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Original Article

Waist Circumference, Weight, and Body Mass Index of Iranians based on National Non-Communicable Disease Risk Factors Surveillance

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Abstract

Background: Obesity is an important and life-threatening disease, associated with different chronic conditions such as cardiovascular disease, diabetes, and dyslipidemia. We sought to address the paucity of information on the trends of anthropometric indices such as weight, waist circumference, and body mass index in the adult population of Iran.

Methods: We drew upon data from the First Non-communicable Disease Survey in Iran in 2005. In total, 79,611 participants between 20 and 64 years old were selected via the random multistage cluster sampling. The Lambda Median Scale method was applied to construct normal curves for anthropometric indices.

Results: The mean of waist circumference in both genders increased with age and in all the age groups except those between 20 and 24 years old was higher in the women. The mean of body mass index was higher in all the age brackets in the women, but the means of weight and height were higher in the men. The association of theses indices with diabetes, hypertension, and dyslipidemia was stronger in men.

Conclusion: The ranges of waist circumference and body mass index in Iranian population are different from those of other countries. The higher body mass index and waist circumference in females and the direct association between obesity and chronic diseases, is advisable that the effects of this phenomenon be fully investigated and due heed be paid to the importance of lifestyle modification.

Keywords: Waist circumference, Body mass index, Weight, Iran

Introduction

Obesity has become one of the most life-threatening diseases (1), associated with some chronic conditions (2, 3). The prevalence of obesity in some countries such as Pacific regions have the highest rates, and in some others like China and Thailand have lower rates but with a rapid rise in recent years (4). The prevalence of obesity and its complications is high in the Middle East (5).

In epidemiological studies, the normal ranges of anthropometric indices such as body mass index (BMI) and waist circumference are mainly obtained from Caucasians and in particular Europeans; they are, therefore, not necessarily representative of the indices in other ethnics . Furthermore, the association of these indices with diabe-

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tes and dyslipidemia is varied in different populations (6).

There are some articles on the prevalence of obesity and overweight in different parts of Iran. (7, 8). Moreover various anthropometric cut-offs, based on both cross-sectional and longitudinal studies were reported (9).

However, there is still a dearth of information on the trends and reference values of weight, waist circumference, and BMI specifically among adults in Iran and some other Middle-Eastern countries. Hence, we utilized the data of the Non-Communicable Disease (NCD) Survey, which was carried out in 2005, to evaluate the trends of weight, waist circumference, and BMI.

Materials and Methods

The first nationwide Surveillance of Risk Factors of NCD was a cross-sectional study conducted in 2005, which was followed by another survey in 2007. Its protocol in detail can be found elsewhere (10).

In accordance with the stepwise approach recommended by WHO (11), samples were selected via the random multistage cluster sampling method. Each cluster contained 20 habitants, half of them male. Finally, 89,440 individuals aged between 15 and 64 from and proportional to the size of urban and rural non-institutionalized populations of 28 provinces of Iran were selected. The focus of our study being upon the analysis of the information of participants between 20 and 64 years of age so, the sample size was decreased to 79,611 individuals.

The questionnaires were mainly based on the WHO's stepwise approach to NCD risk factors surveillance and filled in through face-to-face interviews. The information was recorded by interviewing i.e., asking questions about demographic status as well as collecting data through physical and laboratory measurements such as weight, waist circumference, height, blood pressure, Fasting Blood Sugar (FBS), and cholesterol. The Auto-analyzer and enzymatic methods were utilized to assess cholesterol and FBS. FBS was measured by the glucose oxidase/peroxidase-4 aminophenazone-phenol (GOD-PAP) method, and cholesterol was assessed by the cholesterol oxidase/p-aminophenazone (CHD-PAP) method. Glucose and cholesterol were recorded using the "Pars Azmun" (Pars Azmun Co., Tehran, Iran) Kit. The kits in all the laboratories bore the same serial and production permit numbers with the same expiration date.

