Central obesity in elderly individuals in south-western Saudi Arabia: prevalence and associated morbidity

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حدوث السِّمنة المركزية بين المسنِّين في جنوب غرب المملكة العربية السعودية: معدل انتشارها والأمراض المرتبطة بها

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الخلاصـة: تم تحديد حدوث السِّمنة المركزية في صفوف جميع الأشخاص الذي بلغوا الخامسة والستين أو تجاوزوها (العـدد = 810) في دوائـر نشـاط ثلاثـة من مراكز الرعاية الصحية الأولية في أبها، على أساس محيط الخصر والنسبة بـين محيط الخصـر ومحيط الورك. وكان معدل انتشار السـمنة المركزية المصحَّح وفقاً للسن هو 32.4%، على أساس مؤشـر محيط الخصـر و 43.5% عـلى أساس مؤشر النسبة بين محيط الخصر ومحيط الورك. وقد ارتبط محيط الخصر، بصـورة ملموسـة، بخطـر الإصـابة بالسـكري وارتفـاع ضـغط الـدم، بينما ارتبطت النسبة بين محيط الخصر ومحيط الورك، بصورة ملموسة، بخطر الإصابة بالسكري وحده. وتشير هذه النتائج إلى أن الحد من انتشار السمنة المركزية في الشـيخوخة مـن شـأنه التقلـيل من خطر الإصابة بالسكري وارتفاع ضغط الدم. ويمثل محيط الخصر وحده نذيراً قوياً ينذر بخطر التعرض للإصابة بارتفاع ضغط الدم بصفة أساسية، بينما تمثل النسبة بين محيط الخصر ومحيط الورك نذيراً يعوّل عليه بخطر الإصابة بالسكري.

ABSTRACT Central obesity in all individuals aged 65 years and over ($n = 810$) in the catchment areas of three primary health care centres in Abha was determined from the waist circumference (WC) and waist-to-hip ratio (WHR). The age-adjusted prevalence of central obesity was 32.4% and 43.5% based on the WC and WHR indicators respectively. WC was significantly associated with the risk of diabetes and hypertension, while WHR was significantly associated with the risk of diabetes only. These findings suggest that reducing the prevalence of central obesity in old age would decrease the risk of diabetes and hypertension. WC is a powerful independent predictor mainly of hypertension risk, while WHC is a good predictor of the risk of diabetes.

L'adiposité centrale chez les personnes âgées dans le sud-ouest de l'Arabie saoudite : prévalence et morbidité associée

RESUME L'adiposité centrale chez toutes les personnes âgées de 65 ans et plus (n = 810) dans les zones de desserte de trois centres de soins de santé primaires à Abha a été déterminée par le tour de taille (TT) et le rapport tour de taille/tour de hanches (RTH). La prévalence de l'adiposité centrale ajustée sur l'âge s'élevait à 32,4 % et 43,5 % sur la base des indicateurs TT et RTH respectivement. Il y avait une association significative du TT avec le risque de diabète et d'hypertension, tandis que le RTH était significativement associé au risque de diabète uniquement. Ces conclusions laissent penser que la réduction de la prévalence de l'adiposité centrale chez les personnes âgées permettrait de diminuer le risque de diabète et d'hypertension. Le TT est un facteur prédictif indépendant principalement pour le risque d'hypertension tandis que le RTH est un bon facteur prédictif du risque de diabète.

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Introduction

Obesity can be divided into general and "regional". There are two main types of regional obesity in terms of fat distribution and the risk of the development of disease. The gynoid type of fat distribution is common in women, where a pear shape indicates heavier deposits of fat around the thighs and buttocks. This fat functions mainly as an energy reserve to support pregnancy and lactation. Individuals with this type of distribution typically do not develop impaired glucose metabolism. In contrast, the android type of fat distribution (apple shape) is more typical of men and features fat deposits around the waist and upper abdomen. This pattern is associated with a significant risk of hypertension [*1–3*], cardiovascular disease [*4–6*] and type 2 diabetes mellitus [*1,6–12*].

