Sultan Qaboos University Med J, November 2014, Vol. 14, Iss. 4, pp. e460–467, Epub. 14TH Oct 14
Submitted 8TH Jan 14
Revision Req. 17TH Feb 14 Revision Recd. 20TH Mar 14
Accepted 17TH Apr 14

CLINICAL & BASIC RESEARCH

Metabolic Syndrome and Its Components

Secondary analysis of the World Health Survey, Oman

Mahmoud Abd El-Aty,[1] *Ruth Mabry,[2] Magdi Morsi,[1] Jawad Al-Lawati,[3] Asya Al-Riyami,[1] Medhat El-Sayed[4]

المتلازمة الأيضية ومكوناتها

تحليل ثانوي للمسح الصحي العالمي في عمان

محمود عطيه عبد العاطي، روث مابري، مجدي مرسي، جواد اللواتي، آسيا الريامية، مدحت السيد

ABSTRACT: ***Objectives:*** The study aimed to describe the prevalence of metabolic syndrome (MS) and its components among Omani adults. ***Methods:*** The 2008 Oman World Health Survey dataset was used to determine the national prevalence of MS. Logistic regression using all key sociodemographic, clinical and behavioural variables was used to identify the associations of independent variables with MS. ***Results:*** The age-adjusted prevalence of MS was 23.6%. MS was significantly associated with age, marital and work status and wealth level. MS was more common for people aged 50 years and older compared to the youngest cohort (OR 3.6, CI: 2.4–5.3; *P* <0.001) and in people who were married or employed (OR 1.6, CI: 1.3–2.1; *P* <0.001 and OR 1.3, CI: 1.1–1.8; *P* = 0.043, respectively) compared to their unmarried and unemployed counterparts. MS was also more common in people in the second lowest wealth quintile (OR 1.6, CI: 1.2–2.2; *P* = 0.05) compared to the lowest quintile and in those who sat for more than six hours per day (OR 1.3, CI: 1.1-1.7; *P* = 0.035). ***Conclusion:*** One in four adults had MS in Oman. This may fuel the epidemic of non-communicable diseases (NCDs) in Oman, particularly given the increasingly elderly population. Urgent action is required to ensure quality patient care at all levels of the healthcare system. Further research on behavioural risk factors is needed. Developing and implementing a multisectoral strategy to prevent NCDs should be at the top of the current health agenda for Oman.

Keywords: Metabolic Syndrome X; Chronic Diseases; Epidemiology; Public Health; Oman.

الملخص: الهدف: هدفت الدراسة إلى وصف معدل انتشار المتلازمة الأيضية ومكوناتها بين العمانيين البالغين. **الطريقة:** تم استخدام قاعدة بيانات المسح الصحي العالمي بالسلطنة لعام 2008 لتحديد المعدل الوطني لانتشار المتلازمة الأيضية، وتم استخدام معادلة الانحدار اللوجستي لكل المتغيرات الأساسية للعوامل الاجتماعية- السكانية والسريرية والسلوكيات للتعرف على العلاقة المستقلة للمتغيرات المستقلة مع المتلازمة الأيضية. **النتائج:** وجد أن معدل انتشار المتلازمة الأيضية المعدل حسب السن يبلغ 23.6%. ووجد أيضا ارتباط ذو دلالة إحصائية مع العمر والحالة الزواجية والعمل والثروة. وكانت المتلازمة أكثر انتشارا بين الأفراد البالغين من العمر 50 عاما فأكثر بالمقارنة مع الفئة العمرية الأصغر (الاحتمال المرجح: 3.6 وحدود الثقة 5.3–2.4، P<0.001). ووجد أيضا أن المتلازمة الأيضية أكثر شيوعا بين المتزوجين والعاملين (الاحتمال المرجح: 1.6 حدود الثقة 2.1–1.3، P<0.001 والاحتمال المرجح1.3 وحدود الثقة 1.8–1.1، P = 0.043 على التوالي) مقارنة بغير المتزوجين والعاطلين عن العمل. كما وجد أن المتلازمة أكثر انتشارا بين المستوى الثاني الأقل من ترتيب أخماس الثروة (الاحتمال المرجح:1.6 وحدود الثقة 2.2–1.2، P = 0.05) مقارنة بالفئة الأدنى. وأظهر أيضا الأفراد الذين يجلسون لأكثر من 6 ساعات يوميا علاقة ذات دلالة معنوية مع المتلازمة الأيضية (الاحتمال المرجح: 1.3 وحدود الثقة 1.7–1.1، P = 0.035). **الخلاصة:** وجد أنه من بين كل أربعة بالغين في عمان يوجد شخص واحد مصاب بالمتلازمة الأيضية. وهذا مما يزيد من وبائية الأمراض غير المعدية، خاصة مع زيادة عدد المسنين. ويتطلب الأمر عملا عاجلا لضمان توفير رعاية ذات جودة عالية للمرضى على كل مستويات النظام الصحي، واجراء بحوث أخرى على عوامل السلوكيات الخاطئة ويجب تبني استراتيجية متعددة القطاعات للوقاية من الأمراض غير المعدية وتنفيذها لتكون في مقدمة الأجندة الصحية في عمان.