Physical measurements were obtained by trained health staff, and all the instruments were standardized daily before the examinations. Height measurement was done using portable height measuring inflexible bars with the subjects looking straightforward in light clothing without shoes and socks with their heels attached to the wall. Weight was measured with the subjects in light clothing without shoes and socks using analogue portable scales. Standard constant tension tapes were used in order to measure waist circumference in the midaxillary line at the mid-point between the free head of the lower rib and the anterior superior iliac spine and at the end of normal expiration (12). BMI was computed by dividing weight in kilogram by the square of the height in meter (5).

Mercury Richter sphygmomanometers were employed for the daily calibration of the sphygmomanometers. Blood pressure was measured with appropriate-sized cuffs from the right arm after 5 minutes of rest in the sitting position. First Korotkoff sound indicated systolic blood pressure and the cuff pressure at which the sound stopped indicated diastolic pressure. After two measurements with 5-minute intervals, the average blood pressure was reported; if after two measurements the difference between systolic and/or diastolic pressures was more than 10 mm Hg, the third measurement was recorded. Individuals who used antihypertensive drugs or subjects with systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg were considered hypertensive patients (13). Blood samples were obtained from 25 to 64-year-old participants after a 12-hour fasting period and in the sitting position. The participants who were not fasting and the samples, which had been collected in-

correctly, were excluded. Participants who reported a history of physician-diagnosed diabetes or used oral hypoglycemic agents, insulin, or those with FBS ≥126 mg/dl in blood samples (14) were regarded as diabetics. Blood cholesterol level ≥200 mg/dl was regarded as hypercholesterolemia (15).

Statistical Analysis

The Lambda Median Scale (LMS) method was applied in order to construct normal curves for waist circumference, weight, and BMI against age. In this procedure, the best degrees of freedom for the cubic splines and goodness-of-fit statistics were chosen based on the available diagnostic criteria (16). Modeling median, scale, and shape of distribution was conducted through Fractional Polynomials. Wright and Royston's (17) package "xriml", which is developed in the STATA environment, was used to test the fitting of the Fractional Polynomials. Based on the deviance criteria, a model with the smallest deviance was chosen.

Results

Totally, 79,611 individuals aged between 20 and 64 were recruited. This population comprised 50.1% men and 49.9% women, and the portions of gender in each age group were approximately similar.

The mean of waist circumference in the men and women were 87.91±12.42 and 90.99±14.22 cm respectively. The waist circumference mean in both genders was higher in older ages and in all the age groups was higher in women in comparison with the men and the exception group was those between 20 and 24 years of age. The differences in the means increased with age, and the maximum difference in both genders was seen in those between 55 and 64 years old (Table 1). Waist circumference in both genders decreased after 55 to 59 years old.

Table 1: The means of height, weight, waist circumference, and BMI in 20 to 64 years old Iranian men and women according to National Non-Communicable Disease Risk Factor Surveillance in Iran in 2005

Age Category (Years)	Waist Circumference (cm)		Weight (kg)		Height (cm)		BMI[a] (kg/m²)	
	Male	Female	Male	Female	Male	Female	Male	Female
20-24	80.47	79.50	68.11	59.02	172.72	158.92	22.91	23.38
25-34	84.77	86.37	71.59	64.35	171.82	158.05	24.30	25.74
35-44	88.22	92.33	72.77	67.94	170.07	156.61	25.21	27.63
45-54	90.83	95.01	72.78	67.88	168.67	155.49	25.61	28.00
55-64	91.03	95.60	70.66	65.37	166.95	154.05	25.35	27.50
Total	87.91	90.99	71.58	65.57	169.71	156.38	24.90	26.79

[a] BMI: Body Mass Index

If normal cut-off points of waist circumference in men and women are defined as 102 and 88 cm respectively (1), tables illustrate that women more than men and in lower age would have waist circumferences beyond the normal ranges. For instance, a 48-year-old man with a 106-cm waist circumference would be in the 90th percentile for waist circumference; in other words 10% of men in society would have waist circumferences higher than his (Table 2). On the other hand, a 48-year-old woman with a 106-cm waist circumference would stand between the 75th and 85th percentiles, which mean that the waist circumference of 15 to 25 % of women in society would be higher than hers (Table 3).

