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Relationship between certain obesity indices and risk of chronic medical conditions in a population sample of Zawia city

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ABSTRACT

The body mass index, waist circumference, and waist to hip ratio have a linear relation with increasing the diseases. The aim of the current study was to find the better anthropometric measure to relate with chronic health conditions and their associated socio-demographic correlates in a population sample of Zawia city. A total of 211 (92 men and 119 women) between the ages of 30 and 85 years participated in this study. Participants were permanent residents in Zawia city. Anthropometric measurements include weight (kg), height (cm), waist circumference (cm), and hip circumference (cm) measured at the time of the interview. Body mass index was calculated as weight divided by height squared (kg/m^2) while WHR was determined by dividing waist circumference by hip circumference. Participants provided information on their socio-demographic details and chronic health conditions. Blood samples (10 ml) were collected from each participant after an overnight fast and lipid profiles of all individuals were measured. The number of participants in all age groups were 35 (30-39), 53 (40-49), 76 (50-59) and 47 (60 and above) in the study sample. The overall prevalence of obesity and overweight was 50.71% and 43.12%, respectively, while normal weight was

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15.71%, and high WHR was 65.40% (n=138). Prevalence of chronic health conditions in study sample was 27.01% diabetes, 26.06% hypertension, and 8.05% heart problems. The results showed that age group had no significant relationship (P=0.679) with BMI levels, while a significant relationship (P=0.011) between the age group and WHR was found. Multiple logistic regressions showed that participants who were oldest (60+) were more likely to have high WHR as compared to participants who were in younger groups. In addition, the odds ratio with a high WHR is 2.46 times more likely to get diabetes than a low WHR.
Key words: Body mass index, waist-hip ratio, chronic medical conditions, Zawia city.

العلاقة بين بعض مؤشرات السمنة وخطر الإصابة بالأمراض المزمنة في عينة من سكان مدينة الزاوية

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الملخص

يرتبط مؤشر كتلة الجسم، ومحيط الخصر، ونسبة الخصر إلى الورك ارتباطًا خطيًا بزيادة الأمراض. هدفت الدراسة الحالية إلى إيجاد أفضل مقياس أنثروبومتري مرتبط بالأمراض المزمنة وعلاقته بالعوامل الاجتماعية والديموغرافية في عينة من سكان مدينة الزاوية. شملت الدراسة 211 مشارك (92 ذكر و119 انثى) تراوحت أعمارهم بين 30 و85 عامًا. وكان المشاركون من المقيمين الدائمين في مدينة الزاوية. شملت القياسات الأنثروبومترية الوزن (كجم)، والطول (سم)، ومحيط الخصر (سم)، ومحيط الورك (سم) والتي تم قياسها وقت المقابلة. تم حساب مؤشر كتلة الجسم بقسمة الوزن على مربع الطول (كجم/م^2)، بينما تم تحديد نسبة الخصر إلى الورك بقسمة محيط الخصر على محيط الورك. قدّم المشاركون معلومات عن البيانات الاجتماعية والديموغرافية وكذلك حالاتهم

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الصحية المزمنة. تم جمع عينات دم (10 مل) من كل مشارك بعد صيام ليلة كاملة، وقياس مستويات الدهون لديهم. بلغ عدد المشاركين في جميع الفئات العمرية 35 (30-39)، و53 (40-49)، و76 (50-59)، و47 (60 فأكثر) في عينة الدراسة. وبلغت نسبة انتشار السمنة وزيادة الوزن 50.71% و43.12% على التوالي، بينما بلغت نسبة الوزن الطبيعي 15.71%، في حين كانت نسبة الخصر إلى الورك المرتفعة 65.40% (ن = 138). وكانت نسبة انتشار الأمراض المزمنة في عينة الدراسة 27.01% مرض السكري، 26.06% مرض ارتفاع الضغط و8.05% امراض القلب. أظهرت النتائج عدم وجود علاقة دالة إحصائيًا (P=0.679) بين الفئة العمرية ومستويات مؤشر كتلة الجسم، بينما وُجدت علاقة دالة إحصائيًا (P=0.011) بين الفئة العمرية ونسبة الخصر إلى الورك. وأظهرت نسبة الارجحية أن المشاركين الأكبر سنًا (60 عامًا فأكثر) كانوا أكثر عرضة لارتفاع نسبة الخصر إلى الورك مقارنةً بالمشاركين الأصغر سنًا. كما أن نسبة احتمال الإصابة بمرض السكري لدى من لديهم نسبة عالية من الخصر إلى الورك أعلى بمقدار 2.46 مرة ممن لديهم نسبة منخفضة من الخصر إلى الورك.
الكلمات المفتاحية: مؤشر كتلة الجسم، نسبة الخصر إلى الورك، الحالات الطبية المزمنة، مدينة الزاوية.