مفتاح الكلمات: المتلازمة الايضية X؛ الأمراض المزمنة؛ الوبائيات؛ الصحة العامة؛ عمان.

Advances in Knowledge

- *This is the first descriptive study at the national level in Oman of metabolic syndrome (MS), a precursor of cardiovascular disease and type 2 diabetes.*
- *One in four Omani adults was found to have MS. Furthermore, older adults, people who were married and those who were employed were observed to be some of the key high-risk groups for MS.*
- *From the results of this study, it was found that a large portion of Omani adults did not achieve the recommended amount of daily physical activity and did not consume the recommended amount of fruits and vegetables.*

Application to Patient Care

- *The results of this study, which observed a high proportion of Omani adults with MS and its components, highlight the need for appropriate measures to ensure that the healthcare system can provide quality care, including prevention, screening for early diagnosis and management.*

Departments of [1]Research & Studies and [4]Information & Statistics, Directorate General of Planning and [3]Non-Communicable Diseases Surveillance & Control, Directorate General of Health Affairs, Ministry of Health; [2]Office of the World Health Organization, Muscat, Oman

**Corresponding Author e-mail: rmmabry@gmail.com*

Metabolic syndrome (MS) includes a cluster of cardiovascular and diabetes risk factors.[1,2] People with this syndrome are at higher risk of developing diabetes and cardiovascular disease as well as premature mortality.[1] MS also increases the risk of other diseases, including cancer, kidney disease and mental illness.[3–5] Thus, MS is widely used as a marker for evaluating outcomes of population-based strategies aimed at preventing non-communicable diseases.[6]

The first internationally recognised working definition for MS was proposed at a World Health Organization (WHO) consultation in 1988 and numerous attempts have been made since then to develop a standard definition. Most identified a person with MS as one who had at least three of the following: central obesity, high fasting blood glucose levels, elevated blood pressure (BP), high cholesterol and high triglycerides, with the main difference between definitions being the cut-off points for each of these clinical indicators.[7]

Non-communicable diseases account for 83% of all deaths in Oman.[8] Despite the increasing rates of overweight/obesity, hypertension and type 2 diabetes, limited information is known about MS in Oman.[9–11] A community-based study conducted in 2001 in Nizwa, Oman, reported an age-adjusted prevalence of 19.5% in men and 23.0% in women aged 20 years and older.[12,13] A more recent survey in Sur, Oman, found the age-adjusted prevalence of MS to be 24.2% in men and 29.8% in women aged 20 years and above.[14] Despite the differences in age groups and definitions for MS, these studies demonstrate a clear gender difference, with a higher prevalence of MS in women, which is a trend that has been identified in other countries of the region as well.[15] This study aimed to provide for the first time a descriptive epidemiology of MS and its components at the national level in Oman.

Methods

The World Health Survey was developed by the WHO more than 10 years ago to obtain comprehensive information on the health of a population using a standard methodology.[16] The Oman World Health Survey (OWHS) was a population-based household survey conducted in 2008 to obtain a wide range of reliable and comparable information on the population's health and healthcare system in Oman. The prevalence of non-communicable diseases and associated risk factors were captured by the survey. The OWHS used the WHO STEPwise approach.[17] A multi-stage stratified cluster sampling design was used to select respondents aged 18 years and above.

Data were collected at the household level and included the following variables: gender, age, marital status (never married, currently married, separated/divorced or widowed), education level (illiterate, primary/preparatory, secondary or post-secondary), work status (currently working, previously worked or never worked) and wealth (in quintiles, with quintile 1 being the lowest and quintile 5 being the wealthiest). Respondents were asked to identify if they had ever been diagnosed with hypertension or diabetes and if so, whether they were taking medication or other treatments. Respondents were also asked about their health risk behaviours (tobacco use, physical inactivity, sitting time and fruit and vegetable intake). An individual who was a current user of any tobacco product was defined as a current smoker. Physical activity was assessed according to intensity, duration and frequency in three domains (work, transport and leisure); the total metabolic equivalent of task (MET) in minutes per day was calculated according to the WHO guidelines to estimate the total minutes of moderate physical activity per week for each individual. A person was determined as doing sufficient physical activity if they had performed the equivalent of at least 150 minutes of moderate physical activity per week. One survey item assessed the number of hours the participant sat per day. Fruit and vegetable intake was assessed by totalling the numbers of each item consumed on a typical day.

