

The comparison of waist circumference, waist-to-hip ratio, and waist-to-height ratio among rural women adults in the North of Iran, between the years 2004 and 2013

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Original Article

Abstract

BACKGROUND: Central obesity is a common health disorder, and the main objective of this study was to compare its changings among rural women in the north of Iran, between the years 2004 and 2013.

METHODS: Two cross-sectional studies were established on the 2839 and 2478 subjects in 2004 (first stage) and 2013 (second stage), respectively. Among 118 villages, 20 were selected using random sampling; they were the same in two studies. Central obesity was defined as waist circumference (WC) > 88 cm, waist-to-hip ratio (WHR) > 0.8, and waist-to-height ratio (WHtR) > 0.5.

RESULTS: The prevalence of central obesity in 2013 based on WC, WHR, and WHtR were 37.4%, 73.5%, and 67.8%, respectively. Compared with 2004, the prevalence of central obesity based on WHR increased as 5.4% (68.1% vs. 73.5%) ($P = 0.001$), whereas morbid obesity (WHtR > 0.6) based on WHtR decreased as 3.7% in 2013 (28.8% vs. 25.1%) ($P = 0.004$). Central obesity based on WHR significantly decreased in less or equal 24-year-old group (76.6% vs. 70.1%) ($P = 0.003$), while it increased in 25-34- (65.1% vs. 74.0%) and in equal or more than 35-year-old group (54.1% vs. 78.9%) ($P = 0.001$ for all). Moreover, morbid obesity decreased in all age, economic, and education groups (except uneducated one) ($P < 0.050$ for all).

CONCLUSION: Despite the decrease in central obesity based on WC and WHR indices in 2004-2013 duration, we found the evidence of a decline in sever obesity based on WHtR in that period. These trends have an alarm for health policy makers, not only in this area but also in same communities. Comprehensive studies are recommended to determine the best obesity indicator related to health in future.

Keywords: Central Obesity, Trends, Women, Socioeconomic Status, Iran

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Introduction

Non-communicable diseases will account for approximately three quarters of all deaths in the developing countries by the year 2020.¹ Among them, obesity is a main risk factor for chronic diseases, and plays a central role in the “metabolic syndrome” or “insulin resistance”, which includes hyperinsulinemia, hypertension, hyperlipidemia, and type 2 diabetes mellitus.²

Obesity has been increased in recent years in the world,³ and is well-known as a health problem in Iran.^{4,5} Besides, central obesity has been recognized as a major health problem in the north of Iran,⁶ and its prevalence is 9.7-12.9 and 54.5-63.7 percent in Iranian men and women, respectively.^{7,8}

Several indices such as body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR),

and waist-to-height ratio (WHtR) are used to classify general and central obesity in clinical practice. Even though, WHtR and WC are better measures of visceral and abdominal fat distribution.^{9,10} On the other hand, some studies reported that WC is a better indicator of cardiovascular disease (CVD) risk than BMI and WHR,¹¹⁻¹³ however, a high WHR has been identified as an increasing risk factor of dyslipidemia, hypertension, CVD, and diabetes mellitus compared with BMI.¹⁴

Golestan province is located in the north of Iran (south east of Caspian Sea), and among its 1.7 million people, 25.6% live in rural areas. Agriculture is the main job in rural areas, and different ethnic groups such as Fars-native, Turkmen, and Sistani are living in this region.¹⁵

Some studies have identified that life style,

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education, economic status, and ethnicity are the major obesity associated factors.^{11,16,17} On the other hand, rapid socio-economic development and industrialization over the last decades have undoubtedly changed the life style in Iran. However, as far as the researchers concerned, there has been no discussion about the changing of obesity trend based on WC, WHR, and WHtR in rural women in Golestan province. In this regard, this study aimed to compare the central obesity based on WC, WHR, and WHtR, and some related socio-demographic factors between the years 2004 (first stage) and 2013 (second stage) in rural women in the north of Iran.