Introduction

Obesity can result in various health problems like diabetes mellitus type 2, hypertension, chronic heart disease (CHD), deep vein thrombosis (DVT), and asthma (De Schutter et al., 2014). Overweight and obesity are among the major risk factors for cardiovascular disease (CVD) and are closely linked to morbidity and mortality worldwide (Lavie et al., 2016). Large prospective studies have shown that overweight and obesity are associated with increased cardiovascular disease (CVD) risk (Dorn et al., 1997; Hubert et al., 1983; Libby et al., 2019; Manson et al., 1990).

A number of clinical measurements have been used to determine the obesity (Cameron et al., 2003). These include anthropometric indices such as body mass index (BMI), waist-hip ratio (WHR), and waist circumference (WC) (Bray & Gray, 1988; Sanya et al., 2009). Body mass index (BMI) has been identified by the World Health Organization (WHO) as the most useful epidemiological measure of obesity. It is nevertheless a crude index that does not take into account the distribution of body fat, resulting in variability in different individuals and populations (Organization, 2000). In the

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assessment of obesity, the central distribution of body fat cannot be overlooked; hence, the use of other anthropometric indices such as WC and WHR as measures of adiposity (Welborn et al., 2003).

The World Health Organization operates with a four-level classification system, where BMI is categorized as underweight (BMI < 18.5 kg/m^2), normal (BMI 18.5 –24.99 kg/m^2), overweight (BMI 25-29.99 kg/m^2) and obese (BMI ≥ 30 kg/m^2 (Ohlson et al., 1985). Body mass index is a proven predictor for mortality and morbidity (James, 1996).

Waist Circumference (WC) has been recommended as a simple and practical measure for identifying overweight and obese patients. It is particularly useful for individuals and population groups with different body builds (Lapidus et al., 1984; Larsson et al., 1984; Welborn et al., 2003).

The waist-to-hip ratio (WHR) is the ratio of the smallest measurable circumference of the waist divided by the widest circumference of the hips (Pazhoohi et al., 2020). Ideally, to maintain a low risk level of encountering health problems associated with obesity, the WHR should be no greater than 0.95 for males and 0.80 for females, with moderate and high health risk cut-off points shown in body fat location also being an important health risk factor (Napier, 2011).

WHR is correlated with body fat and has been shown to be associated with the development of CVD, type 2 diabetes, and death in adults (Health, 2012). This measure can be used to indicate the prevalence of abdominal obesity, to evaluate health promotion and disease prevention, and to monitor progress towards national public health policy (Wyatt et al., 2006).

As fat in the abdominal region is associated with increased health risks, many foundations like NICE and NIH recommend these measures as a practical tool to measure risk factors for diseases like diabetes and hypertension (UK & (UK, 2006; N. A. A. for the S. of Obesity et al., 2000). Several studies have shown that there is a strong positive association between risk factors for diseases with measures of waist circumference or WHR instead of BMI alone (Ardern et al., 2003; Chan et al., 1994; Janssen et al., 2002; Rexrode et al., 1998). This study, therefore, aimed to investigate the relationship between some obesity indexes and chronic health conditions in a population sample of Zawia city.

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Materials and Methods

Study Design

This cross-sectional study was conducted in Zawia city between March and June of 2021. It was conducted on 211 people (92 male and 119 female) aged 30 to 85 years old, and they were Zawia citizens and permanent residents. Participants were randomly selected from visitors of Arraed Laboratory for Medical Analysis in Zawia city at the time of the survey. Young people under the age of 30 years, non-fasting people, athletes with massive muscle mass, pregnant women, individuals who are taking supplements to increase weight, and also individuals who have cancer and have been treated with chemotherapy were excluded. A written informed consent was taken from their legally acceptable representative before including the participant in the study.

Data Collection

During the initial data collection session, the participant's age, gender (men, women), marital status (never married, married, widowed, divorced), education (none, primary (basic), secondary, completed), and employment status (employed, unemployed, homemaker, retired) were recorded. Medical history (hypertension, heart problems, diabetes) was also collected at the time of the interview.