In addition, the anthropometrics (height, weight and waist circumference) of the respondents were assessed and three BP measurements were taken. Blood samples were collected after 8–14 hours of fasting to determine fasting blood glucose levels, total cholesterol levels, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol and triglyceride levels. The samples were labelled and transferred immediately in cold boxes filled with ice to a laboratory in a regional hospital. Samples for measuring blood glucose levels were collected in 2 mL sodium fluoride oxalate anticoagulant containers and samples for measuring cholesterol were collected in 2 mL lithium heparin anticoagulant containers. After plasma separation by centrifuge, the blood glucose and lipid levels were estimated using a Hitachi 911 automated clinical chemistry analyser (Roche Diagnostics, Basel, Switzerland) by the enzymatic colourimetric method.[18]

Out of the 5,465 individuals who were invited, a total of 4,717 individuals successfully completed the interviews with a response rate of 86.3%. Biomarkers were successfully analysed from 3,686 individuals (78.3%).[9] Details of the study methodology have been published elsewhere.[9]

Table 1: Distribution of selected sociodemographic, metabolic and lifestyle characteristics by gender of the Omani population sample using the 2008 Oman World Health Survey data (N = 3,137)*

		Men n = 1,459	Women n = 1,678	Total
Sociodemographic characteristics				
Age group in years	20–29	36.5	32.1	34.2
	30–39	23.7	27.0	25.5
	40–49	14.8	13.6	14.1
	50–59	10.0	14.5	12.4
	≥60	15.1	12.8	13.8
	Mean ± SD	39.4 ± 16.6	39.5 ± 15.1	39.4 ± 15.8
Marital status	Married	63.6	63.2	63.4
Education level	No formal education	29.0	48.1	39.2
	Primary or preparatory	21.5	17.2	19.2
	Secondary	32.8	24.3	28.3
	Post-secondary	16.7	10.4	13.3
Work status	Employed	60.3	10.7	33.8
Wealth status†	Q1	16.5	17.7	17.1
	Q2	23.1	25.0	24.1
	Q3	22.1	22.6	22.4
	Q4	18.6	20.4	19.6
	Q5	19.7	14.2	16.8
Metabolic components				
BMI in kg/m²		25.9 ± 6.3	26.3 ± 6.6	26.1 ± 6.5
WC in cm		90.5 ± 15.8	89.6 ± 17.8	90.0 ± 16.9
SBP in mm Hg		138.4 ± 21.4	126.0 ± 20.8	131.8 ± 21.9
DBP in mm Hg		84.9 ± 14.3	77.0 ± 13.4	80.7 ± 14.4
FBG in mmol/L		5.7 ± 2.2	5.4 ± 1.9	5.5 ± 2.1
Triglycerides in mmol/L		1.40 ± 1.1	1.17 ± 0.8	1.30 ± 0.9
HDL cholesterol in mmol/L		1.18 ± 0.3	1.36 ± 0.4	1.26 ± 0.4
Lifestyle characteristics				
Current smoker		15.1	0.3	7.2
<150 minutes of moderate physical activity/week		32.0	40.5	36.6
>6 hours sitting per day		21.5	25.6	23.7
Median sitting time in hours/day		3.0	4.0	3.0
<5 servings of fruit/vegetables per day		84.6	80.9	82.6
Servings of fruit/vegetables per day		3.0 ± 2.3	3.2 ± 2.7	3.1 ± 2.5

*Q = quintile; SD = standard deviation; BMI = body mass index; WC = waist circumference; SBP = systolic blood pressure; DBP = diastolic blood pressure; FBG = fasting blood glucose; HDL = high-density lipoprotein.*Data is expressed as unweighted percentages or mean ± SD. †Wealth status was divided into quintiles, with Q1 being the lowest and Q5 being the wealthiest.*

Among the participants, MS was identified using the National Cholesterol Education Program's Revised Adult Treatment Panel III (ATPIII) definition.[7] This identified individuals as having MS if they were taking medication for or had at least three of the following: central obesity with a waist circumference of ≥102 cm for men or ≥88 cm for women; raised triglycerides of ≥1.7 mmol/L; reduced HDL cholesterol of <1.03 mmol/L for men or <1.3 mmol/L for women; raised systolic BP of ≥130 mm Hg or diastolic BP of ≥85 mm, and raised fasting plasma glucose of ≥5.6 mmol/L.[7] In addition to central obesity, obesity was also assessed using body mass index (BMI) calculated in kg/m^2. The prevalence of MS was examined according to sociodemographic and behavioural risk factors for Omani participants with complete information for all adults aged 20 years and above.

