Clustering of cardiovascular risk factors among Omani adults

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الخلاصـة: في سبيل التعرف على توزع وترابُطات مجموعات الاختطار القلبية الوعائية تم تحليل معطيات المسح الصحي الوطني العُماني لعام 2000 وتحليلها، وقد تم توزيع 5660 من الأشخاص المدروسين إلى فئات على أساس المعطيات الديموغرافية (ضغط الدم، سكر الدم على الريق، كوليستيرول المصل، الوزن، الطول، قياسات الخصر والورك) بحسب ما تشتمل عليه من عوامل الاختطار القلبية الوعائية الأربعة (فرط ضغط الدم، فرط كوليستيرول الدم، السكري، زيادة الوزن أو السِّمنة). وقد وجد أن لدى 72٪ من الأشخاص المدروسين أقل من عامل اختطار واحد، وأن لدى 2٪ منهم العوامل الأربعة مجتمعة. وتزداد عوامل الاختطار مع تقدُّم العمر، في حين يكون لعيش الإنسان في المناطق الريفية أو عيشه بمفرده دور وقائي. وتُعَدُّ المتلازمة القلبية الوعائية الاستقلابية من المشكلات الشائعة في الصحة العمومية في عُمان. ومن الضروري زيادة الوعي بين العاملين على إيتاء الرعاية الصحية وبين سائر أفراد المجتمع من خلال توزيع واسع للنتائج التي أسفرت عنها هذه الدراسة المسحيّة.

ABSTRACT To determine the distribution and correlates of clustering of cardiovascular disease (CVD) risk factors, data from the Oman National Health Survey, 2000 were analysed. Based on demographic data (blood pressure, fasting blood glucose, serum cholesterol, weight, height, waist and hip measurements), 5660 subjects were grouped according to how many of four CVD risk factors (hypertension, high cholesterol, diabetes, overweight/obesity) they had. We found that 72% of subjects had less than one risk factor and 2% had all four. Older age exacerbated risk, while living in rural areas or being single was protective. Metabolic cardiovascular syndrome is a public health problem in Oman. Increasing awareness in healthcare providers and the wider population by comprehensive dissemination of the survey results is crucial.

Association des facteurs de risque cardio-vasculaire chez des adultes omanais

RESUME Les données provenant de l'enquête nationale sur la santé réalisée à Oman en 2000 ont été analysées pour déterminer la distribution et les corrélats de l'association des facteurs de risque des maladies cardio-vasculaires. Sur la base des données démographiques (tension artérielle, glycémie à jeun, cholestérol sérique, mesures du poids, de la taille, du tour de taille et de hanches), 5660 sujets ont été groupés en fonction du nombre de facteurs de risque de maladie cardio-vasculaire qu'ils avaient parmi les quatre suivants : hypertension, cholestérol élevé, diabète, surcharge pondérale/obésité. Nous avons constaté que 72 % des sujets présentaient au moins un facteur de risque et que 2 % présentaient les quatre. L'âge avancé exacerbait le risque, tandis que le fait de vivre en milieu rural ou d'être célibataire constituait une protection. Le syndrome métabolique cardio-vasculaire est un problème de santé publique à Oman. La sensibilisation des prestataires de soins de santé et de la population générale par la large diffusion des résultats de l'enquête est cruciale.

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Introduction

Social advances in Oman since 1970 have been accompanied by cultural changes, a reduction in the prevalence of communicable diseases, increased life expectancy, changes in nutritional habits and habitual physical activity and increased prevalence of noncommunicable diseases such as hypertension and diabetes [*1*]. Environmental and behavioural changes such as the adoption of new dietary habits and a sedentary lifestyle, and the stress of urbanization and of working conditions have all contributed to the rise in cardiovascular disease (CVD) risk factors [*2*]. The primary risk factors for CVD are hypertension, high cholesterol, diabetes, overweight, cigarette smoking and physical inactivity. The first 4 of these may cluster in some persons and have been identified as components of a syndrome known as metabolic cardiovascular syndrome, or the "deadly quartet" [*3*].