Body composition alters with age. As lean body mass declines, there is an accompanying increase in fat mass [*13*]. Furthermore, the distribution of fat becomes more central [*14*]. Several studies of generalized obesity [*15–19*] and its association with some chronic diseases [*20*] have already been conducted in Saudi Arabia. However, none of these studies considered central obesity. The aim of our study was to estimate the prevalence of central obesity and the risk of diabetes and hypertension among elderly people in Abha, south-western Saudi Arabia.

Methods

Study population

Abha, the capital city of Asir province (population 1 200 000) in south-western Saudi Arabia, lies about 2250 m above sea level and approximately 200 km from the northern border of the Republic of Yemen. Because of the abundance of water and the fertile soil, agriculture is the main occupation in the region of Abha. Industrial activity in the region includes the production of construction materials, timber processing, maintenance workshops and other secondary industries.

As an urban population, people enjoy many modern facilities but retain the dietary and social habits of rural communities. Meat, chicken and rice constitute the major dietary items. Health services are provided by primary health care centres (PHCCs).

This study identified the population of people aged 65 years and above in the catchment areas of three PHCCs as the target group. The three PHCCs were selected from the six centres in the city of Abha on the basis of an existing collaboration between the College of Medicine and Health Sciences, King Khalid University and these centres. A total of 919 people aged 65 years and above were registered at these centres. Of these, 810 responded to an invitation to participate in the study, giving a response rate of 88%.

By means of a home-based survey, the waist and hip circumferences were measured with the individuals standing upright and undressed from the waist up. The waist was measured just above the level of the lateral iliac crest, below the lowest rib, and the hip circumference under the inferior rim of the symphysis, in the midline. All measurements were performed twice using a tape measure and recorded to the nearest centimetre. The waist-to-hip ratio (WHR) was calculated. Abdominal obesity was diagnosed when the waist circumference (WC) was ≥ 95 cm for women, ≥100 cm for men, and/or WHR was > 0.85 in women and > 0.95 in men [*14,21*]. The presence of diabetes mellitus and/or hypertension was recorded for each participant, based upon previous diagnosis and/or current medications.

Pre-final year medical students at the College of Medicine and Medical Sciences were trained to conduct the interview and to perform the anthropometric measurements. Accuracy of measurements was assured by faculty members of the Department of Family and Community Medicine at the College giving practical training sessions to the students. Students and field supervisors met daily following field activities to solve logistic problems, and to ensure standardization of measurements.

Data analysis

Data were analysed using *SPSS* and *Epi-Info*. The 10th, 25th, 50th, 75th and 90th percentiles of WC and WHR were calculated exactly using the frequencies procedure. A computer program placed each value of WC and WHR in one of the following centile bands: < 10th, 10th–24th, 25th–49th, 50th–74th, 75th–89th and > 90th.

Pearson chi-squared test was used to compare categorical data. The chi-squared test for linear trend (LT) was used to establish whether the increasing percentiles of WC and WHR were associated with increased diabetes and/or hypertension risk. Odds ratios (OR) were calculated with a 95% confidence interval (CI) for the likelihood of an elderly person being diabetic and/or hypertensive according to the different percentiles. The 10th percentile groups for WC and WHR were used as the reference categories for each risk variable.

To estimate the independent association of each indicator of central obesity with diabetes and/or hypertension risk, logistic regression analysis was applied. Confounding factors included: sex, smoking, WHR (in the analysis of WC) and WC (in the analysis of WHR), diabetes (in the analysis of hypertension) and hypertension (in the analysis of diabetes). Age was not included in the models, as in the $r \times 2$ tables it was not associated with diabetes or hypertension. $P = 0.05$ was used as the level of statistical significance.

Results

Prevalence of central obesity

The overall age-adjusted prevalence of central obesity among elderly people in Abha was 32.4% when identified by WC and 43.5% when identified by WHR. Males showed a significantly higher prevalence of central obesity than females based on both WC (34.1% versus 29.2%) ($\chi^2 = 5.81$, $P = 0.02$) and WHR (48.2% versus 34.9%) ($\chi^2 = 37.45$, $P = 0.01$). As age increased, the prevalence of central obesity became significantly lower as shown by the chi-squared test for linear trend (Table 1).