Data were entered on microcomputers using the Census and Survey Processing (CSPro) System (United States Census Bureau, Washington, D.C., USA). Survey data were cleaned using CSPro as well as Stata, Version 13 (StataCorp LP, College Station, Texas, USA). The Statistical Package for the Social Sciences (SPSS), Version 18 (IBM Corp., Chicago, Illinois, USA) was used for statistical analysis. Logistic regression using all key sociodemographic, clinical and behavioural variables determined the associations of independent variables with MS. Models were age-adjusted to the population of Oman using national 2008 population statistics. Results were reported as percentages, means with standard deviations (SD) and odds ratios (OR) with 95% confidence intervals (CI).

This secondary analysis of the OWHS for chronic non-communicable diseases and associated risk factors was approved by the Research and Ethical Review and Approval Committee of the Ministry of Health (MOH).

Results

A total of 3,137 Omani participants had complete information for all of the variables and were included in this study (85%). The sample was relatively young (39.4 ± 15.8 years) and 46.5% were men. Nearly two-thirds (63.4%) of the participants were married [Table 1]. Approximately half of the men (49.5%) had received at least a secondary school education compared to only 34.7% of the women, and a larger proportion of men (60.3%) were employed compared to women (10.7%).

The mean BMI and systolic BP measurements of the sample were higher than normal at 26.1 ± 6.5 kg/m^2 and 131.8 ± 21.9 mm Hg, respectively. Elevated means were observed among men for BMI, systolic BP,

Table 2: Adjusted prevalence and odds ratio of demographic and behavioural risk factors for metabolic syndrome* in the Omani population using the 2008 Oman World Health Survey data (N = 3,137)

	Metabolic syndrome		OR (95% CI)	*P* value
	n	Age-adjusted prevalence %		
Sociodemographic characteristics				
Gender				
Women	1,678	24.4	1	-
Men	1,459	22.8	0.9 (0.7–1.2)	0.539
Age group in years				
20–29	1,072	13.5	1	-
30–39	799	25.3	1.5 (1.2–2.1)	0.004
40–49	444	33.4	2.2 (1.5–3.1)	<0.001
>50	823	39.5	3.6 (2.4–5.3)	<0.001
Marital status				
Other	1,148	16.5	1	-
Married	1,989	27.9	1.6 (1.3–2.1)	<0.001
Education level				
Illiterate	1,229	33.7	1	-
Primary/ preparatory	603	24.3	0.98 (0.7–1.4)	0.945
Secondary	886	16.4	0.84 (0.6–1.2)	0.314
Post-secondary	419	18.1	0.76 (0.5–1.2)	0.199
Work status				
Not employed	2,077	23.2	1	-
Employed	1,059	24.4	1.3 (1.1–1.8)	0.043
Wealth status†				
Q1	537	23.4	1	-
Q2	756	29.9	1.6 (1.2–2.2)	0.005
Q3	703	18.6	0.8 (0.6–1.2)	0.308
Q4	615	21.6	1.0 (0.7–1.4)	0.859
Q5	526	23.6	1.2 (0.8–1.7)	0.439
Behavioural risk factors				
Smoking				
Not a current smoker	2,910	23.4	1	-
Current smoker	226	26.1	0.9 (0.6–1.3)	0.500
Moderate physical activity per week				
≥150 minutes	1,990	23.4	1	-
<150 minutes	1147	24.0	0.9 (0.7–1.1)	0.143
Sitting time per day				
≤6 hours	2,395	22.8	1	-
>6 hours	742	26.5	1.3 (1.1-1.7)	0.035
Servings of fruits and vegetables per day				
≥5	829	23.5	1	-
<5	2,308	24.1	1.0 (0.7–1.3)	0.870
Total	**3,173**	**23.6**	-	-

OR = odds ratio; CI = confidence interval; Q = quintile.

**Metabolic syndrome was identified according to the National Cholesterol Education Program's Revised Adult Treatment Panel III definition. † Wealth status was divided into quintiles, with Q1 being the lowest and Q5 being the wealthiest.*

blood glucose and triglycerides levels in comparison to women, where these variables were within normal ranges. However, women's obesity measurements were outside these normal ranges. The mean waist circumferences of women (89.6 ± 17.8 cm) were above the normal range and similar to those of men (90.5 ± 15.8 cm).

A high percentage of the sample ate less than the recommended five servings of fruit and vegetables per day (82.6%) and did less than 150 minutes of moderate physical activity per week (36.6%). Tobacco use was relatively common among men (15.1%) but rare among women (0.3%).

Overall, the age-adjusted prevalence of MS was 23.6%; it was slightly higher in women (24.4%) than men (22.8%), but this difference was not statistically significant [Table 2]. The age-adjusted prevalence of MS was particularly high in adults aged 40–49 years (33.4%), those aged 50 years and above (39.5%) and those with no formal education (33.7%).

The prevalence of the various components of MS varied according to gender [Figure 1]. The components with the highest prevalence for women were central obesity and low HDL cholesterol (73.7% and 59.8%, respectively). For men, the components with the highest prevalence were high BP, high triglycerides and impaired fasting glucose levels (60.1%, 56.4% and 53.0%, respectively). The gender difference in prevalence rates were highly significant for all components (P <0.001).

