1(0.1) | | |
| WIS | | | <0.001† | | | <0.001† | <0.001† |
| Poor | 417(37.3) | 473(45.8) | | 160(28.0) | 552(46.2) | | |
| Average | 228(20.4) | 181(17.5) | | 116(20.3) | 228(19.1) | | |
| Rich | 473(42.3) | 378(36.6) | | 295(51.7) | 414(34.7) | | |

BMI, body mass index; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; FPG, fasting plasma glucose; TC, total cholesterol; TG, triglyceride; HDL, high density lipoprotein; LDL, low density lipoprotein; (WIS), Wealth index score

*Analyzed by the independent t-test.

†Analyzed by the Chi-square test.

**Table 5.** Multinomial Logistic regression analysis of overweight and obesity by sociodemographic and anthropometric variables in Bandare-Kong Cohort Study (n = 3921)

| | BMI | | | | | |
|---|---|---|---|---|---|---|
| | Overweight | | | Obesity | | |
| **Variables** | **Crude OR (95% CI)** | **Adjusted OR (95% CI)** | **Adjusted P-value** | **Crude OR (95% CI)** | **Adjusted OR (95% CI)** | **Adjusted P-value** |
| Age | 0.99 (0.98-1.01) | 0.97(0.95-0.98) | < 0.001 | 0.98 (0.97-0.99) | 0.93 (0.91-0.94) | < 0.001 |
| FPG | 1.02(1.01-1.03) | ..... | | 1.02(1.01-1.03) | ..... | |
| HDL | 0.98 (0.97-0.98) | 0.98(0.97-0.99) | < 0.001 | 0.98 (0.97-0.99) | 0.98(0.96-0.99) | < 0.003 |
| LDL | 1.02(1.01-1.03) | --- | | 1.03(1.02-1.04) | ---- | |
| Education | 1.01 (0.99-1.03) | ---- | | 1.00(0.98-1.01) | ---- | |
| Daily Energy intake | 1.02(1.01-1.03) | 1.03 (1.02-1.04) | < 0.001 | 1.02 (1.01-1.03) | 1.03(1.02-1.04) | < 0.001 |
| Gender | | | | | | |
| Male | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Female | 1.46 (1.26-1.69) | 1.91(1.42-2.55) | < 0.001 | 2.79 (2.34-3.32) | 5.11(3.74-6.96) | < 0.001 |
| Place of residence | | | | | | |
| Rural | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Urban | 1.242(1.018-1.515) | 1.69(1.28-2.21) | < 0.001 | 1.43(1.09-1.870) | 2.99(2.06-4.32) | < 0.001 |
| Marital status | | | | | | |
| Single | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Married | 2.75(1.63-4.64) | 2.51(1.10-5.71) | 0.028 | 2.53(0.92-2.54) | --- | |
| Widowed+ Divorced | 3.20(1.80-5.70) | 2.81(1.16-6.79) | 0.022 | 1.83 (1.29-3.26) | --- | |
| Occupation | | | | | | |
| Employed | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Unemployed | 1.23(1.22-1.69) | 0.72(0.55-0.93) | 0.013 | 1.96(1.66-2.33) | 0.66(0.45-0.95) | 0.029 |
| Smoking status | | | | | | |
| Never | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Current | 0.72 (0.53-0.97) | 0.64(0.46-0.88) | 0.007 | 0.48(0.32-0.71) | 0.57(0.34-0.96) | 0.035 |
| Former | 0.53 (0.41-0.68) | ----- | | 0. 31(0.22-0.43) | ---- | |
| Physical activity | | | | | | |
| Low | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Moderate | 0.90 (0.76-1.08) | --- | --- | 0.78 (0.64-0.95) | | |
| Vigorous | 0.59 (0.47-0.74) | --- | --- | 0.34 (0.25-0.46) | 0.59 (0.39-0.91) | 0.019 |
| Hypertension | | | | | | |
| No | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Yes | 1.731(1.475-2.032) | 1.74(1.39-2.18) | < 0.001 | 2.21(1.85-2.64) | 2.43(1.81-3.26) | < 0.001 |
| Hypertriglyceridemia | | | | | | |
| No | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Yes | 2.07(1.77-2.42) | 1.59(1.27-1.99) | < 0.001 | 2.35(1.98-2.80) | 1.76(1.31-2.38) | < 0.001 |
| Hypercholesterolemia | | | | | | |
| No | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Yes | 1.58(1.36-1.82) | ------ | | 1.76(1.48-2.08) | ----- | |
| WC | | | | | | |
| < 95 cm | 1.00 | 1.00 | | 1.00 | 1.00 | |
| ≥ 95 cm | 21.94(16.83-28.59) | 23.55(17.67-31.38) | < 0.001 | 420.42(284.80-620.63) | 503.89(331.76-765.32) | < 0.001 |
| WSI | | | | | | |
| Poor | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Average | 1.15(0.94-1.40) | ---- | | 1.08(0.868-1.35) | ---- | |
| Rich | 1.57(1.33-1.84) | 1.51(1.29-1.88) | < 0.001 | 1.20(0.99-1.44) | ----- | |