Table 2 shows that in the men, 3% of those between 20 and 24 years old, 5% of the ones between 25 and 34, 10% of those between 35 and 44, and 15% of the ones between 45 and 64 were not categorized within the normal waist circumference range. However, in women, 15% of those between 20 and 24 years old, 25% of the ones between 25 and 34, and 50% of those between 35 and 64 were not within the normal waist circumference range (Table 3). The cut-off points of abnormal waist circumference in the women in comparison with the men were in lower percentiles (Fig. 1 and 2).

Table 2: The mean percentiles of waist circumference (cm) in 5 years categories in 20 to 64 years old Iranian men according to National Non-Communicable Disease Risk Factor Surveillance in Iran in 2005

Age category (Years)	Percentiles for Waist Circumference							
	C[a]3	C25	C50	C75	C85	C90	C95	C97
20-24	63.80	73.43	79.86	87.21	91.61	94.79	99.84	103.35
25-29	64.88	75.69	82.57	90.13	94.50	97.58	102.35	105.59
30-34	65.92	77.88	85.20	93.00	97.38	100.44	105.08	108.18
35-39	66.69	79.59	87.27	95.27	99.70	102.75	107.35	110.39
40-44	67.27	81.10	89.12	97.32	101.80	104.86	109.45	112.45
45-49	67.52	82.08	90.36	98.71	103.23	106.30	110.87	113.85
50-54	67.44	82.68	91.17	99.65	104.19	107.27	111.83	114.78
55-59	67.01	82.74	91.38	99.93	104.48	107.55	112.08	115.01
60-64	66.06	82.19	90.92	99.48	104.00	107.05	111.52	114.41

The colored columns: Abnormal waist circumference (waist circumference >102cm) according to metabolic syndrome criteria by World Health Organization (1)/ [a] **C:** Percentile

Table 3: The mean percentiles of waist circumference (cm) in 5 years categories in 20 to 64 years Old Iranian women according to National Non-Communicable Disease Risk Factor Surveillance in Iran in 2005

Age category (Years)	Percentiles for Waist Circumference							
	C[a]3	C25	C50	C75	C85	C90	C95	C97
20-24	60.84	71.27	78.46	86.95	92.17	96.01	102.22	106.63
25-29	63.43	75.58	83.38	91.99	96.98	100.52	106.01	109.74
30-34	65.64	79.37	87.68	96.45	101.35	104.74	109.89	113.30
35-39	67.19	82.18	90.87	99.76	104.61	107.93	112.90	116.16
40-44	68.36	84.48	93.48	102.47	107.29	110.55	115.39	118.53
45-49	68.97	85.95	95.16	104.19	108.97	112.19	116.92	119.97
50-54	69.10	86.79	96.12	105.14	109.87	113.03	117.66	120.63
55-59	68.74	86.90	96.28	105.23	109.89	112.99	117.51	120.40
60-64	67.79	86.24	95.57	104.39	108.94	111.96	116.34	119.14

The colored columns: Abnormal waist circumference (waist circumference > 88 cm) according to metabolic syndrome criteria by World Health Organization (1)/ [a] **C:** Percentile