Table 2 presents the results of the logistic regression analysis using all key sociodemographic, clinical and behavioural variables. MS was significantly associated with age, wealth and marital and work status. MS was more common for people aged 50 years

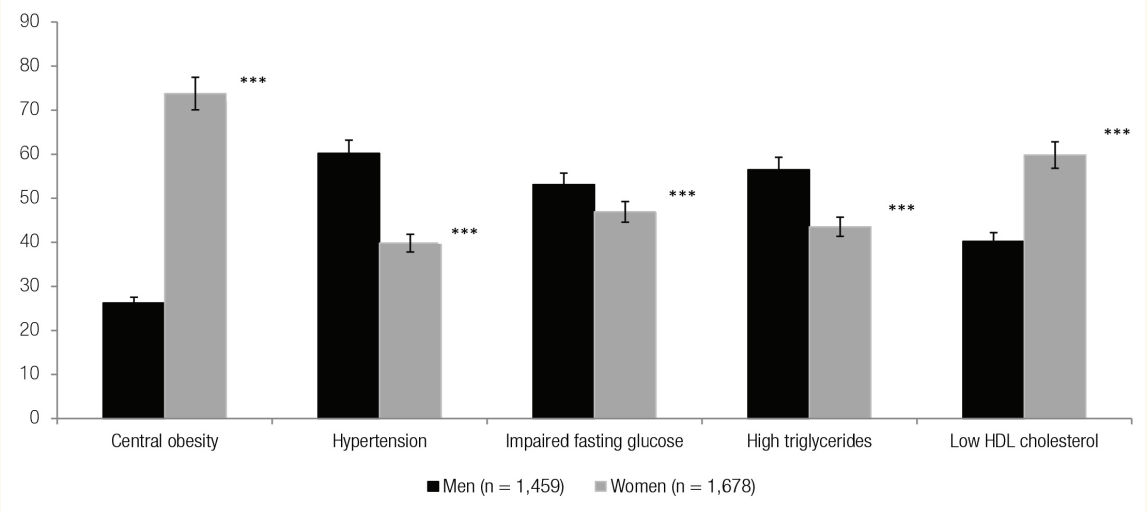

Figure 1: The age-adjusted prevalence of various components of metabolic syndrome among men and women using the 2008 Oman World Health Survey. Metabolic syndrome was defined according to the National Cholesterol Education Program's Revised Adult Treatment Panel III criteria. The error bars denote 95% confidence intervals.
*HDL = high-density lipoproteins. ***Significance was P <.001.*

and over compared to the youngest cohort (OR 3.6, CI: 2.4–5.3; *P* <0.001). It was more common in people who were married or employed (OR 1.6, CI: 1.3–2.1; *P* <0.001 and OR 1.3, CI: 1.1–1.8; *P* = 0.043, respectively) compared to their unmarried and unemployed counterparts. MS was also more common in people in the second lowest wealth quintile (OR 1.6, CI: 1.2–2.2; *P* = 0.005) compared to the lowest quintile. Of the behavioural risk factors examined (smoking, physical activity, sitting time and dietary intake), only sitting time showed a significant association with MS. The syndrome was more common in people who sat more than six hours per day in comparison to those who sat less (OR 1.3, CI: 1.1–1.7; *P* = 0.035).

Discussion

The results of this study showed a high national prevalence of MS (23.6%). This prevalence differed from other prevalences recorded in Oman—it was slightly higher than that seen in Nizwa in 2001 (21.0%) but lower than that seen in Sur (27.3%).[12,14] These differences could be due to the definition of MS that was used in these studies. The prevalence found was also slightly lower than in Qatar (26.5%), but much lower than prevalences recorded among other countries of the Gulf Cooperation Council (GCC) region, like Saudi Arabia (39.3%) and the United Arab Emirates (UAE) (39.6%).[15] Like Oman, other countries of the GCC region reported a higher prevalence of MS among women, with gender differences ranging between 4.8% in Saudi Arabia using the ATPIII definition to 13% in the UAE using the International Diabetes Federation definition.[15] The prevalence rates in Oman were lower than in the USA, where the rates were 35.1% and 32.6% for men and women, respectively.[19] However, the rates for men and women were higher than those found in Australia (15.7% and 14.4%, respectively)[20] and European countries such as Italy (15% and 18%, respectively)[21] and France (16% and 11%, respectively).[22] The lower prevalence seen in Oman compared to neighbouring countries is likely due to the lower rates of obesity and possibly also a reflection of the relatively lower gross domestic product (GDP) per capita.[23]