Measurements

Measurements were performed at Arraed Laboratory for Medical Analysis in Zawia city by examiners. Weight (kg), height (cm), waist circumference (cm), and hip circumference (cm) were measured at the time of the interview.

Body Mass Index (BMI)

The height and weight of each study sample were taken using a tape measure and a portable digital scale (with OMRON) that is calibrated before each use. Participants were weighed wearing light clothing and no shoes. Body mass index was calculated as weight divided by height squared (kg/m^2) using a medical calculator. A BMI of less than 18.5 was classified as underweight, a BMI of 18.5 to 25 as normal weight, a BMI of 25.01 to 30.0 as overweight, and a BMI >30.0 as obese.

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Waist Circumference (WC)

Waist circumference was measured on a horizontal plane using a flexible tape while the participants were wearing light clothing. WC was measured (as the narrowest part of the body between chest and hips) midway between the lower border of the ribs and the iliac crest (Wang & Hoy, 2004).

Hip Circumference (HC)

Participants' hip circumference was measured as the maximum circumference around the buttocks from behind at the level of the greater trochanter (hip bones). For the measurement of hip circumference, a tape measure was placed around the hips at the most protuberant area.

Waist to Hip Ratio (WHR)

WHR was determined by dividing waist circumference by hip circumference. (Organization, 2011) recommended WHR cut-off values of 0.90 and 0.80 for men and women, respectively, where a higher ratio indicates an increased risk of various health complications.

Blood sample

Blood samples (10 ml) were collected from each subject at 8:00 to 9:00 a.m. after an overnight fast using dry sterile syringes. After collection of serum by centrifugation, serum total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglyceride (TG) were recorded. Lipid profiles of all individuals were analyzed at Arraed Laboratory for Medical Analysis in Zawia city using standard laboratory protocol.

Data Analysis

Descriptive and inferential statistics were used to analyze data, including mean, standard deviation, multinomial logistic regression, and odds ratio. The level of significance (α) for the analyses was at (0.05); 95% confidence intervals. The statistical package for the social sciences (SPSS, v.25) was used for the analyses.

Results

The total number of participants in this study was 211, and the majority of the study sample was female (56.4%). Participants were permanent residents in Zawia city. The researcher randomly

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selected them at the time of the survey. The distribution of participants according to gender is shown in Fig 1.

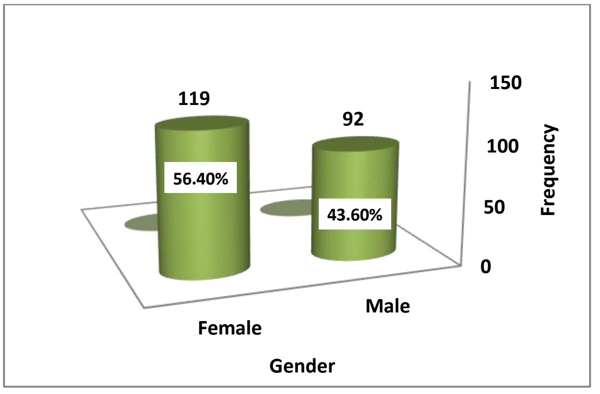

Fig. 1. : Distribution of participants according to the gender.

Numbers of participants in all age groups were 35 (30-39), 53 (40-49), 76 (50-59), and 47 (60 and above) in the study sample. The prevalence of those who were married, completed education, and were employees based on their socio-demographic details was 79.62%, 43.12%, and 65.87%, respectively. Table (1) shows the distribution of participants according to the age groups, marital status, education, and employment status.

Prevalence of chronic health conditions in the study sample was 27.01% diabetes, 26.06% hypertension, and 8.05% heart problems. The overall prevalence of obesity and overweight was 50.71% and 34.12%, respectively, while normal weight was 15.71%. The prevalence of high WHR in our sample was 65.40% (n=138). 55 (26.1%) of the participants had high hypertension, and 156 (73.9%) did not have high hypertension. Also, the results showed that 57 (27.0%) of the participants had diabetes, while 19 (9.0%) of the participants had heart problems. The distribution of the study population according to the age groups, chronic health conditions, and BMI is seen in Table 2.