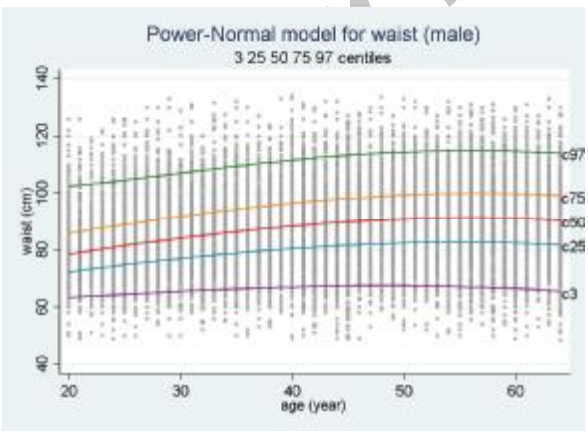

Fig. 1: The mean percentiles of waist circumference (cm) in 10 years categories in 20 to 64 years old Iranian men according to National Non-Communicable Disease Risk Factor Surveillance in Iran in 2005

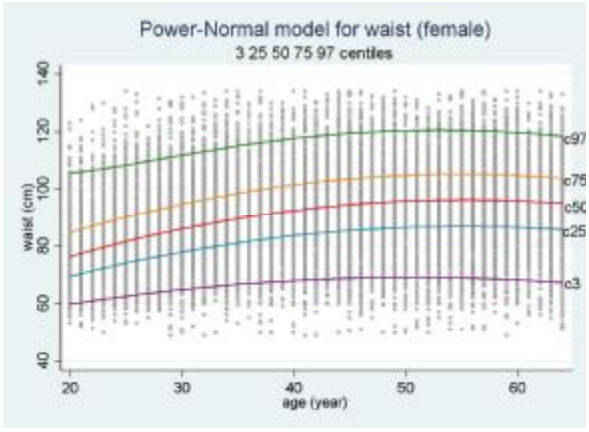

Fig. 2 : The mean percentiles of waist circumference (cm) in 10 years categories in 20 to 64 years old Iranian women according to National Non-Communicable Disease Risk Factor Surveillance in Iran in 2005

The mean of weight in the men and women was 71.58±12.66 and 65.57±13.14 kg, respectively. In the men, the weight mean increased with age in the group composed of 20 to 54-year-olds, whereas in the group of 55 to 64-year-olds it dropped to less than the mean of those in the 25 to 34-year-old bracket. In the women, the ascending trend in the mean of weight was seen in the 20 to 44-year-olds but the descending trend happened in the lower age group (45 to 54 years old). Hence, the maximum of weight mean in the women was in those between 35 and 44 years old and in the men in those between 45 and 54 years of age; in all the age groups the mean was higher in the men than that in the women (Table 1).

The mean of height in the men and women was 169.71±7.49 and 156.38±6.81 cm respectively; it was higher in the men and it decreased with age in both genders. In addition, the difference in the height mean in both genders decreased with age (Table 1).

The mean of BMI in the men and women was 24.90±4.20 and 26.79±5.15 kg/m^2, respectively. In both genders, the mean was higher in the older age groups and the maximum of BMI was seen in those between 45 and 54 years old, followed by a drop. In all the age groups, the mean of BMI in the women was higher than that in the men, the maximum difference of the BMI mean, between genders, was in the 35 to 44-year-old category, and the minimum difference was in the group composed of those between 20 and 24 years of age (Table 1).

If BMI >25 kg/m^2 is defined as overweight (1), 25 % of the men between 20 and 39 years old and 50% of those between 40 and 64 (Table 4), as well as 25% of the women between 20 and 29 years old and 50% of those between 30 and 64 years old (Table 5) would be overweight or obese. It means that women in lower age in comparison with men would be overweight or obese. If BMI >30 kg/m^2 is defined as obese (1), 5% of the men between 20 and 29 years old and 10% of those between 30 and 64 would be obese; in the women the percentiles would be different, however: 5 % of the women between 20 and 24 years old, 10 % of those between 25 and 29, 15% of the ones between 30 and 34, and 25 % of those between 35 and 64 would have obesity. In other words, obesity in women begins in lower percentiles according to different age groups (75th, 85th, 90th and 95th percentiles), and the number of women who suffer from obesity is higher in comparison with men (Fig. 3 and Fig.4).