It is concerning that despite having a young population compared to developed countries, one in four Omani adults in the 2008 OWHS were found to have MS. The prevalence of non-communicable diseases and their risk factors, such as obesity and high BP, are on the increase.[9–11] Evidence indicates that the Omani population is genetically susceptible to some components of MS such as obesity, high cholesterol levels and elevated BP.[24] In addition, evidence indicates that malnutrition *in utero*, a likely scenario for the current generation of adults, is linked to MS in adults.[25] Given the population's increased vulnerability to MS, extensive efforts should be made by the government of Oman to implement multisectoral, cost-effective, population-wide interventions such as the actions outlined in the United Nations' Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases.[8,26]

Interestingly, of the behavioural risk factors examined (smoking, physical inactivity, sitting time

and dietary intake), only sitting time was found to be associated with MS in this study. Evidence clearly demonstrates that these behaviours can prevent MS and its components.[8,14,27,28] Thus, it is concerning that a large portion of Omani adults do not meet the recommended amount of physical activity, sit for long periods of time and do not consume the recommended amount of fruit and vegetables.[8,29] Successful interventions within the GCC region, including the Nizwa Healthy Lifestyle Project, demonstrate how community-based activities can bring about behavioural changes.[30,31] A more strategic approach to promoting physical activity and healthy eating involves changes in policies which are largely outside the health sector, such as agriculture, commerce, education, media, sports, transportation and urban planning.[32]

The high proportion of adults suffering from MS and its components is likely to increase in the near future given the increase in life expectancy and the high susceptibility of the population. Despite the existence of well-defined clinical management guidelines and a national screening programme for non-communicable diseases,[33–35] several studies have raised concerns regarding the quality of care for people with diabetes.[31,36,37] Improving the delivery of care, patient education and training for health workers at the primary care level have been identified as key areas for improvement.[36,37]

The significant associations of MS with older age and lower education are similar to the findings of other studies in Oman and other GCC countries.[12,15,38,39] The positive association with age is also commonly found in other parts of the world.[40] However, the association with education and income varies internationally.[40] Given the significant associations with age and education in Oman, the growth of the elderly population and a high proportion of older adults with MS, extensive efforts are required to ensure that prevention and disease management messages can be clearly understood and followed by all, including those with limited literacy skills.[41] Improving the quality of care by emphasising a patient-centred approach is a key way to address this particular issue.[36,37]

The main strength of this study is that it was a population-based study with a large sample. By obtaining information and collecting clinical measurements and blood at the household level, participants were not obligated to visit a health centre. On the other hand, the long questionnaire, which required an average of 2.25 hours to complete, may have wearied respondents and potentially lead to inaccuracy, particularly among self-reported items such as the questions regarding health risk behaviours. In addition, as a cross-sectional study, the associations identified do not necessarily denote causality.

Four main recommendations can be made based on the findings of this study. First, greater efforts should be made by the MOH to advocate for an all-government approach to promoting healthy behaviours as part of a national strategy to prevent non-communicable diseases and their precursor, MS. Given the vast amount of evidence demonstrating that physical activity and healthy dietary behaviours can prevent MS and its components, further research is recommended to better understand these behaviours and to test interventions. Additionally, a patient-centred approach that ensures the provision of quality primary healthcare interventions to prevent, screen for and manage MS and its components is required in order to prevent complications and reduce hospitalisation and mortality. Prevention and disease management messages need to be developed so that they can be easily understood and followed, particularly by older adults who may have limited literacy skills.

Conclusion

In conclusion, one in four Omani adults was found to have MS, which is a proximal precursor to cardiovascular disease and diabetes. This prevalence rate is higher than in many developed countries despite the much younger population in Oman. An enormous amount of effort by various sectors is needed to reduce the prevalence of MS and its components in order to build on the health gains of the past and to meet the country's United Nations commitments to addressing non-communicable diseases.

ACKNOWLEDGEMENTS

The authors would like to thank the MOH for providing the raw data as well as the WHO Regional Office for the Eastern Mediterranean Region for technical support and the relevant GCC authorities for their coordination with the original OWHS. The views expressed in this paper are those of the authors and do not necessarily reflect those of the WHO.

References

1. Alberti KG, Zimmet P, Shaw J. Metabolic syndrome: A new world-wide definition. A consensus statement from the International Diabetes Federation. Diabet Med 2006; 23:469–80. doi: 10.1111/j.1464-5491.2006.01858.x.

2. Zimmet P, Alberti G, Shaw J. A new IDF worldwide definition of the metabolic syndrome: The rationale and the results. Diabetes Voice 2005; 50:31–3.

3. Borena W, Edlinger M, Bjørge T, Häggström C, Lindkvist B, Nagel G, et al. A prospective study on metabolic risk factors and gallbladder cancer in the metabolic syndrome and cancer (Me-Can) collaborative study. PLoS One 2014; 9:e89368. doi: 10.1371/journal.pone.0089368.