Materials and Methods

Two cross-sectional studies in 2004 with 2839 cases (first stage),¹⁸ and in 2013 with 2478 cases (second stage) were conducted among women living in rural areas in the north of Iran. 20 of 118 villages in Gorgan and Aq-Qala districts (two capital cities in the north of Iran), were selected by random sampling. Villages and questioners were the same in two studies. A trained 20-member reviewer team completed a questionnaire including socio-demographic questions as age, economic status, and educational levels, and measured the anthropometric indices. The recorded data were combined and statistically analyzed. Sampling methods were similar to previous study.¹⁸

Based on age distribution among client women to primary health care, age was classified in three groups as ≤ 24 , 25-34, and ≥ 35 years. Economic status was categorized based on possession of 10 facility items necessary for modern-day life, such as telephone, running water, gas pipeline, personal house, color television, computer, microwave oven, private car, freezer, and cooler.¹⁸ According to this list, the economic status of sample population in these studies was categorized as low: ≥ 3 , moderate: 4-6, and good: 7-10. According to the education classification in Iran, the education was categorized as uneducated (those women who could not write and read), 1-12 years of schooling, and college educated (who were educated at university).

Weight measurement without shoes and clothing was carried out using the health system scale (Seca, UK), and recorded as the nearest 0.5 kg. Height, waist, and hip measured using a tape measuring as the nearest 0.5 cm, while the participants were standing on their feet. WC was measured over the iliac and lower border of the ribs. Hip circumference was measured at the widest point over the buttocks.¹⁹

WHR was obtained by dividing the WC by hip circumference, and WHtR was obtained by dividing WC by mean of height. Abdominal obesity defined by WC > 88 cm and WHR > 0.8 cm.¹⁹ WHtR was classified as normal: < 0.4 , overweight: 0.4-0.5, obese: 0.5-0.6, and morbidly obese: > 0.6 .^{20,21} All women who were coming to primary health centers participated in two studies. Pregnant women and the subjects who did not like to participate were excluded from the studies.

The WC, WHR, and WHtR values were reported based on mean and standard deviation (SD), and categorized by obesity indices. To control the confounding effects of age, economic status, and education level, we compared the obesity indices by their subgroups in two stage studies. Categorical data has been presented by frequencies and percent.

After establishing the normality using the Kolmogorov-Smirnov test, data were analyzed using SPSS software (version 18.0, SPSS Inc., Chicago, IL, USA). Statistical analyses included independent sample t test, and analysis of variance (ANOVA) for continues variables. In addition, two-way ANOVA was used for assessing of interaction between economic status and education levels based on obesity indices, and Tukey's test was used for group comparisons. For categorical variables, chi-square test was used. P-value of less than 0.050 was considered as significant.

The studies were approved by Ethical Research Committee of Golestan University of Medical Sciences, Gorgan, Iran (G-P-35-1112), and verbal informed consents were received from all cases.

Results

Table 1 illustrates the main characteristics of two studies. As indicated, there was a little change in age, and hip and WC values. However, significantly increasing changes were seen in height and weight. WHR and WHtR values decreased significantly during two studies ($P < 0.050$ for all). Moreover, the improving of economic condition and education levels were seen during the two studies.

The mean and SD of WC, and the prevalence of central obesity based on it are compared between the two studies in table 2. The prevalence of central obesity by WC > 88 cm was 37.4% in 2013; however, this value unchanged during two studies. The change of central obesity during two studies was not significant by age groups and education levels ($P > 0.050$ for all); however, central obesity significantly decreased (5.7%) in moderate economic group during the two studies ($P = 0.003$).

Table 1. The comparison of anthropometric indices and socio-demographic factors status between the years 2004 and 2013

| Variable | Year | 2004 (2753 cases) | | 2013 (2386 cases) | | P |
|-------------------------------|----------------------|-------------------|--|-------------------|--|---------|
| | | Mean ± SD | | Mean ± SD | | |
| Age (year) | | 28.290 ± 6.140 | | 28.010 ± 5.670 | | 0.093 |
| Hip (cm) | | 97.950 ± 10.990 | | 98.100 ± 12.320 | | 0.645 |
| Height (cm) | | 157.710 ± 5.970 | | 158.790 ± 5.800 | | < 0.001 |
| Weight (kg) | | 62.420 ± 12.940 | | 65.470 ± 13.410 | | < 0.001 |
| Waist circumference (WC) (cm) | | 84.400 ± 12.770 | | 83.890 ± 13.260 | | 0.161 |
| Waist to hip ratio (WHR) | | 0.861 ± 0.082 | | 0.856 ± 0.092 | | 0.040 |
| Waist to height ratio (WHtR) | | 0.536 ± 0.018 | | 0.529 ± 0.083 | | < 0.001 |
| Variable | | n (%) | | n (%) | | P |
| Economy [#] | Poor | 1067 (38.8) | | 554 (23.2) | | < 0.001 |
| | Moderate | 1521 (55.2) | | 1250 (52.4) | | |
| | Good | 165 (6.0) | | 582 (24.4) | | |
| Education | Uneducated | 658 (23.9) | | 188 (7.9) | | < 0.001 |
| | 1-12 years schooling | 1917 (69.6) | | 2145 (89.9) | | |
| | College | 178 (6.5) | | 53 (2.2) | | |
| Age group (year) | ≤ 24 | 1043 (37.9) | | 706 (29.6) | | < 0.001 |
| | 25-34 | 1357 (49.3) | | 1344 (56.3) | | |
| | ≥ 35 | 353 (12.8) | | 336 (14.1) | | |