Approximately 50% of hypertensive people can be considered to have insulin resistance and hyperinsulinaemia. It appears likely that insulin resistance and hyperinsulinaemia predispose to, rather than result from, hypertension. Insulin resistance is associated with abnormalities in lipoprotein metabolism, hypercoagulability, and endothelial function, which probably account in part for the increased cardiovascular risk among hypertensive patients [*4*]. Patients with at least 1 component of the metabolic syndrome have been found to be obese, hyperinsulinaemic, insulin resistant, hyperglycaemic, hypertensive, and dyslipidaemic [*5*].

The association between hyperinsulinaemia and cardiovascular risk factors has been investigated in Gulf countries. In the United Arab Emirates, Bener et al. examined the association between acanthosis negricans, hyperinsulinaemia and cardiovascular risk factors [*6*]. They found that patients with acanthosis negricans had a high prevalence of abnormal glucose tolerance and hyperinsulinaemia. In addition, euglycaemic patients with hyperinsulinaemia had a cluster of risk factors for CVD. In Bahrain, Musaiger and al-Roomi found that obesity, hypertension and diabetes were highly prevalent and significantly more frequently reported among women than men, with 79.6% of women overweight or obese, compared to 56% of men [*7*]. They also recommended the need for a national health policy to prevent and control CVD. In Egypt, Ibrahim et al. studied the clustering of CVD risk factors in hypertensive patients. They found that obesity was prevalent in 33% of hypertensive men and 47% of hypertensive women [*8*]. After adjusting for age, hypertensive men had significantly higher total cholesterol, fasting blood sugar, body mass index (BMI) and waist-hip ratio than their normotensive counterparts. In addition, hypertensive women had higher low-density lipoprotein (LDL) cholesterol.

Using World Health Organization criteria (WHO) [*9*], the Oman National Health Survey, 2000 identified the prevalence of hypertension, high cholesterol, diabetes, overweight and obesity among Omani adults. The National Health Survey was a cross-sectional community-based study involving all 10 regions of Oman. The aim of our study was to examine the aggregation or clustering of these CVD risk factors and the correlates of this clustering among those Omani subjects aged ≥ 20 years who had been included in the National Health Survey.

Methods

Sample design and participants

The sample for the survey was selected to be representative of the whole nation. The survey adopted a multistage stratified probability sampling design. All 10 regions of the country were sampled proportionally. Depending on the size of the population for each region, one or more *wilayat* (districts) were randomly chosen from that region, with 16 *wilayat* selected for the survey from a national total of 59. Each *wilayat* was stratified into urban or rural (villages/remote areas), resulting in an urban:rural ratio of 2:1, similar to that of the 1993 national census. Within each of these strata, enumeration areas (EAs, census units used during the 1993 population census, each containing approximately 80 households) were randomly selected. Households within each of the EAs were then randomly selected. Maps of the selected EAs were updated, and a comprehensive listing of all Omani households in each EA was made to obtain the sampling frame.

All individuals aged ≥ 20 years (n = 7011) in the selected households (n = 1968) were invited to participate in the survey. The response rate varied from 81% to 91%, according to the type of measurement or laboratory investigation completed. Of the 7011 eligible participants, 5660 (81%) completed the questionnaire, had their blood taken to measure fasting blood glucose and completed the other necessary measurements and laboratory investigations in order to have their data analysed.

Questionnaire and measurements

The Household Health Status questionnaire covered demographic data such as age and sex, and marital, education and employment status, as well as self-reporting for diabetes mellitus and hypertension. Education status was classified into 3 groups: illiterate; those who could read and write and had completed either primary or preparatory school, or had spent some years in secondary school; and those who had completed secondary school, college, university or postgraduate tertiary studies.