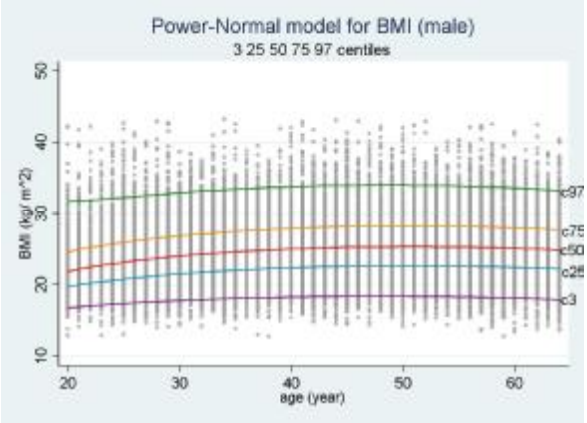

Fig. 3 : The mean percentiles of Body Mass Index in 10 years categories in Iranian 20 to 64 years old men according to National Non-Communicable Disease Risk Factor Surveillance in Iran in 2005

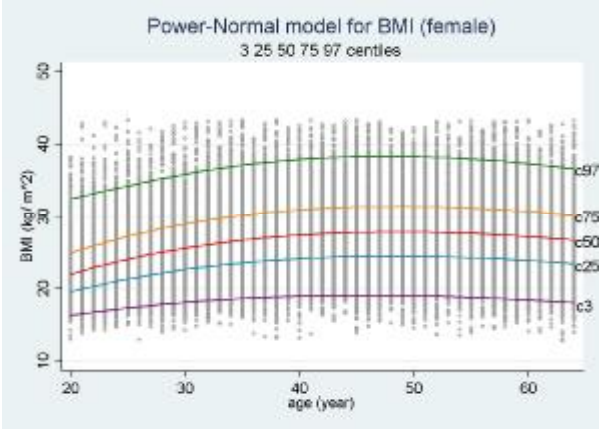

Fig. 4 : The mean percentiles of Body Mass Index in 10 years categories in Iranian 20 to 64 years old women according to National Non-Communicable Disease Risk Factor Surveillance in Iran in 2005

For instance, BMI ≥ 31.2 kg/m^2 was seen in 10% of the women between 25 and 29 years of age, whereas just 5% of the men in the similar age

group had BMI ≥ 31.2 kg/m^2 (Table 4 and Table 5). Furthermore, 25% or more of the women aged between 45 and 49 had BMI ≥ 31.41 kg/m^2 and were categorized in the obese group (Table 5). In contrast, 25% or more of the men aged between 45 and 49 had BMI approximately equal to 28.23 kg/m^2; they were categorized in the overweight group and not in the obese group (Table 4).

Table 4: The mean of percentiles for BMI in 5 years categories in Iranian 20 to 64 years old men according to National Non-Communicable Disease Risk Factor Surveillance in Iran in 2005

Age category (Years)	Percentiles for BMI[a]							
	C[b]3	C25	C50	C75	C85	C90	C95	C97
20-24	17.06	20.23	22.49	25.23	26.97	28.27	30.41	31.97
25-29	17.56	21.11	23.53	26.33	28.02	29.25	31.20	32.57
30-34	17.94	21.78	24.31	27.16	28.84	30.03	31.91	33.20
35-39	18.18	22.20	24.80	27.68	29.35	30.54	32.38	33.63
40-44	18.33	22.50	25.15	28.05	29.72	30.90	32.71	33.93
45-49	18.39	22.64	25.32	28.23	29.89	31.06	32.85	34.06
50-54	18.36	22.66	25.35	28.26	29.91	31.07	32.84	34.02
55-59	18.26	22.57	25.26	28.15	29.78	30.93	32.68	33.85
60-64	18.04	22.34	25.01	27.86	29.47	30.60	32.32	33.46