Adjusted variables: Gender, age, marital status, place of residence, education, wealth index score (WIS), occupation, hypertension, fasting plasma glucose (FPG), hypertriglyceridemia, hypercholesterolemia, high-density lipoprotein (HDL), low-density lipoprotein (LDL), smoking status, physical activity (low < 36, moderate 36-44.9, and vigorous ≥ 45 METS), daily calorie intake.
*Normal BMI (< 25 kg/m$^2$) is the reference. Only statistically significant values have been mentioned.

**Table 6.** Binary Logistic regression analysis of central obesity by sociodemographic characteristics in Bandare-Kong Cohort Study (n=3921)

| Variables | Central obesity WC≥95 | | Adjusted p-value |
|---|---|---|---|
| | Crude OR(95% CI) | Adjusted OR(95% CI) | |
| Age | 1.02 (1.01-1.03) | 1.03(1.02-1.04) | <0.001 |
| FPG | 1.02(1.01-1.04) | 1.03(1.01-1.04) | 0.025 |
| HDL | 0.99(0.98-0.99) | 98(0.97-0.99) | |
| LDL | 1.02(1.01-1.03) | ------ | |
| Education | 0.96 (0.95-0.97) | ------- | |
| Daily Energy intake | 0.98 (0.97-0.99) | ------- | |
| Gender | | | |
| Male | 1.00 | 1.00 | |
| Female | 2.26(1.98-2.58) | 1.70(1.34-2.16) | <0.001 |
| Place of residence | | | |
| Rural | 1.00 | 1.00 | |
| Urban | 0.85(0.71-1.01) | 0.58(0.45-0.76) | <0.001 |
| Marital status | | | |
| Single | 1.00 | 1.00 | |
| Married | 1.47(0.95-2.26) | ----- | |
| Widowed+ Divorced | 1.96(1.21-3.66) | ----- | |
| Occupation | | | |
| Employed | 1.00 | 1.00 | |
| Unemployed | 2.12(1.866-2.418) | 1.49(1.18-1.89) | 0.001 |
| Smoking status | | | |
| Never | 1.00 | 1.00 | |
| Current | 0.43(0.34-0.55) | ---- | |
| Former | 0.64(0.48-0.85) | ---- | |
| Physical activity | | | |
| Low | 1.00 | 1.00 | |
| moderate | 0.76(0.0.66-0.89) | ----- | |
| vigorous | 0.38(0. 30-0.47) | ----- | |
| Hypertension | | | |
| No | 1.00 | 1.00 | |
| Yes | 1.97 (1.72-2.26) | 1.26(1.04-1.52) | 0.018 |
| Hypertriglyceridemia | | ----- | |
| No | 1.00 | 1.00 | |
| Yes | 1.93(1.69-2.20) | 1.26(1.05-1.51) | 0.01 |
| Hypercholesterolemia | | | |
| No | 1.00 | 1.00 | |
| Yes | 1.64(1.44-1.86) | ---- | |
| BMI | | | |
| <25 kg/m² | 1.00 | 1.00 | |
| ≥25 kg/m² | 44.33 (34.20-57.46) | 46.81 (35.53-61.67) | <0.001 |
| WSI | | | |
| Poor | 1.00 | 1.00 | |
| Average | I.05(0.88-1.25) | ---- | |
| Rick | 1.04(0.90-1.20) | ---- | |

Adjusted variables: Gender, age, marital status, place of residence, education, wealth index score (WIS), occupation, hypertension, fasting plasma glucose (FPG), hypertriglyceridemia, hypercholesterolemia, high-density lipoprotein (HDL), low-density lipoprotein (LDL), smoking status, physical activity (low<36, moderate 36-44.9, and vigorous≥45 METS), daily calorie intake.
*Normal (WC<95 cm) is the reference. Only statistically significant values have been mentioned.

multiple risk factors such as parity, which has previously been shown as a risk factor of obesity among females (25, 26). Our study included women aged 35-70 years who may have had higher parity compared to younger women. Additionally, in this study, most women were housewives and had a sedentary lifestyle, reflected in the lower percentage of women with vigorous physical activities compared to men. In addition, hormonal changes after menopause play an essential role in women's obesity as well (27), which might be the case for various women over the age of 45 in our study.