Blood pressure (BP) was measured manually. This measure, together with data for weight, height, waist and hip circumference, was registered in the questionnaire. Waist-hip ratio was not considered as a variable in this analysis. WHO procedures were used to obtain the measurements [*9*]. The results of laboratory investigations taken for fasting blood glucose and serum cholesterol were also entered on the questionnaire. Certain important biochemical measurements related to CVD risk factors, such as high-density lipoprotein (HDL) cholesterol, LDL cholesterol, triglyceride or microalbuminuria levels were not collected during the survey.

Specimen collection and analysis

For specimen collection and analysis, 25 teams were assembled and trained in the methodology of the survey for 2 weeks. Each team consisted of a nurse to take measurements, a laboratory technician to draw samples, a health educator to interview subjects, a health inspector to transport laboratory samples and a field supervisor (statistician) to supervise and review the questionnaires in the field.

Eligible members of the selected households were requested to commence fasting 1–2 hours before midnight the night before they were to be visited by the survey team. At 07.00 the following morning, household members were interviewed, had their measurements taken and venous fasting blood glucose samples collected. Fasting blood samples for glucose were collected in sodium fluoride potassium oxalate tubes, labelled and transferred immediately in cold boxes, along with laboratory forms, to the laboratory at the *wilayat* hospital. Samples were immediately centrifuged, the plasma separated and fasting plasma glucose determined by a glucose oxidase method on the same day, using a Hitachi 911 automated clinical chemistry analyser (Boehringer Mannheim). The same manufacturer supplied the reagents. Samples for estimation of cholesterol were collected in tubes containing lithium heparin anticoagulants and transferred to the laboratory, where the investigations were carried out by the enzymatic colorimetric method, also using the Hitachi 911 analyser.

Diagnostic criteria

The 1999 WHO criteria [*9*] for diagnosis of hypertension, hypercholesterolaemia, anthropometric measurement and glucose intolerance were used.

Diastolic hypertension

Patients who self-reported being hypertensive were categorized as having diastolic hypertension (even if their blood pressure reading at the time of screening was normal) only if the interviewer either sighted their medication, or verified that the subject had been diagnosed as hypertensive by a medical practitioner. Patients were also categorized as having diastolic hypertension if the mean of two BP readings was ≥ 90 mm Hg diastolic phase 5, regardless of their systolic blood pressure readings. Hypertensive subjects were further classified in the logistic regression models as having mild hypertension (diastolic BP 90–104 mm Hg) or moderate/severe hypertension (diastolic BP ≥ 105 mm Hg).

Hypercholesterolaemia

Patients were categorized as having hypercholesterolaemia if their total cholesterol level was ≥ 5.2 mmol/L or ≥ 200 mg/dL.

Anthropometric measurements

Body mass index [BMI = weight (kg)/ height^2 (m^2)] was classified according to the accepted norms: underweight (BMI < 18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), obese (30.0–39.9 kg/m^2) and morbidly obese (≥ 40.0 kg/m^2).

Diabetes mellitus

Participants were categorized as having diabetes mellitus if they self-reported having diabetes, or their fasting blood glucose reading was ≥ 7.0 mmol/L.

Data processing and analysis

Data were entered using *Epi-Info*, version 6.04 software. Preparation of the data was completed by July, 2000. Data were analysed using *SPSS*, version 9.0. Data were given as counts, means and percentages. Group means were compared using ANOVA, and the chi-squared test examined the distribution of data using the likelihood ratio.

Step-wise logistic regression was conducted to test for the factors most strongly associated with the dependent variable under study and to obtain the adjusted odds ratio (OR) for each factor. All independent variables used in the logistic models were dichotomous (after recoding some of them to be so). The OR shows the change in the odds of the dependent variable under study when the independent variable changed from 0 to 1. A *P*-value < 0.05 was considered statistically significant.