SD: Standard deviation

* According to 10 facilities, the economic status categorized as low: ≥ 3, moderate: 4-6, and good: 7-10.

Chi-square and t tests were used for qualities and quantities values, respectively.

Table 3 shows the comparison of mean and SD of WHR, and the prevalence of central obesity based on it between the two studies. The prevalence of obesity by WHR > 0.8 was 73.5% in 2013, and increased (5.4%) during the two studies (P = 0.001).

The increasing trends of WHR were seen in 25-34 and ≥ 35 years age groups (P = 0.001 for all), while it decreased (6.5%) in ≤ 24 years age group (P = 0.003). In addition, central obesity significantly increased during two studies in moderate and good economic groups, besides in 1-12 years schooling

and in uneducated groups (P < 0.050 for all).

The mean and SD of WHtR and central obesity are presented in table 4. The prevalence of overweight, obesity, and morbid obesity in 2013 were 24.1%, 18.6%, and 25.1%, respectively. Despite morbid obesity tend to decrease in total and in all groups but, obesity increased in these groups.

Tukey's post hoc test revealed statistical significant differences by three central obesity indices between age groups with together in two studies (P < 0.050 for all).

Table 2. The comparison of waist circumference (WC) of adult women in the north of Iran between the years 2004 and 2013

| Variable | Year | 2004 | | | 2013 | | | P ^{**} | | |
|----------------------|--------------------------------------|------|----------------|----------------------|------------------------|------|----------------|-----------------|----------------------|------------------------|
| | | n | WC(cm) Mean±SD | Normal weight [n(%)] | Central obesity [n(%)] | n | WC(cm) Mean±SD | | Normal weight [n(%)] | Central obesity [n(%)] |
| Age (year) | ≤24 ^a | 1043 | 81.52 ± 12.28 | 754 (72.3) | 289 (27.7) | 706 | 80.95 ± 12.12 | 506 (71.7) | 200 (28.3) | 0.819 |
| | 25-34 ^b | 1357 | 85.77 ± 12.58 | 767 (56.5) | 590 (43.5) | 1344 | 84.36 ± 13.33 | 810 (60.3) | 534 (39.7) | 0.053 |
| | ≥35 ^c | 353 | 87.68 ± 13.25 | 181 (51.3) | 172 (48.7) | 336 | 88.21 ± 13.84 | 177 (52.7) | 159 (47.3) | 0.770 |
| | | | | P=0.001 [*] | | | | | | |
| Economy [#] | Poor ^d | 1067 | 81.99 ± 12.31 | 746 (69.9) | 321 (30.1) | 554 | 81.03 ± 13.34 | 399 (72.0) | 155 (28.0) | 0.409 |
| | Moderate ^e | 1521 | 85.70 ± 12.74 | 881 (57.9) | 640 (42.1) | 1250 | 83.80 ± 12.92 | 795 (63.6) | 455 (36.4) | 0.003 |
| | Good ^f | 165 | 88.04 ± 13.38 | 75 (45.5) | 90 (54.5) | 582 | 86.82 ± 13.30 | 299 (51.4) | 283 (48.6) | 0.209 |
| | | | | P=0.001 [*] | | | | | | |
| Education | Uneducated ^d | 658 | 83.88 ± 12.87 | 425 (64.6) | 233 (35.4) | 188 | 85.32 ± 13.83 | 112 (59.6) | 76 (40.4) | 0.241 |
| | 1-12 years of schooling ^h | 1917 | 84.49 ± 12.73 | 1169 (61.0) | 748 (39.0) | 2145 | 83.75 ± 13.26 | 1347 (62.8) | 798 (37.2) | 0.247 |
| | College ^e | 178 | 85.55 ± 12.78 | 108 (60.7) | 70 (39.3) | 53 | 84.75 ± 10.56 | 34 (64.2) | 19 (35.8) | 0.767 |
| | | | | P=0.221 [*] | | | | | | |
| Total | | 2753 | 84.40 ± 12.77 | 1702 (61.8) | 1051 (38.2) | 2386 | 83.89 ± 13.26 | 1493 (62.6) | 893 (37.4) | 0.600 |