After adjustment for socio-demographic and anthropometric variables, we surprisingly found lower odds of general obesity with advancing age. However, consistent with other studies, female gender and urban residence were significantly associated with general obesity (14, 28). Furthermore, a higher prevalence of hypertension and hypertriglyceridemia and lower serum HDL concentrations were observed among obese people. The higher prevalence of general obesity in younger subjects can be due to urbanization and the transition to a westernized lifestyle (1). Several studies have confirmed the association between obesity (BMI > 30) and hypertension (29-32). Some studies have also demonstrated the association between dyslipidemia and obesity (33, 34)

Based on WC as an index of obesity, central obesity was higher in the elderly, women, rural residents, and the unemployed. Age is a risk factor for central obesity (14, 35). In the elderly, there is a reduction in growth hormone, which has a preventive effect against abdominal obesity (36). Moreover, we concluded that older persons had less physical activity compared to younger individuals. This may be due to low socioeconomic status and malnutrition, especially during childhood, leading to central obesity in adulthood. Additionally, a low-quality diet increases the risk of obesity (1, 37). Unexpectedly, unlike general obesity, the risk of central obesity was higher in rural residents. Rural women also had higher parity and less access to the gym and outdoor exercise. As BMI was lower in rural participants than in their urban counterparts, sarcopenic obesity should be considered as well (38). In this study, housewives fell under the unemployed category. The higher rate of central obesity in the unemployed is partly due to these participants, who comprised a relatively large proportion of this group.

Subjects with central obesity had greater FPG levels and less PAL. It has been represented that central obesity is a risk factor for pre-diabetes and diabetes (39-41), which can account for the correlation between central obesity and high FPG in the current study. On the other hand, contrary to general obesity, no significant correlation was found between daily calorie intake and central obesity after adjustment for socio-demographic and anthropometric factors. This could be due to malnutrition and sarcopenic obesity in the group with abdominal obesity (38). Nevertheless, since there is no information about body composition in our study, we cannot be certain whether these factors were present in individuals with abdominal obesity.

The present study had some limitations. The first limitation was the cross-sectional design which made it impossible to determine an actual cause and effect association since exposure and outcome were evaluated concurrently. In addition, the information regarding alcohol consumption was unreliable due to religious and cultural issues and was not included in our analysis. Further, we only evaluated individuals aged 35-70 years; therefore, the prevalence of obesity in this population cannot reflect its general prevalence. Finally, anthropometric measurements such as BMI and WC and their associated factors were only measured once because of the study's design; hence it might be a possible explanation for the insignificant association between general obesity and some known risk factors such as higher FPG levels after adjustment for socioeconomic and demographic factors. On the other hand, the most important strength of the study is its unique design with a relatively large sample size and precise measurements by a trained research team, which was conducted in the country's southern coastal region. Therefore, any information about non-communicable diseases and their risk factors would benefit from prevention and management strategies. Likewise, the current study estimated the prevalence of general and central obesity in the indigenous urban and rural residents of the south coastal region who differ from the other parts of the country in terms of socioeconomic status and eating habits. The data used for the current study were extracted from the baseline information of the BKNCD cohort, thus it is recommended that the trend of general and central obesity be evaluated over time when data from the second and third phases of the cohort are available.

## Conclusion

Overall, general and central obesity were higher in the women of this study. General obesity was higher in younger and urban citizens, while central obesity was more prevalent in older and rural ones. In addition, a higher prevalence of hypertension and hypertriglyceridemia was observed in the obese. Moreover, a significant correlation was found among female gender, hypertension, and hypertriglyceridemia with general and central obesity in this study. Therefore, it is recommended that prospective longitudinal studies be conducted to better evaluate the trend of overweight and obesity and their predisposing factors in this population. Given the high prevalence of obesity, health authorities should pay more attention to promoting a healthy lifestyle, especially in this population.

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**Author Contributions**
**Conceptualization:** Sara Bahri.
**Methodology:** Ladan Hajiabdolrassouli.
**Validation:** Seyed Hossein Davoudi.
**Formal Analysis:** Shideh Rafati.
**Investigation:** Masoud Shareghi Brojeni.
**Resources:** Azim Nejatizadeh.
**Data Curation:** Roghayeh Shahbazi.
**Writing – Original Draft Preparation:** Masoumeh Kheirandish.
**Writing – Review and Editing:** Ghazal Zoghi.
**Visualization:** Sara Bahri.
**Supervision:** Ladan Hajiabdolrassouli, Seyed Hossein Davoudi.
**Project Administration:** Roghayeh Shahbazi, Masoud Shareghi Brojeni.
**Funding Acquisition:** Masoumeh Kheirandish.

**Conflict of Interests**
The authors declare that they have no competing interests.

**Ethical Approval**
The study has been approved by the Institutional Review Board of Hormozgan University of Medical Sciences and complies with the statements of the Declaration of Helsinki (IR.HUMS.REC.1398.131).

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