Results

Table 1 shows participants' demographic and social characteristics. Males and females were equally represented, a majority (62.1%) were aged between 20 and 39 years, 73% lived in rural areas, approximately 34% were illiterate, and 7% were current smokers.

The 4 CVD risk factors investigated in our study were diastolic hypertension, dia-

Table 1 **Demographic and social characteristics of National Health Survey participants, Oman, 2000**

Characteristic	No.	%
Age group (years)		
20–39	4353	62.1
40–59	1753	25.0
≥ 60	905	12.9
Total	7011	100.0
Sex		
Male	3506	50.0
Female	3505	50.0
Total	7011	100.0
Residence		
Urban	5143	73.4
Rural	1868	26.4
Total	7011	100.0
Education		
Illiterate	2333	33.8
< Secondary	2824	40.9
≥ Secondary	1753	25.3
Total	6910	100.0
Work status		
Working	2778	39.9
Not working	4191	60.1
Total	6969	100.0
Marital status		
Married	4668	66.7
Not married	2327	33.3
Total	6995	100.0
Family size		
≤ 10 members	3696	52.7
> 10 members	3315	47.3
Total	7011	100.0
Currently smoking		
Yes	488	7.0
No	6515	93.0
Total	7003	100.0

betes mellitus, hypercholesterolaemia, and overweight/obesity. Of the 5660 subjects tested (aged 20 years and above), 25.2% had high diastolic blood pressure, approximately 11% had diabetes, 41% had a high level of serum cholesterol and 48% were overweight or obese. Only 28% of subjects had none of these CVD risk factors (i.e. 72% had at least 1 CVD risk factor), 34.8% had 1 risk factor, 24.6% had 2 risk factors, 10.6% had 3 risk factors and 2% had all 4 risk factors.

Participants were divided into 2 groups, as having either ≤ 1 risk factor (63% of the study sample) or having ≥ 2 risk factors (37%). The dependent variable introduced in the logistic models was having (or not having) ≥ 2 risk factors. The independent variables were gender, age group, place of residence, marital status, level of education and work status.

Table 2 shows the means of the CVD risk factors in the overall sample and the comparison of these means among groups of subjects with 0, 1, or > 1 risk factors. The BP measurement increased steadily with clustering of risk factors. Subjects with none of the risk factors had a mean BP of 119.3/75.3 mm Hg, while those with 4 risk factors had a mean BP of 149/95.6 mm Hg (SBP measurements are not shown in Table 2). The differences between the mean values for diastolic blood pressure were significant for the groups overall and between each group, using the Tukey method ($P < 0.05$ is statistically significant). The mean values for fasting blood glucose, serum cholesterol and BMI also increased significantly with the number of aggregated risk factors.

To identify the significantly associated variables with the dependent binary variable having (or not having) 2 or more risk factors, we used multiple logistic regression. From the different models, we obtained the OR for each significant independently associated variable. The independent variables included in the models were: age, sex, place of residence, marital status, and level

Table 2 **Comparison of means of cardiovascular disease risk factors among groups of subjects with zero, one or more CVD risk factors, National Health Survey, Oman, 2000**

Variable	**Mean (total sample)**	**Mean according to number of risk factors**					***F***	***P*-value**
	Overall ***N* = 5660**	**0** ***n* = 1586**	**1** ***n* = 1970**	**2** ***n* = 1394**	**3** ***n* = 598**	**4** ***n* = 112**		
Diastolic blood pressure (mm Hg)	80.4	75.3	78.7	83.2	90.4	95.6	496.3	< 0.05
Fasting blood glucose (mmol/L)	5.5	4.8	5.1	5.8	7.2	10.5	332.6	< 0.05
Fasting serum cholesterol (mmol/L)	5.1	4.2	4.9	5.7	6.1	6.5	712.3	< 0.05
Body mass index (kg/m²)	25.4	21.0	25.3	28.2	30.0[a]	30.9[a]	654.1	< 0.05

[a]*All differences of the means were significant below the 0.05 level by the ANOVA-Tukey method, except for the BMI mean difference between subjects with 3 risk factors and subjects with 4 risk factors.*

of education. The OR for each variable was adjusted for the other variables in the model to account for confounding between these variables.