The results showed that BMI levels had no significant relationship (P>1.108, 1.307, 0.651) with the occurrence of hypertension, heart problems, and diabetes. WHR level had no significant relationships (P>0.735, 0.193) with the occurrence of hypertension and heart problems, while WHR level had a significant relationship (P>0.012) with the occurrence of diabetes. In addition, the odds ratio with high WHR is 2.46 times more likely to get diabetes than low WHR (Table 3).

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The study indicated that BMI had significant relationships (P>0.012, 0.048, 0.006) with marital status, education and employment status (Table 4). Table 5 showed that WHR had significant relationships (P>0.001) with marital status, while it had no significant relationship (P>0.096, 0.358) with education and employment status.

Table 1. Distribution of participants according to the age groups and socio-demographic details.

Age groups	30-39		40-49		50-59		60+	
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)
Marital Status								
Married	24	68.60	46	86.8	59	77.60	39	83.00
Divorced	1	2.90	2	3.80	2	2.60	0.00	0.00
Widowed	0.00	0.00	0.00	0.00	5	6.60	7	14.90
Never Married	10	28.60	5	9.40	10	13.20	1	2.10
Total	35	100.0	53	100.0	76	100.0	47	100.00
Education								
None	0.00	0.00	1	1.90	4	5.30	19	40.00
Primary	2	5.70	15	28.30	17	22.40	11	23.40
Secondary	5	14.30	12	22.60	22	28.90	12	25.50
Completed	28	80.00	25	47.20	33	43.40	5	10.60
Total	35	100.0	53	100.0	76	100.0	47	100.0
Employment Status								
Home Maker	3	8.60	10	18.90	15	19.70	18	38.30
Employed	30	85.70	43	81.10	53	69.70	13	27.70
Unemployed	2	5.70	0.00	0.00	2	2.60	1	2.10
Retired	0.00	0.00	0.00	0.00	6	7.90	15	31.90
Total	35	100.0	53	100.0	76	100.0	47	100.0

Table 2. Distribution of participants according to the age groups, chronic health conditions, BMI, and WHR.

Chronic Health Conditions							
Age groups		Diabetes		Hypertension		Heart Problems	
		(N)	(%)	(N)	(%)	N	(%)
30-39	Yes	3	8.60	2	5.70	0.00	0.00
	No	32	91.40	33	94.30	35	100.0
	Total	35	100.0	35	100.0	35	100.0
40-49	Yes	5	9.40	13	24.50	2	3.80
	No	48	90.60	40	75.50	51	96.20
	Total	53	100.0	53	100.0	53	100.0
50-59	Yes	25	32.90	23	30.30	7	9.20
	No	51	67.10	53	69.70	69	90.80

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	Total	76	100.0	76	100.0	76	100.0
60+	Yes	24	51.10	17	36.20	10	21.30
	No	23	48.90	30	63.80	37	78.70
	Total	47	100.0	47	100.0	47	100.0
Body Mass Index, Waist-Hip Ratio							
Age Group	(N)	BMI			WHR		
		Normal	Over Weight	Obese	Low WHR	High WHR	
30-39	35	7	14	14	20	15	
40-49	53	6	17	30	19	34	
50-59	76	11	23	42	23	53	
60+	47	8	18	21	11	36	
Total	(N)	32	72	107	73	138	
	(%)	15.17	34.12	50.71	34.60	65.40	

Table 3. Significance (P values) of WHR level effects on occurrence of hypertension, heart problems, and Diabetes.

WHR Level	Hypertension						df	Chi square value	P value	
	Yes		No		Total					
	(N)	(%)	(N)	(%)	(N)	(%)				
Low	18	8.5	55	26.1	73	34.6	1	0.115	0.735	
High	37	17.5	101	47.9	138	65.4				
Total	55	26.1	156	73.9	211	100.0				
WHR Level	Heart problems						df	Chi square value	P value	
	Yes		No		Total					
	(N)	(%)	(N)	(%)	(N)	(%)				
Low	4	1.9	69	32.7	73	34.6	1	1.693	0.193	
High	15	7.1	123	58.3	138	65.4				
Total	19	9.0	192	91.0	211	100.0				
WHR Level	Diabetes						df	Chi square value	P value	Odds Ratio
	Yes		No		Total					
	(N)	(%)	(N)	(%)	(N)	(%)				
Low	12	5.7	61	28.9	73	34.6	1	6.332	0.012	2.46
High	45	21.3	93	44.1	138	65.4				
Total	57	27.0	154	73.0	211	100.0				

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Table 4. Relationship between BMI level and marital status, education, and employment status.