Dark colored columns: Obesity (BMI ≥ 30 kg/m^2) according to metabolic syndrome criteria by World Health Organization (1)
Light colored columns: Overweight (BMI ≥ 25 kg/m^2) according to metabolic syndrome criteria by World Health Organization (1)/ [a] BMI: Body Mass Index/ [b] C: Percentile

Table 5: The mean of percentiles for BMI in 5 years categories in Iranian 20 to 64 years old women according to National Non-Communicable Disease Risk Factor Surveillance in Iran in 2005

Age category (Years)	Percentiles for BMI[a]							
	C[b]3	C25	C50	C75	C85	C90	C95	C97
20-24	16.74	20.30	22.83	25.88	27.78	29.20	31.52	33.19
25-29	17.66	21.86	24.68	27.92	29.84	31.23	33.42	34.93
30-34	18.35	23.05	26.10	29.48	31.45	32.84	34.99	36.46
35-39	18.77	23.81	27.00	30.48	32.47	33.87	36.02	37.46
40-44	19.01	24.30	27.59	31.14	33.14	34.54	36.69	38.12
45-49	19.06	24.49	27.84	31.41	33.41	34.81	36.94	38.35
50-54	18.94	24.44	27.80	31.37	33.36	34.74	36.84	38.23
55-59	18.69	24.19	27.53	31.05	33.02	34.38	36.44	37.80
60-64	18.24	23.68	26.96	30.41	32.33	33.65	35.66	36.98

Dark colored columns: Obesity (BMI ≥ 30 kg/m^2) according to metabolic syndrome criteria by World Health Organization (1)
Light colored columns: Overweight (BMI ≥ 25 kg/m^2) according to metabolic syndrome criteria by World Health Organization (1)/ [a] BMI: Body Mass Index/ [b] C: Percentile

According to the odds ratios, which are shown in Table 6, the association of the increases in BMI, weight, and waist circumference with complications such as diabetes, hypertension, and hypercholesterolemia was stronger in the men. Nevertheless, overall, the increases in BMI, weight, and waist circumference in both genders had stronger associations with diabetes and hypertension rather than with hypercholesterolemia.

Table 6: Odds Ratios for diabetes, hypertension, and hypercholesterolemia in Iranian men and women more than 25 years old according to National Non-Communicable Disease Risk Factor Surveillance in Iran in 2005

≥ 25 years old		Waist Circumference (cm)		Weight (kg)		BMI[a] (kg/m²)	
		Male	Female	Male	Female	Male	Female
Hypertension	C[b] 75	2.08	1.78	1.91	1.76	2.11	1.80
	C 85	3.67	1.79	2.04	1.84	2.17	1.79
	C 90	2.15	1.83	2.15	1.82	2.22	1.85
	C 95	2.39	1.96	2.30	1.87	2.38	2.05
	C 97	2.73	1.83	2.53	1.85	2.49	2.11
Diabetes	C 75	2.03	1.82	1.81	1.71	2.03	1.63
	C 85	2.13	1.78	1.91	1.74	1.90	1.69
	C 90	2.03	1.91	1.86	1.68	1.88	1.71
	C 95	2.22	2.01	1.86	1.65	2.01	1.55
	C 97	2.61	2.06	2.00	1.74	2.18	1.68
Total Cholesterol	C 75	1.84	1.52	1.61	1.48	1.83	1.52
	C 85	1.80	1.55	1.65	1.44	1.86	1.49
	C 90	1.82	1.47	1.65	1.40	1.82	1.47
	C 95	1.95	1.49	1.69	1.40	1.90	1.43
	C 97	1.96	1.41	1.73	1.44	1.86	1.49

[a] BMI: Body Mass Index / [b] C: Percentile

In both genders and in each percentile, the association between waist circumference and diabetes was stronger than that between BMI and diabetes. The odds ratios of the mean of waist circumference in the 97th percentile in the men and women were 2.61 and 2.06, but the odds ratio of BMI in the 97th percentile was lower: 2.18 in the men and 1.68 in the women. In the women and in all the percentiles, BMI rather than waist circumference was related to hypertension. The odds ratios of diabetes significantly increased in both genders by the increase in waist circumference from the 97th percentile.