Table 3 shows the significantly associated variables with the group having ≥ 2 risk factors, and the adjusted OR in 3 different multiple logistic models, i.e. for the whole sample and for male and female sex. The risk of being in this group (having ≥ 2 risk factors) increased with the higher age group and with living in urban areas in the 3 different models. Subjects aged ≥ 60 years were 2.6 times more likely to be in the group of ≥ 2 risk factors compared to younger age groups (20–39 years) in the total sample. Being single decreased the risk in the 3 models. Having a higher level of education (secondary and above) increased the risk for male subjects but decreased it for females.

Table 4 shows the adjusted OR for the group having ≥ 2 or more risk factors in the 3 different age groups. Urban residence increased the risk in the 3 age groups. Being female was protective in the age group 20–39 years, but increased the risk among the older age groups, 40–59 years and ≥ 60 years. The adjusted OR values were 0.73, 1.29 and 1.7 respectively.

Discussion

Health institution-based statistics usually give health planners an underestimation of the noncommunicable disease problem in Oman. For example, the registration of cases in diabetic registries nationwide is still unsatisfactory. In 2000 (the year of our study), the percentage of new and old cases of diabetes registered and treated in Ministry of Health institutions was 3.04% of the population aged ≥ 20 years. The hypertension figure for this age group was only

Table 3 **Adjusted odds ratio (OR) of factors significantly associated with subjects having ≥ 2 cardiovascular disease risk factors in the total sample population and among males and females, National Health Survey, Oman, 2000**

Variable	Total (*N* = 5557)[a] Adjusted OR	Total *P*-value	Males (*n* = 2781) Adjusted OR	Males *P*-value	Females (*n* = 2776) Adjusted OR	Females *P*-value
Age group (years)						
20–39 = 1 (RC)	1.00		–	–	1.00	
40–59 = 2	2.83	< 0.001	2.93	< 0.001	3.04	< 0.001
≥ 60 = 3	2.61	< 0.001	2.43	< 0.001	3.85	< 0.001
Place of residence						
Urban = 0	–	–	–	–	–	–
Rural = 1	0.76	< 0.001	0.75	0.002	0.76	0.004
Work status						
Working = 0	–	–	–	–	–	–
Not working = 1	0.87	0.030	–	–	–	–
Education level						
Illiterate = 1 (RC)	–	–	1.00		1.00	
< Secondary = 2	–	–	1.40	0.003	1.04	0.747
≥ Secondary = 3	–	–	1.87	0.000	0.69	0.024
Marital status						
Single = 1	0.38	< 0.001	0.31	< 0.001	0.50	< 0.001
Divorced/separated = 2	1.22	0.200	0.82	0.478	1.51	0.032
Widowed = 3	1.24	0.080	1.15	0.685	1.07	0.628
Married = 4 (RC)	1.00		1.00		1.00	

[a]*The total number of subjects in the study was 7011, of whom 5660 (81%) completed the physical and laboratory measurements. However, the data of 3 subjects (0.05% of 5660 subjects) were not entered in the logistic regression models due to missing data in some of the independent variables.*
RC = Reference category

4.8% [*10*], whereas in our study, the prevalence of diabetes and hypertension were 11% and 25%, respectively. Only by identifying the distribution and correlates of clustering of CVD risk factors in a community-based study were we able to obtain an accurate estimate of the magnitude of the problem in both urban and rural settings.