WC: Waist circumference; SD: Standard deviation

* One-way ANOVA was used for quantitative values for more than two groups; ** Chi-square test was used for qualitative values;

According to 10 facilities, the economic status categorized as low: ≥ 3, moderate: 4-6, and good: 7-10.

Tukey's post hoc revealed statistical significant differences between quantitative values of a and b, a and c, b and c, d and e, and d and f (P < 0.050 for all) in 2004, and of a and b, a and c, b and c, d and e, d and f, and e and f in 2013 (P < 0.050 for all).

Table 3. The comparison of waist to hip ratio (WHR) of adult women in the north of Iran between the years 2004 and 2013

| Variable | Year | 2004 | | | 2013 | | | P** | | |
|----------------------|--------------------------------------|------|---------------|-----------------------|-------------------------|------|---------------|------------|-----------------------|-------------------------|
| | | n | WHR Mean ± SD | Normal weight [n (%)] | Central obesity [n (%)] | n | WHR Mean ± SD | | Normal weight [n (%)] | Central obesity [n (%)] |
| Age (year) | ≤24 ^a | 1043 | 0.84 ± 0.08 | 244 (23.4) | 799 (76.6) | 706 | 0.85 ± 0.09 | 211 (29.9) | 495 (70.1) | 0.003 |
| | 25-34 ^b | 1357 | 0.87 ± 0.08 | 472 (34.9) | 882 (65.1) | 1344 | 0.86 ± 0.09 | 350 (26.0) | 994 (74.0) | 0.001 |
| | ≥35 ^c | 353 | 0.89 ± 0.07 | 162 (45.9) | 191 (54.1) | 336 | 0.87 ± 0.09 | 71 (21.1) | 265 (78.9) | 0.001 |
| | | | | P=0.001* | | | | P=0.001* | | |
| Economy [#] | Poor ^d | 1067 | 0.85 ± 0.08 | 287 (26.9) | 780 (73.1) | 554 | 0.85 ± 0.09 | 163 (29.4) | 391 (70.6) | 0.309 |
| | Moderate ^e | 1521 | 0.87 ± 0.08 | 519 (34.2) | 1000 (65.8) | 1250 | 0.85 ± 0.09 | 337 (27.0) | 913 (73.0) | 0.001 |
| | Good ^f | 165 | 0.87 ± 0.08 | 72 (43.9) | 92 (56.1) | 582 | 0.86 ± 0.09 | 132 (22.7) | 450 (77.3) | 0.001 |
| | | | | P=0.001* | | | | P=0.080* | | |
| Education | Uneducated ^j | 658 | 0.87 ± 0.08 | 229 (34.6) | 429 (65.2) | 188 | 0.87 ± 0.09 | 43 (22.9) | 145 (77.1) | 0.003 |
| | 1-12 years of Schooling ^h | 1917 | 0.86 ± 0.08 | 599 (31.3) | 1315 (68.7) | 2145 | 0.86 ± 0.09 | 575 (26.8) | 1570 (73.2) | 0.002 |
| | College ^p | 178 | 0.86 ± 0.08 | 50 (28.1) | 128 (71.9) | 53 | 0.85 ± 0.08 | 14 (26.4) | 39 (73.6) | 0.949 |
| | | | | P=0.005* | | | | P=0.061* | | |
| Total | | 2750 | 0.86 ± 0.08 | 878 (31.9) | 1872 (68.1) | 2386 | 0.86 ± 0.09 | 632 (26.5) | 1754 (73.5) | 0.001 |

WHR: Waist to hip ratio; SD: Standard deviation

* One-way ANOVA was used for quantitative values for more than two groups; ** Chi-square test was used for qualitative values;

According to 10 facilities, the economic status categorized as low: ≥ 3, moderate: 4-6, and good: 7-10.