Discussion

The mean of waist circumference in all the age brackets except in the 20 to 24-year-old age group was higher in the women. We used the WHO's criteria for the definition of the normal range of waist circumference (1) but Because diabetes is diagnosed in Asians in lower BMI, WHO (18) also has defined the normal range of BMI as 18.5 to 22 kg/m^2 in Asian populations.; nonetheless, the IDF has recommended that although there are no new data on the normal range of waist circumference in the Middle-Eastern regions, the cut-off points of Europeans, i.e., 94 cm in men and 80 cm in women, be applied for the definition of the normal range of waist circumference (12). The cut-off points of waist circumference according to a study in Tehran-Iran in 2008 were 91.5 and 85.5 cm in men and women respectively (19). According to the results of a population-based longitudinal study in Iran, the cut-off point of WC for predicting the incidence of CVD was the same in men and women, 94.5 cm (20).

Additionally recent study aiming to determine the optimal cut-off value of waist circumference (WC) for predicting Insulin Resistance suggested that the optimal cut-off value for waist circumference reflecting insulin resistance is considered to be 88.5 cm for reproductive aged women of different geographic regions of Iran (21).

Furthermore, in a NCD survey in Iran in 2007 done on 3,027 participants from 30 provinces of Iran, the prevalence of metabolic syndrome in urban women aged between 55 and 64 was higher than that in men and the population who lived in rural areas and the other age groups. The best cut-

off points for defining metabolic syndrome in men and women were 89 and 91 cm, respectively (22). In the Golestan cohort in Iran, the mean of waist circumference was 98 cm in women, which was higher than that in men (96 cm) (7).

Moreover, the finding of population-based cross-sectional study in Tehran, the capital of Iran suggested that WC cut-offs for defining at least two major CVD risk factors, was between 84 – 95 cm in women and 86 – 92 cm in men. The results also showed these cut-points are higher for Iranians comparing with other Asian populations (23).

According to the study evaluating Gender-Specific Differences in the Association of Adiponectin, gene Polymorphisms with BMI in Rafsanjan, mean WC was significantly lower in females whereas, mean BMI was significantly higher in females and diabetics (24).

In Oman and Iraq, waist circumference was reported to be 80 and 97 cm in men and 84.5 and 99 cm in women, respectively (25, 26). In Korea, the cut-off points of waist circumference in the 80^{th} percentile in men and women were 90 and 86.5 cm, respectively. For detecting central obesity, however, these cut-off points were 85 cm in men and 80 cm in women (27).

In our study, waist circumference was higher in the women than that in the men; this finding, albeit in line with those reported by the Oman and Iraq studies (25, 26), Cohort of Golestan (7), Iran's NCD Survey in 2007 (22), and cross-sectional study in Tehran (23) does not chime in with the findings of the Tehran study (19), Rafsanjan study (24) and Korea study (27).

In Tehran study (19), the lower waist circumference in women could be attributed to higher rates of occupation amongst Tehran women in comparison with other Iranian women elsewhere. High waist circumference in our females also stands in contrast with the widely held notion that obesity in women is distributed in the femur and buttocks (28). In Rafsanjan study (24) in which WC was lower in women, it pointed to the relatively small city of the country, which is not the reprehensive of the country.