Prevalence of diabetes and hypertension

Previously diagnosed diabetes mellitus was found in 31.1% of the elderly people in Abha (age-adjusted), and it was significantly more prevalent among males (33.1% versus 27.1% for females) ($\chi^2 = 8.55$, $P = 0.005$) (Table 2). On the other hand, hypertension had previously been diagnosed in 21.3% of the elderly people (age-adjusted), with a significantly higher prevalence among females (28.0% versus 17.5%) ($\chi^2 = 32.83$, $P < 0.001$). Age did not have a significant impact on the prevalence of either diabetes ($P = 0.07$) or hypertension ($P = 0.08$).

Central obesity: associated morbidities

There was an appreciable increase in the risk of diabetes with increasing WC per-

Table 1 **Prevalence of central obesity among elderly people in Abha city according to different obesity indicators, by age and sex**

Age group (years)	Males			Females			Males and females		
	Total	Cases		Total	Cases		Total	Cases	
	no.	No.	%	no.	No.	%	no.	No.	%
				Waist circumference					
65–74	365	163	44.7	161	58	36.0	526	221	42.0
75–84	121	45	37.2	59	17	28.8	180	62	34.4
85+	63	13	20.6	38	8	21.1	101	21	20.8
Total	549	221	40.3	258	83	32.2	807	304	37.7
Age-adjusted prevalence			34.1			29.2			32.4
$P = 0.02^a$, $P < 0.001^b$									
				Waist-to-hip ratio					
65–74	365	190	52.1	161	71	44.1	526	261	49.6
75–84	121	64	52.9	59	25	42.4	180	89	49.4
85+	63	25	39.7	38	7	18.4	101	32	31.7
Total	549	279	50.8	258	103	39.9	807	382	47.3
Age-adjusted prevalence			48.2			34.9			43.5
$P < 0.001^a$, $P = 0.006^b$									

[a]Difference in rates between men and women.
[b]Difference in rates by age; chi-squared test for linear trend was applied.
Figures shown for participants whose data were available.

centile ($\chi^2_{LT} = 12.705$, $P = 0.0004$), and with increasing WHR percentile ($\chi^2_{LT} = 11.98$, $P = 0.0005$). OR for the 90th percentile versus the 10th percentile of WC was 4.5 (95% CI: 1.9–10.8), and the OR for the 90th percentile of WHR versus the 10th percentile was 2.8 (95% CI: 1.2–6.6) (Tables 3 and 4). On the other hand, there was an increased risk of hypertension with increasing WC ($\chi^2_{LT} = 8.11$, $P = 0.004$), but not with increasing WHR ($\chi^2_{LT} = 0.35$, $P = 0.55$). OR for the 90th percentile of WC versus the 10th percentile was 2.4 (95% CI: 1.0–5.9).

After adjustment for sex and other potentially confounding factors by logistic regression models, WC was significantly associated with the risk of diabetes ($P = 0.014$) and hypertension ($P = 0.0009$), while WHR was significantly associated with the risk of diabetes only ($P = 0.003$) (Table 5).

Discussion

A community-based rather than sample cluster study design was chosen for this survey in order to avoid random error. Selection bias is a possible source of error in this study. However, the relatively high response to the survey (88%) and efforts to

Table 2 **Prevalence of diabetes and hypertension among elderly people in Abha city by age and sex**