BMI Level	Marital Status									df	Chi square value	P value
	Married		Divorced	Widow		Single		Total		6	14.585	0.012
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)		(N)	(%)	
18.5-25	21	10.0	1	0.5	0	0.0	10	4.7		32	15.2	
25-30	62	29.4	0	0.0	4	1.9	6	2.8		72	34.1	
>30	85	40.3	4	1.9	8	3.8	10	4.7		107	50.7	
Total	168	79.6	5	2.4	12	5.7	26	12.3		211	100.0	
BMI Level	Education									df	Chi square value	P value
	None		Primary	Secondary		Completed		Total		6	12.700	0.048
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)		(N)	(%)	
18.5-25	2	0.9	1	0.5	10	4.7	19	9.0		32	15.2	
25-30	8	3.8	14	6.6	20	9.5	30	14.2		72	34.1	
>30	14	6.6	30	14.2	21	10.0	42	19.9		107	50.7	
Total	24	11.4	45	21.3	51	24.2	91	43.1		211	100.0	
BMI Level	Employment Status									df	Fisher Exact Test	P value
	Home maker		Employed	Unemployed		Retired		Total		6	16.655	0060.
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)		(N)	(%)	
18.5-25	4	1.9	23	10.9	2	0.9	3	1.4		32	15.2	
25-30	8	3.8	52	24.6	1	0.5	1	5.2		72	34.1	
>30	34	16.1	64	30.3	2	0.9	7	3.3		107	50.7	
Total	46	21.8	139	65.9	5	2.4	21	10.0		211	100.0	

Table 5. Relationship between WHR level and marital status, education, and employment status

WHR Level	Marital Status										df	Fisher Exact Test	P value
	Married		Divorced		Widowed		Single		Total		3	21.636	0.001
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)			
Low	46	21.8	3	1.4	5	2.4	19	9.0	73	34.6			
High	122	57.8	2	0.9	7	3.3	7	3.3	138	65.4			
Total	168	79.6	5	2.4	12	5.7	26	12.3	211	100.0			
WHR Level	Education										df	Chi square value	P value
	None		Primary		Secondary		Completed		Total		3	6.353	0.096
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)			
Low	7	3.3	13	6.2	13	6.2	40	19.0	73	34.6			
High	17	8.1	32	15.2	32	18.0	51	24.2	138	65.4			
Total	24	11.4	45	21.3	45	24.2	91	43.1	211	100.0			
WHR Level	Employment Status										df	Chi square value	P value
	Home maker		Employed		Unemployed		Retired		Total		3	3.223	0.358
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)			
Low	19	9.0	48	22.7	2	0.9	4	1.9	73	34.6			
High	27	12.8	91	43.1	3	1.4	17	8.1	138	65.4			
Total	46	21.8	139	65.9	5	2.4	21	10.0	211	100.0			

There is no significant difference between the mean of triglyceride, LDL, HDL, and cholesterol with the BMI levels as seen in Table 6. Significant difference was found between the mean of triglycerides and HDL with the WHR levels, while there was no significant difference found between the mean of LDL and cholesterol with the BMI levels table (6). Triglyceride mean for low WHR (130.29) was significantly less than triglyceride mean for high WHR (153.78), where T-test = (-2.207) and P = 0.028 < 0.05. HDL mean for low

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WHR (48.00) was significantly higher than HDL mean for high WHR (44.27) since T-test = 3.73 and P = 0.037 < 0.05.

Table 6. The significant difference in Triglyceride, LDL, HDL and Cholesterol based on BMI and WHR level.

Variable	WHR Level	(N)	Mean	Std.	T-test value	P value
Triglyceride	18.5-25	32	72.898	12.887	1.772	0.173
	25-30	72	84.648	9.976		
	>30	107	66.154	6.395		
LDL	18.5-25	32	74.218	5.109	2.050	0.131
	25-30	72	62.125	10.982		
	>30	107	41.640	4.907		
HDL	18.5-25	32	35.182	3.401	0.412	0.663
	25-30	72	42.613	2.934		
	>30	107	11.463	2.026		
Cholesterol	18.5-25	32	14.941	1.761	1.440	0.239
	25-30	72	10.707	1.035		
	>30	107	12.383	.852		
Variable	WHR Level	(N)	Mean	Std.	T-test value	P value
Triglyceride	Low	73	130.29	67.694	-2.207	0.028
	High	138	153.78	76.438		
LDL	Low	73	138.70	52.285	0.633	0.527
	High	138	134.79	36.624		
HDL	Low	73	48.00	11.273	2.099	0.037
	High	138	44.27	12.783		
Cholesterol	Low	73	171.62	47.761	-0.067	0.740
	High	138	172.04	32.456		