4. Pan A, Keum N, Okereke OI, Sun Q, Kivimaki M, Rubin RR, et al. Bidirectional association between depression and metabolic syndrome: A systematic review and meta-analysis of epidemiological studies. Diabetes Care 2012; 35:1171–80. doi: 10.2337/dc11-2055.

5. Thomas G, Sehgal AR, Kashyap SR, Srinivas TR, Kirwan JP, Navaneethan SD. Metabolic syndrome and kidney disease: A systematic review and meta-analysis. Clin J Am Soc Nephrol 2011; 6:2364–73. doi: 10.2215/CJN.02180311.

6. Simmons RK, Alberti KG, Gale EA, Colagiuri S, Tuomilehto J, Qiao Q, et al. The metabolic syndrome: Useful concept or clinical tool? Report of a WHO Expert Consultation. Diabetologia 2010; 53:600–5. doi: 10.1007/s00125-009-1620-4.

7. Kassi E, Pervanidou P, Kaltsas G, Chrousos G. Metabolic syndrome: Definitions and controversies. BMC Med 2011; 9:48. doi: 10.1186/1741-7015-9-48.

8. World Health Organization. Global status report on noncommunicable disease: 2010. From: www.whqlibdoc.who.int/publications/2011/9789240686458_eng.pdf?ua=1 Accessed: May 2014.

9. Al Riyami A, Elaty MA, Morsi M, Al Kharusi H, Al Shukaily W, Jaju S. Oman World Health Survey: Part 1 - Methodology, sociodemographic profile and epidemiology of non-communicable diseases in Oman. Oman Med J 2012; 27:425–43.

10. Al-Lawati JA, Al Riyami AM, Mohammed AJ, Jousilahti P. Increasing prevalence of diabetes mellitus in Oman. Diabet Med 2002; 19:954–7. doi: 10.1046/j.1464-5491.2002.00818.x.

11. Al Riyami AA, Afifi MM. Hypertension in Oman: Distribution and correlates. J Egypt Public Health Assoc 2002; 77:383–407.

12. Al-Lawati JA, Mohammed AJ, Al-Hinai HQ, Jousilahti P. Prevalence of the metabolic syndrome among Omani adults. Diabetes Care 2003; 26:1781–5. doi: 10.2337/diacare.26.6.1781.

13. Al-Lawati JA, Jousilahti P. Prevalence of metabolic syndrome in Oman using the International Diabetes Federation's criteria. Saudi Med J 2006; 27:1925–6.

14. Mabry RM, Winkler EA, Reeves MM, Eakin EG, Owen N. Associations of physical activity and sitting time with the metabolic syndrome among Omani adults. Obesity (Silver Spring) 2012; 20:2290–5. doi: 10.1038/oby.2012.26.

15. Mabry RM, Reeves MM, Eakin EG, Owen N. Gender differences in prevalence of the metabolic syndrome in Gulf Cooperation Council countries: A systematic review. Diabet Med 2010; 27:593–7. doi: 10.1111/j.1464-5491.2010.02998.x.

16. World Health Organization. WHO World Health Survey. From: www.who.int/healthinfo/survey/en/ Accessed: May 2014.

17. World Health Organization. Chronic diseases and health promotion: STEPwise approach to chronic disease risk factor surveillance (STEPS). From: www.who.int/chp/steps/riskfactor/en/ Accessed: May 2014.

18. Oman Ministry of Health. World Health Survey - Oman. From: www.moh.gov.om/en/reports/WHSSurvey2008(1).pdf and www.moh.gov.om/en/reports/WHSSurvey2008(2).pdf Accessed: May 2014.

19. Ervin RB. Prevalence of metabolic syndrome among adults 20 years of age and over, by sex, age, race and ethnicity, and body mass index: United States, 2003–2006. Natl Health Stat Report 2009; 5:1–7.

20. Adams RJ, Appleton S, Wilson DH, Taylor AW, Dal Grande E, Chittleborough C, et al. Population comparison of two clinical approaches to the metabolic syndrome: Implications of the new International Diabetes Federation consensus definition. Diabetes Care 2005; 28:2777–9. doi: 10.2337/diacare.28.11.2777.

21. Miccoli R, Bianchi C, Odoguardi L, Penno G, Caricato F, Giovannitti MG, et al. Prevalence of the metabolic syndrome among Italian adults according to ATP III definition. Nutr Metab Cardiovasc Dis 2005; 15:250–4. doi: 10.1016/j.numecd.2004.09.002.

22. Balkau B, Vernay M, Mhamdi L, Novak M, Arondel D, Vol S, et al. The incidence and persistence of the NCEP (National Cholesterol Education Program) metabolic syndrome: The French D.E.S.I.R. study. Diabetes Metab 2003 29:526–32. doi: 10.1016/S1262-3636(07)70067-8.