In Ford et al. (29) study and according to the Third National Health and Nutrition Examination Survey (*NHANES*) databases, waist circumference in American men was higher than that in women and it increased by age 70. This study together with another study in the UK demonstrated that waist circumference was higher in men in comparison with women (29, 30); our findings of course are not along the same lines. The increase in the waist circumference of the Iranian women older than 25 years of age in our study could be in consequence of their less active role in society by comparison with men. Other likely culprits for obesity are urbanization and its concomitant lifestyle changes such as lower physical activity (1, 8, 31, 32).

Mostly in the Iranian culture, women who work outside their homes are far outnumbered by men. In one survey in Iran 70 to 80% of the Iranian population had no physical activity and it was suggested as one of the most important general health problems (33). As was mentioned before, the weight mean in all age groups in our study was higher in the men and it may be due to their more muscle mass. The mean of height in both genders decreased with age and it could be a result of cohort effect or vertebra fractures (34).

The mean of BMI in both genders had an ascending trend and was higher in the women in all the age categories. The descending trend, which was observed in those aged between 55 and 64, could be due to the cohort effect and higher mortality rates in the obese population. BMI had a rising trend in both genders from 1982 to 1997 according to a study in Finland (35). In our study, BMI in both genders had ascending trends as well. In Tunis study, the cut-off point of BMI for detecting the risk factors of cardiovascular diseases was 24 kg/m^2 in men and 27 kg/m^2 in women (36). In Oman, the normal ranges of BMI in men and women were 23.2 and 26.8 kg/m^2, respectively (25). In these studies (25, 36) as well as the Cohort of Golestan in Iran (7), Rafsanjan study (24) and our study, BMI was higher in women than in men. That could be explained by the fact that in Iran the women were shorter than the men were.

In our study, in both genders and each percentile, the association between waist circumference and diabetes was stronger than that between BMI and diabetes; this is in line with articles underscoring the relation between waist circumference, rather

than BMI, and the risk factors of cardiovascular and metabolic diseases (37, 38).

There is a relationship between obesity and cardiovascular disease (CVD); obesity in conjunction with an increase in the prevalence of hypertension gives rise to an increase in the incidence of CVD (39). Since overweight is one of the independent risk factors of CVD and diabetes type II, the American Heart Association has added obesity to the major risk factors of CVD (31). Razak et al. (6) demonstrated that South Asians, Chinese, and Aboriginals of Canada had a similar distribution of glucose and lipids at lower BMI compared with Europeans; the cut-off point for defining obesity in terms of the risk factors of lipid level and glucose in non-Europeans was approximately 6 kg/m^2 lower than that of Europeans. A study in Asia using BMI>30 kg/m^2 according to the WHO's definition for obesity just had 6.7% sensitivity in men and 13.4% in women; changing the cut-off point to 27 in men and 25 kg/m^2 in women increased the sensitivity to 46.7% in men and 60.8% in women (40).

By applying these charts, which are shown in this article, it is possible to estimate the trends of obesity in society.

One of the limitations of this study is the non-measurement of triglyceride and HDL (High-Density Lipoprotein) as metabolic syndrome criteria, which precluded an assessment of their relation with weight and BMI percentiles. The findings of the present study require follow-up studies to delve further into the association of different levels of waist circumference and BMI with metabolic disorders and CVDs.

This study demonstrated that the ranges of waist circumference and body mass index in the Iranian population differ from those of other nations. Because of the fact that these parameters are normally utilized for the prediction and assessment of the risk of metabolic diseases in communities, an in-depth understanding of local thresholds seems essential. Furthermore, given the higher BMI and waist circumference in the women in our study and the direct link between obesity and such diseases as CVD, diabetes, dyslipidemia (2, 3) it is prudent that the causes of this phenomenon and their effect on women's health be fully investigated and due emphasis be placed upon the significance of losing weight and lifestyle modification, not least in women.

Ethical considerations

A national committee was established to review the tools and guidelines to prevent the occurrence of any technical or ethical errors. The study was approved after inspection by the Ethics Committee of the Iranian Center for Disease Management and Control, and informed oral and written consent was obtained from all the participants.

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

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