Age group (years)	Males Total no.	Males Cases No.	Males Cases %	Females Total no.	Females Cases No.	Females Cases %	Males + females Total no.	Males + females Cases No.	Males + females Cases %
				Diabetes					
65–74	321	126	39.3	155	44	28.4	476	170	35.7
75–84	113	36	31.9	58	15	25.9	171	51	29.8
85+	60	17	28.3	37	10	27.0	97	27	27.8
Total	494	179	36.2	250	69	27.6	744	248	33.3
Age-adjusted prevalence			33.1			27.1			31.1
$P < 0.005^a$, $P = 0.07^b$									
				Hypertension					
65–74	322	58	18.0	155	43	27.7	477	101	21.2
75–84	113	17	15.0	58	14	24.1	171	31	18.1
85+	61	12	19.7	37	12	32.4	98	24	24.5
Total	496	87	17.5	250	69	27.6	746	156	20.9
Age-adjusted prevalence			17.5			27.6			21.3
$P < 0.001^a$, $P = 0.08^b$									

[a]Difference in rates between men and women.
[b]Difference in rates by age, chi-squared test for linear trend was applied.
Figures shown for participants whose data were available.

ensure standardized measurements both help to minimize this type of error.

Since abnormal glucose and lipid metabolism are more strongly associated with central obesity, it may not be adequate to use a general measurement, such as the weight-for-height index, to evaluate obesity [22]. In our study, both WC and WHR were used as more appropriate indicators of central obesity [22]. According to these two indicators, the overall prevalence of central obesity among elderly people in Abha before age-adjustment was 37.7% and 47.3% respectively. These figures are relatively high if the association of central obesity with morbidity and mortality is considered.

Although WC and WHR are both indicators of central obesity, each could be interpreted differently [23]. A WC higher than expected may indicate excess abdominal subcutaneous fat or visceral fat accumulation, whereas a hip circumference lower than expected may reflect reduced femoral fat, small pelvic bone structure or gluteofemoral muscle atrophy [23]. This fact may explain the finding of different prevalence figures for central obesity from the measures used in the present study.

Several studies of general obesity in Saudi Arabia have indicated a significantly higher prevalence of obesity among females than among males [16,18,20]. Our study shows the reverse, with males signif-

Table 3 **Frequency and odds ratio of diabetes and hypertension according to different centiles of waist circumference among elderly people in Abha city**

Waist circumference centile	Total no.	Diabetes No.	Diabetes %	Diabetes OR (95% CI)	Hypertension No.	Hypertension %	Hypertension OR (95% CI)
< 10th[®]	59	9	15.3	1	9	15.3	1
< 25th	88	25	28.4	2.1 (0.9–5.0)	14	15.9	1.0 (0.4–2.5)
< 50th	140	45	32.1	2.5 (1.1–5.6)	18	12.9	0.8 (0.3–1.9)
< 75th	145	58	40.0	3.6 (1.6–7:8)	32	22.1	1.5 (0.7–3.4)
< 90th	91	32	35.2	2.9 (1.3–6.7)	21	23.1	1.6 (0.7–3.8)
> 90th	61	28	45.9	4.5 (1.9–10.8)	19	31.1	2.4 (1.0–5.9)
Total	584	197	33.7		113	19.3	
P-value[a]			$P = 0.0004$			$P = 0.004$	

[®]*Reference category.*
[a]*Chi-squared test for linear trend was applied.*
Figures shown for participants whose data were available.
OR = odds ratio.
CI = confidence interval.

Table 4 **Frequency and odds ratio of diabetes and hypertension according to different centiles of waist-to-hip ratio among elderly people in Abha city**

Waist-to-hip ratio centile	Total no.	Diabetes No.	Diabetes %	Diabetes OR (95% CI)	Hypertension No.	Hypertension %	Hypertension OR (95% CI)
< 10th[®]	47	13	27.7	1	11	23.4	1
< 25th	74	22	29.7	1.1 (0.5–2.5)	8	10.8	0.4 (0.2–1.1)
< 50th	118	38	32.2	1.2 (0.6–2.6)	26	22.0	0.9 (0.4–2.1)
< 75th	120	40	33.3	1.3 (0.6–3.8)	25	20.8	0.9 (0.4–1.9)
< 90th	72	36	50.0	2.6 (1.2–5.8)	14	19.4	0.8 (0.3–1.9)
> 90th	50	26	52.0	2.8 (1.2–6.6)	11	22.0	0.9 (0.4–2.4)
Total	481	175	36.4		95	19.8	
P-value[a]			$P = 0.0005$			$P = 0.55$	

[®]*Reference category.*
[a]*Chi-squared test for linear trend was applied.*
Figures shown for participants whose data are available.
OR = odds ratio.
CI = confidence interval.