Tukey's post hoc revealed statistical significant differences between quantitative values of a and b, a and c, b and c, d and e, d and f, and h and j (P < 0.050 for all) in 2004, and of a and b, a and c, and b and c in 2013 (P < 0.050 for all).

In education groups, this differences were seen based on WHR index between 1-12 years schooling and uneducated groups in two studies (P < 0.050 for all). In addition, the results of this test were significant between different economic groups by all central obesity indices (P < 0.050 for all), except between moderate and good economic groups by WHR and WHtR in 2004 and by WHR in 2013 (Tables 2-4).

The results of two-way ANOVA between economic status and education levels by three indices are presented in table 5. In the first study, the main effects were statistically significant with economic status in WC [F = 13.852 at 2 degrees of freedom (df), P < 0.001], WHR (F = 6.889 at 2 df, P = 0.001), and WHtR (F = 9.485 at 2 df, P < 0.001). In addition, there was no interaction between economic status and education levels in those indices. In the second study, the main effects were statistically significant with economic status in WC (F = 4.454 at 2 df, P = 0.012) and in WHtR (F = 3.632 at 2df, P = 0.027). The interaction between economic status and educational levels was not seen in none of three central obesity indices.

Discussion

We discuss the variation of central obesity during 2004 to 2013 and its association with age, economic status, and educational levels in this section. The interesting finding is that WHR increased while WHtR decreased during two

studies. Besides, the risk of obesity in older people was more than the other age groups. The associations of education and economy with the kinds of central obesity are not alike. In case, low educated groups were more than other groups at risk of morbid obesity. Moreover, the positive association was seen between economic status and WHR, but it was opposite to WHtR.

One of the important findings of this study was that WC did not change, but while WHtR decreased, WHR increased during two studies. In a trend study in the north of Iran, central obesity elevated as 14.1% over 5 years.²² In Tehran, Iran, it increased as 23.2% from 1999 to 2011.²³ In this respect, in Colombian adults,²⁴ central obesity increased from 13.9% to 16.4% during 2005 to 2010. Moreover, in Australia, obesity based on WHtR was prevalent as 8.6%, 13.6%, and 18.3% in 1985, 1995, and 2007, respectively.²⁵ The decline observed in WHtR in our study could be attributed the increase of height and in the same way, this situation has been approved in other studies in this area.^{26,27} Using of WHtR should be re-evaluated in the areas under height failure.

Determining the central obesity rate based on WC, WHR, and WHtR is another finding of the present study. In that respect, it was seen in 37.4%, 73.5%, and 43.7% of women. The prevalence of central obesity based on WC in the north of Iran and in the whole Iran was 56.7% and 43.4%, respectively.²⁸

Table 4. The comparison of waist to height ratio (WHtR) of adult women in the north of Iran between the years 2004 and 2013