23. Ng SW, Zaghloul S, Ali HI, Harrison G, Popkin BM. The prevalence and trends of overweight, obesity and nutrition-related non-communicable diseases in the Arabian Gulf states. Obes Rev 2011; 12:1–13. doi: 10.1111/j.1467-789X.2010.00750.x.

24. Bayoumi RA, Al-Yahyaee SA, Albarwani SA, Rizvi SG, Al-Hadabi S, Al-Ubaidi FF, et al. Heritability of determinants of the metabolic syndrome among healthy Arabs of the Oman Family Study. Obesity (Silver Spring) 2007; 15:551–6. doi: 10.1038/oby.2007.555.

25. Wang J, Wu Z, Li D, Li N, Dindot SV, Satterfield MC, et al. Nutrition, epigenetics, and metabolic syndrome. Antioxid Redox Signal 2012; 17:282–301. doi: 10.1089/ars.2011.4381.

26. United Nations General Assembly. Political Declaration of the High-Level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases. From: www.who.int/nmh/events/un_ncd_summit2011/political_declaration_en.pdf?ua=1 Accessed: May 2014.

27. Edwardson CL, Gorely T, Davies MJ, Gray LJ, Khunti K, Wilmot EG, et al. Association of sedentary behaviour with metabolic syndrome: A meta-analysis. PLoS One 2012; 7:e34916. doi: 10.1371/journal.pone.0034916.

28. Healy GN, Matthews CE, Dunstan D, Winkler EA, Owen N. Sedentary time and cardio-metabolic biomarkers in US adults: NHANES 2003–06. Eur Heart J 2011; 32:590–7. doi: 10.1093/eurheartj/ehq451.

29. Alasfoor D, Rajab H, Al-Rassasi B. Food Based Dietary Guidelines: Technical background and description. From: www.fao.org/ag/humannutrition/19542-0561250979706400b7cc8ca7366cc07c0.pdf Accessed: May 2014.

30. Midhet FM, Sharaf FK. Impact of health education on lifestyles in central Saudi Arabia. Saudi Med J 2011; 32:71–6.

31. Al-Sinani M, Min Y, Ghebremeskel K, Qazaq HS. Effectiveness of and adherence to dietary and lifestyle counselling: Effect on metabolic control in type 2 diabetic Omani patients. Sultan Qaboos Univ Med J 2011; 10:341–9.

32. Gortmaker SL, Swinburn BA, Levy D, Carter R, Mabry PL, Finegood DT, et al. Changing the future of obesity: Science, policy, and action. Lancet 2011; 378:838–47. doi: 10.1016/S0140-6736(11)60815-5.

33. Oman Ministry of Health. A manual for the management of hypertension in primary health care. From: www.moh.gov.om/en/stat/2010/index_eng.htm Accessed: May 2014.

34. Oman Ministry of Health. Diabetes mellitus: Management Guidelines for Primary Health Care. From: www.moh.gov.om/en/reports/DiabetesAfterCorrection1.pdf Accessed: May 2014.

35. Oman Ministry of Health. Operational and Management Guidelines for the National Non-communicable Diseases Screening Program. From: www.moh.gov.om/en/reports/Guidelines_Manual_for_the_national_NCD_screening_program.pdf Accessed: May 2014.

36. Elliott JA, Abdulhadi NN, Al-Maniri AA, Al-Shafaee MA, Wahlström R. Diabetes self-management and education of people living with diabetes: A survey in primary health care in Muscat Oman. PLoS One 2013; 8:e57400. doi: 10.1371/journal.pone.0057400.

37. Al-Shookri A, Khor GL, Chan YM, Loke SC, Al-Maskari M. Effectiveness of medical nutrition treatment delivered by dietitians on glycaemic outcomes and lipid profiles of Arab, Omani patients with type 2 diabetes. Diabet Med 2012; 29:236–44. doi: 10.1111/j.1464-5491.2011.03405.x.

38. Al Rashdan I, Al Nesef Y. Prevalence of overweight, obesity, and metabolic syndrome among adult Kuwaitis: Results from community-based national survey. Angiology 2010; 61:42–8. doi: 10.1177/0003319709333226.

39. Bener A, Zirie M, Musallam M, Khader YS, Al-Hamaq AO. Prevalence of metabolic syndrome according to Adult Treatment Panel III and International Diabetes Federation criteria: A population-based study. Metab Syndr Relat Disord 2009; 7:221–9. doi: 10.1089/met.2008.0077.

40. Cameron AJ, Shaw JE, Zimmet PZ. The metabolic syndrome: Prevalence in worldwide populations. Endocrinol Metab Clin North Am 2004; 33:351–75. doi: 10.1016/j.ecl.2004.03.005.

41. Al-Lawati JA, Mabry R, Mohammed AJ. Addressing the threat of chronic diseases in Oman. Prev Chronic Dis 2008; 5:A99.