ANOVA results showed that the mean values for diastolic blood pressure, fasting blood glucose, cholesterol, and BMI were significantly higher among subjects with ≥ 1 risk factor. Lee et al. found similar results in their study [*5*]. Poulter found that other cardiovascular risk factors, including obesity, smoking, glucose intolerance, physical inactivity and dyslipidaemias often coexist with hypertension in both older and younger age groups [*11*]. He concluded that this ‘clustering’ of risk factors for cardiovascular disease has major implications for treatment thresholds and choice of antihypertensive therapy.

In Italy, Pasini et al. studied the clustering of different combinations of CVD risk factors (systolic and diastolic hypertension, total cholesterol, cigarette smoking and obesity) among nationals aged 40–59

Table 4 **Adjusted odds ratio of factors significantly associated with subjects having ≥ 2 cardiovascular disease risk factors among different age groups, National Health Survey, Oman, 2000**

Variable	**20–39 years (*n* = 3367)**		**39–59 years (*n* = 1479)**		**≥ 60 years (*n* = 711)**	
	Adjusted OR	***P*-value**	**Adjusted OR**	***P*-value**	**Adjusted OR**	***P*-value**
Place of residence						
Urban = 0	–	–	–	–	–	–
Rural = 1	0.81	0.028	0.75	0.014	0.66	0.013
Education level						
Illiterate = 1 (RC)	–	–	1.00	–	–	–
< Secondary = 2	–	–	1.71	< 0.001	–	–
≥ Secondary = 31	–	–	2.88	< 0.001	–	–
Sex						
Male = 0	–	–	–	–	–	–
Female =1	0.73	< 0.001	1.29	0.038	1.70	< 0.001
Marital status						
Single = 1	0.36	< 0.001	–	–	–	–
Divorced/separated = 2	1.66	0.027	–	–	–	–
Widowed = 3	0.80	0.673	–	–	–	–
Married = 4 (RC)	1.00		–	–	–	–

The total number of subjects in the study was 7011, of whom 5660 (81%) completed the physical and laboratory measurements. However, the data of 3 subjects (0.05% of 5660 subjects) were not entered in the logistic regression models due to missing data in some of the independent variables.
RC = Reference category.

years [*12*]. When considering the prevalence of high SBP or DBP, high total cholesterol or cigarette smoking, he found that 72.3% of men and 67.7% of women had at least one of the main risk factors for coronary heart disease and usually higher values for SBP or DBP, whereas 29.3% of men and 21.2% of women had ≥ 2 factors. In our study, where the clustering of DBP, diabetes, overweight/obesity, and high fasting serum cholesterol was investigated, it was found that 72% of the total sample (aged ≥ 20 years) had ≥ 1 risk factor and 37.2% had ≥ 2 risk factors, a higher prevalence than reported in the Pasini study, despite that study's different clustering set and limited age group selection, which would be expected to increase rather than reduce prevalence.

Campos-Outcalt et al. studied another set of CVD risk factors (diabetes, hypertension, hypercholesterolaemia, obesity and smoking) clustering in a different age group among 230 Native Americans from a south-western tribe aged 25–65 years [*13*]. They found that 86% of the participants had ≥ 1 risk factor and 52% had ≥ 2 risk factors. The difference in results between this and our study can be explained by the different clustering set, the very large difference in sample size and the ethnic specificity of Native Americans, who were not a representative sample of the wider population of the United States of America.

Because of the importance of the clustering of CVD risk factors, Mancia concluded that the established major risk factors for CVD, hypertension, hypercholesterolaemia and smoking, are present, often in combination, in populations around the world [*14*]. He added that these factors have been found to interact in a synergistic manner to increase the risk of coronary heart disease. Mancia therefore, suggested that traditional antihypertensive treatments offered little protection against coronary heart disease, perhaps because antihypertensive drugs tend to be prescribed to reduce BP without taking account of the presence of other risk factors. However, it should be borne in mind that the Mancia study was conducted over 15 years ago (1988), and newer antihypertensive medications are increasingly targeting the co-occurrence of hypertension and other CVD risk factors.