| Variable | Year | 2004 | | | | | 2013 | | | | | P** | | |
|------------------|--------------------------------------|------------|----------------|----------------|--------------------|---------------|------------------------|------|----------------|-----------------------|----------------------|------------|---------------|------------------------|
| | | n | WHtR Mean ± SD | Normal [n (%)] | Overweight [n (%)] | Obese [n (%)] | Morbidly obese [n (%)] | n | WHtR Mean ± SD | Normal weight [n (%)] | Overweight † [n (%)] | | Obese [n (%)] | Morbidly obese [n (%)] |
| Age group (year) | ≤ 24 ^a | 1043 | 0.52 ± 0.08 | 409 (39.2) | 282 (27.1) | 135 (12.9) | 217 (20.8) | 706 | 0.51 ± 0.08 | 275 (39.0) | 189 (26.7) | 124 (17.6) | 118 (16.7) | 0.021 |
| | 25-34 ^b | 1357 | 0.54 ± 0.08 | 377 (27.8) | 310 (22.9) | 227 (16.7) | 443 (32.6) | 1344 | 0.53 ± 0.08 | 423 (31.5) | 308 (22.9) | 245 (18.2) | 368 (27.4) | 0.001 |
| | ≥ 35 ^c | 353 | 0.56 ± 0.09 | 76 (20.1) | 86 (24.4) | 63 (17.8) | 133 (37.7) | 336 | 0.56 ± 0.09 | 69 (20.6) | 78 (23.2) | 75 (22.3) | 114 (33.9) | 0.047 |
| | | P = 0.001* | | | | | P = 0.001* | | | | | | | |
| Economy # | Poor ^d | 1067 | 0.52 ± 0.08 | 396 (37.1) | 273 (25.6) | 141 (13.2) | 257 (24.1) | 554 | 0.51 ± 0.08 | 216 (38.5) | 148 (26.6) | 89 (16.1) | 104 (18.8) | 0.024 |
| | Moderate ^e | 1521 | 0.54 ± 0.08 | 419 (27.6) | 373 (24.5) | 256 (16.8) | 473 (31.1) | 1250 | 0.53 ± 0.08 | 408 (32.6) | 303 (24.2) | 226 (18.1) | 313 (25.1) | 0.002 |
| | Good ^f | 165 | 0.55 ± 0.08 | 42 (25.4) | 32 (19.4) | 28 (17.0) | 63 (38.2) | 582 | 0.55 ± 0.08 | 146 (25.1) | 124 (21.3) | 129 (22.2) | 183 (31.4) | 0.301 |
| | | P = 0.001* | | | | | P = 0.001* | | | | | | | |
| Education | Uneducated ^g | 658 | 0.53 ± 0.08 | 205 (31.2) | 165 (25.1) | 117 (17.7) | 171 (26.0) | 188 | 0.53 ± 0.09 | 62 (33.0) | 35 (18.6) | 29 (15.4) | 62 (33.0) | 0.122 |
| | 1-12 years of schooling ^h | 1917 | 0.54 ± 0.09 | 599 (31.2) | 469 (24.5) | 279 (14.6) | 570 (29.7) | 2145 | 0.53 ± 0.08 | 690 (32.2) | 522 (24.3) | 406 (18.9) | 527 (24.6) | 0.001 |
| | College ^p | 178 | 0.54 ± 0.08 | 53 (29.8) | 44 (24.7) | 29 (16.3) | 52 (29.2) | 53 | 0.53 ± 0.07 | 15 (28.3) | 18 (34.0) | 9 (17.0) | 11 (20.7) | 0.491 |
| | | P = 0.511* | | | | | P = 0.068* | | | | | | | |
| Total | | 2753 | 0.54 ± 0.08 | 857 (31.1) | 678 (24.7) | 425 (15.4) | 793 (28.8) | 2386 | 0.53 ± 0.08 | 767(32.2) | 575 (24.1) | 444 (18.6) | 600 (25.1) | 0.002 |

WHtR: Waist-to-height ratio; SD: Standard deviation; WHtR scaling: Normal: < 0.4, Overweight: 0.4-0.5, Obese: 0.5-0.6, Morbidly obese: > 0.6

* One-way ANOVA was used for quantitative values for more than two groups; ** Chi-square test was used for qualitative values; # According to 10 facilities, the economic status categorized as low: ≥ 3, moderate: 4-6, and good: 7-10.

Tukey's post hoc revealed statistical significant differences between quantitative values of a and b, a and c, b and c, d and e, and d and f (P < 0.050 for all) in 2004, and of a and b, a and c, b and c, d and e, d and f, e and f in 2013 (P < 0.050 for all).

Table 5. The results of two-way ANOVA analysis between economic status and education levels based on waist circumference (WC), waist-to-hip ratio (WHR), and waist to height ratio (WHtR) indices

| Criteria | Year | Variable | 2004 | | | 2013 | | |
|----------|------|--------------|-------------|-------------|-------|-------------|-------------|-------|
| | | | Mean square | F Statistic | P | Mean square | F Statistic | P |
| WC | | A: Economic | 2204.826 | 13.852 | 0.001 | 764.386 | 4.454 | 0.012 |
| | | B: Education | 35.210 | 0.221 | 0.802 | 255.157 | 1.487 | 0.226 |
| | | A*B | 25.203 | 0.158 | 0.959 | 163.925 | 0.955 | 0.431 |
| WHR | | A: Economic | 0.045 | 6.889 | 0.001 | 0.016 | 1.971 | 0.140 |
| | | B: Education | 0.010 | 1.572 | 0.208 | 0.018 | 2.164 | 0.115 |
| | | A*B | 0.003 | 0.525 | 0.718 | 0.005 | 0.636 | 0.637 |
| WHtR | | A: Economic | 0.063 | 9.485 | 0.001 | 0.025 | 3.632 | 0.027 |
| | | B: Education | 0.001 | 0.220 | 0.802 | 0.016 | 2.349 | 0.096 |
| | | A*B | 0.003 | 0.517 | 0.724 | 0.009 | 1.305 | 0.266 |