Table 5 **Logistic regression models of diabetes and hypertension according to waist circumference (WC) and waist-to-hip ratio (WHR) among elderly people in Abha city**

Obesity measure	Morbidity	β (SE)	*P*	Expβ	95% CI
WC	Diabetes mellitus[a]	0.02 (0.006)	0.014*	1.02	1.003–1.03
	Hypertension[b]	0.02 (0.007)	0.0009*	1.02	1.01–1.04
WHR	Diabetes mellitus[c]	2.85 (0.96)	0.003*	17.23	2.62–13.48
	Hypertension[d]	0.97 (1.05)	0.36	2.64	0.34–20.63

[a]*Adjusted for sex, hypertension and smoking.*
[b]*Adjusted for sex, diabetes, smoking and WHR.*
[c]*Adjusted for sex, hypertension, smoking and WC.*
[d]*Adjusted for sex, diabetes, smoking and WC.*
**Statistically significant.*

icantly more centrally obese than females. This finding is in agreement with that of Gaudet et al. [*24*], and may be attributed to the increase in central body fat that occurs in males but not in females in the passage from adolescence into adulthood [*25,26*].

A survey to determine the prevalence of diabetes and hypertension among older people in Abha, based on a positive history, history of medication and review of medical records, revealed an overall prevalence of 33.3% (age-adjusted = 31.1%) for diabetes and of 20.9% (age-adjusted = 21.3%) for hypertension. The diagnosis of previously identified cases with a positive history in this study is supported by a number of considerations. First, it has been shown that there is good agreement between self-reporting of chronic diseases such as hypertension and diabetes and actual diagnosis [*27*], especially among older people whose chronic diseases were nearly all detected during their middle-age. Second, it would be very unlikely for a subject to report a positive history of a chronic disease without having been informed of the diagnosis by a health care provider. Third, in most cases the diagnosis could be confirmed from medical records in the PHCC where the patient received health care.

Central obesity has been identified as an important determinant of type 2 diabetes mellitus risk [*7–11*]. The correlations estimated in our study confirm that both WC and WHR are significantly associated with diabetes risk, with the OR for diabetes increasing monotonically with increasing WC and WHR. Even levels of WC percentiles not considered to indicate obesity were associated with significantly elevated diabetes risk. However, after adjustment for other confounding factors by logistic regression, WHR emerged as a more powerful predictor of diabetes risk ($P = 0.003$) than WC ($P = 0.014$). This finding is in agreement with Schmidt et al. [*28*] who reported that central obesity as measured by WHR was significantly and independently associated with diabetes.

An association between hypertension and central obesity has also been reported [*29*]. Central obesity is associated with a specific haemodynamic pattern characterized by high total peripheral resistance, low cardiac output, and a vasoconstriction response to psychosocial stress, leading to cardiovascular disease and hypertension [30]. However, the present study showed such an association for WC but not WHR. Even after adjusting for other confounders, this association remained consistent. This finding is in agreement with Reeder et al. [31], who identified WC as the measure of abdominal obesity most closely correlated with blood pressure and plasma lipid levels.

In conclusion, these findings suggest that there is a need to promote lifestyle changes and to reduce central obesity to prevent the occurrence of diabetes and hypertension among elderly members of the Saudi population. Central obesity is significantly and independently associated with diabetes and hypertension among elderly people. Obese elderly people with predominantly abdominal fat mass (android type) show a less favourable risk profile than those with a glutealfemoral fat distribution (gynoid type). WHR is most highly correlated with diabetes, while WC is a powerful predictor of hypertension. Both measurements are potentially useful tools for clinicians in counselling patients about their diabetes and hypertension risk and risk reduction.

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