Phillips et al. concluded that diabetic patients have a higher prevalence of CVD risk factors than those without diabetes, therefore requiring improved vigilance of diabetic patients and interventions to modify the associated risk factors [*15*]. Bog-Hansen et al. similarly reported a strong coexistence of hypertension and type 2 diabetes [*16*].

Regarding the demographic and social factors significantly associated with clustering in the present study, smoking was not significantly associated and is not shown in the logistic regression models in Table 3 and Table 4. Salgado-Sales found results similar to those in our study. He found that in Acapulco, Mexico, among 1011 women and 1001 men aged ≥ 20 years, the average levels of serum cholesterol were higher in older, overweight, hypertensive individuals and that the differences were statistically significant, but there was no difference in the cholesterol levels of individuals with tobacco smoking habits [*17*].

In our study, urban residence was significantly associated with clustering of CVD risk factors in the overall sample, in the male and female subsamples and in the different age group sub-samples, although this association was not statistically significant with each of the individual risk factors per se (data not shown). This is not necessarily contradictory. As el Mugamer et al. have previously observed for the United Arab Emirates, which has a similar culture to that of Oman, as socioeconomic development in the region intensifies, the difference in lifestyles between urban and rural residents is becoming increasingly blurred [*18*]. Abdul-Rahim et al. concluded that although no significant differences were found in the prevalence of hypertension and diabetes between urban and rural populations, other components of metabolic syndrome, namely elevated triglycerides, low HDL cholesterol and overall obesity were more prevalent in the urban population [*19*].

While being female gender was a protective factor in the younger 20–39-year-old age group (OR = 0.73, $P < 0.05$), it increased the clustering risk in the higher age groups, i.e. the 40–59-year-olds and those aged ≥ 60 years, where females were 1.3 and 1.7 times respectively more likely to have clustering than males in these age groups. This may be explained by the protective role of female sex hormones before the age of 40 years.

Having attained a higher level of education was protective for the female subsample (OR = 0.698, $P < 0.05$), while males who had attained a secondary education or above were 1.87 times more likely to have aggregated risk factors. This cannot be explained by the relatively young age of highly educated females in Oman, as the

OR was already age-adjusted for both genders. It could be explained by other psychosocial factors that should be addressed in future studies.

Conclusion and recommendations

Both diabetes mellitus and hypertension are important public health problems in Oman. There needs to be a heightening of the level of awareness among primary care physicians to be alert to the possible presence of these pathologies among their patients. General community awareness also needs to be raised about individual risk factors for diabetes and hypertension, and about their aggregated effect in the development of CVD.

Improving understanding and awareness among physicians and the general community will aid prevention, diagnosis and management of both diabetes and hypertension, and in turn CVD, and can potentially lead to a reduction in complications arising from these chronic conditions. Disseminating to physicians the results shown in the logistic regression models of those factors significantly associated with clustering will aid in their ability to predict the presence of clustering and prompt them to more closely monitor patients at risk. This will lead to more efficient registration and management of chronic diseases at the primary care level.

Medical practitioners should always suspect clustering of CVD risk factors in patients who are aged ≥ 40 years, married and living in an urban setting. Having an urban place of residence was a common risk factor in all models used in this study.

Improving community awareness of the problem by health education campaigns is essential if the prevalence of CVD risk factors and the burden of CVD in the general population are to be reduced. Patient education and a coordinated approach by physicians, nurses and other healthcare providers in a multidisciplinary approach to the treatment of obese patients are also of fundamental importance to reduce the prevalence of CVD in the population. Abdominal obesity is the earliest symptom of metabolic cardiovascular syndrome. Prevention or early treatment of such obesity can prevent or delay the onset of diseases associated with the syndrome. Vigilance and effecting positive behavioural change, not always easily achieved, are key factors in the prevention, early diagnosis, and reduced complications of risk factors leading to CVD.

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