WC: Waist circumference; WHR: Waist-to-hip ratio, WHtR: Waist-to-height ratio

In other countries, as Ghana,²⁹ Malaysian women,³⁰ South Brazil,¹⁶ Sri Lankan adults,³¹ and Bangladesh,³² the prevalence was 29.8%, 39%, 38.9%, 26.2%, and 39.8%, respectively. In addition, the prevalence of obesity based on WHR in women in north of Iran¹⁸ and in the whole Iran³³ was 68.1% and 72.2%, respectively. In other regions, the prevalence was 71.6% in Bangladesh,³² and 64.6% in Oman.³⁴ Data on WHtR obesity is rare; however, in high school students in Iran³⁵ it was 18.2%, in Portuguese adults³⁶ 18.3%, and in Bangladesh³² 42.1%. Compared with other studies, an alarming rate of central obesity was seen in northern women in Iran, and it was outstanding for WHtR index. It is necessary to establish a preventive program in the north of Iran.

Variation of central obesity among different age groups is another result of present study. In spite of the fact that WHR among ≤ 24 years age group decreased, an upward trend was seen in the older ones. A direct association was seen between central obesity and age in the north of Iran⁶ and in the other countries.^{29,36} The most prevalence of central obesity was seen in 50-59 years age group in Brazil.¹⁶

The decline trend of central obesity in young women is interesting in our study. We did not study all contributing factors on the age and central obesity but, height significantly increased in 2013 compared with 2004, and it was concordant with data from previous study in this area.²⁶ On the other hand, marriage is well-known as an obesity risk factor in women.⁶ Though, the trend studies by age differences are rare in literature, the improvement of height and rising marriage age of women may explain the decline trend of central obesity in young women in this area.

Moreover, heterogenic trend of central obesity among age groups verifies the nutrition transition idea³⁷ in Iran, and the shape of central obesity is predictable in Iranian northern people in future.

Another finding of present study is determining the role of education on the trend of central obesity, hence it has been salient in uneducated group. In spite of constant trend in educated groups, WHR and WHtR increased (especially in morbid group) in second study. Published studies identified heterogenic association between education and obesity. Central obesity in Ghana,²⁹ for instance, was seen more in high-educated people but, in Bangladesh,³² Malaysia,³⁸ Oman,³⁴ and Portugal,³⁶ it was contrary. Besides, low education was considered as an obesity risk factor in a review study.³⁹ Like above studies in developing countries, illiteracy is an important factor in the central obesity distribution in the north of Iran, and it is necessary

to have a preventive program for it, as a CVD risk factor, with emphasis on uneducated people.

The inverse relationship between high economic group and central obesity indices is another finding of present study. In this regard, WHR trend increased; however, WHtR declined in high economic group in second study. Some studies^{16,17,29,30} showed the influence of socio-demographic factors on the central obesity; however, it was fixed in economic groups. Furthermore, short stature was identified as a health problem in Iranian northern children, and it is more in low income families.^{26,40}

As a result, inverse association between economic status and WHtR may be related to short stature in low income groups. This study revealed that classification of obesity by WC, WHR, and WHtR indices should be re-evaluated on the basis of socio-demographic conditions.

In the present study, all of the nutrition-related factors such as food intake, physical activities, ethnicity, and body composition were not assessed. Besides, a proper statistical test was not used in considering the design effect caused by cluster sampling, and maybe economic values has been changed since recent decade in Iran. Therefore, it can be formed a bias in comparison phase at two studies. Those are our limiting study factors.

Conclusion

Obesity remained as a health problem among rural women in the north of Iran. Despite, central obesity decreased based on WC and WHR indices in 2004-2013 period, we found the evidence of a decline in sever obesity based on WHtR index in that period. These trends are an alarm for health policy makers in this area and in the same communities. Downward trend of WHtR obesity is related to height values improvement in last years. Comprehensive studies are recommended to determine the best obesity indicator related to health in future.

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Conflict of Interests

Authors have no conflict of interests.

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