Discussion

The results showed that age group had no significant relationship (P>0.679) with BMI levels (Flegal et al., 2012). A survey done in the US by Katherine et al, (2012), which examined obesity, showed that the prevalence of obesity was lower among those aged above 75 years as compared to other age groups, which was reflected in our results. Results of the current study were not consistent with studies conducted on populations in Spain, Italy, and Germany with BMI levels (Flegal et al., 2012; Maggi et al., 1994; Manson et al., 1990).

The lowest prevalence of overweight and obesity has seen in single individuals, who can give more attention to their diet and physical activity. This observation was in line with those in other studies (Ahmed & Haboubi, 2010; Margetts et al., 2003; Sharaye et al., 2014). A study conducted by Shvedko (2020) in Britain revealed

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that married couples fail to get time (recommended 150 minutes) for physical activity compared to individuals who are never married, which may explain the risen risks in the married group.
The results of this study showed that BMI levels had no significant relationship (P > 1.108, 1.307, 0.651) with the risk factor of chronic diseases (hypertension, heart diseases, and diabetes); these results are not compatible with the studies that have shown that individuals with obese or overweight BMI levels were at a higher risk of developing diabetes, hypertension, and heart diseases (Sharaye et al., 2014; Wang & Hoy, 2004; Zhang et al., 2011).
The prevalence of high WHR in our sample was 65.4% (n=138). Our result found association between age group and WHR (P=0.011). Multiple logistic regressions showed that participants who were oldest (60+) were more likely to have high WHR as compared to participants who were in younger groups.
The study showed an association of high WHR with married people; those who were married had a risk factor of higher WHR than those who were single (Ford et al., 2003). A previous study in the US in 2003 indicated that waist circumference increases with age, which becomes larger in older adults up to 70 years of age, which corresponds to the finding of the present study. Furthermore, the study of Cartwright et al. (2007) referred to an increased WHR in older age, and the reason for that was the redistribution of fat from the subcutaneous to the visceral depots.
This study demonstrated a significant relationship (P > 0.012) between high WHR and diabetes, which was consistent with (Grievink et al., 2004; Olinto et al., 2004; Schmidt et al., 1992), while WHR level had no significant relationships (P > 0.735, 0.193) with the occurrence of hypertension and heart problems. In addition, the odds ratio with high WHR is 2.46 times more likely to get diabetes than low WHR, highlighting the validity of WHR as a strong measure of risk for diabetes.
The results of the present study showed that there is a significant difference found between the mean of triglyceride and HDL with the WHR levels. In addition, the triglyceride mean for low WHR (130.29) was significantly less than the triglyceride mean for high WHR (153.78), where T-test = -2.207 and P = 0.028<0.05. HDL mean for low WHR (48.00) was significantly higher than HDL mean for high WHR (44.27) since T-test = 3.73 and P = 0.037<0.05. This observation corresponds to the findings in a previous study in

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Singapore by Deurenberg-Yap et al. (1999); it was shown that there was an increase in cholesterol levels amongst those with high WHR. Many studies in different cultures have reported different results when comparing the differences between, anthropometric measurements (BMI and WHR) (Beydoun & Wang, 2009; Deurenberg-Yap et al., 2001; Wan Mohamud et al., 2011). In the elderly population, very little assurance is placed on anthropometric measurements and its risk on health. Reduction in muscle mass and metabolic rate are an important determinant of physical function which leads to the clinical risks of obesity appearing at a lower BMI in the elderly peoples (Han et al., 2011). A study (Hannan et al., 2000) referred to the decrease in BMI occurs at the expense of losing muscle mass and an increase in WHR and this changes occur due to losing in total adiposity and in body weight.

Conclusions:

The study demonstrated the association between anthropometric measurements (BMI and WHR) and certain chronic medical conditions. The waist-hip ratio (WHR) has a stronger correlation with diabetes than the body mass index (BMI). The study stressed the importance of anthropometric measurements in the clinical management of the elderly population in Zawia city.

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