**Prevalence and correlates of diabetes and its comorbidities in four Gulf Cooperation Council countries: Evidence from the World Health Survey Plus**

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**ABSTRACT**

**Background:** The Gulf Cooperation Council (GCC) countries are witnessing unprecedented changes due to fast economic development and population growth. The aims of this study were two-fold: firstly to estimate the prevalence of diabetes and its comorbidities. Second, to examine the association of socio-demographic risk factors and healthcare service utilization with diabetes.

**Methods:** Data from the World Health Survey Plus (WHS+) from Kuwait, Oman, Saudi Arabia and the United Arab Emirates were used. The WHS+ is a nationally representative household survey of the adult population, conducted between 2008 and 2009. Both logistic regression and zero-inflated Poisson models were applied to examine associations of risk factors, comorbidity and treatment with self-reported diabetes.

**Results:** The highest level of diabetes was observed in Kuwait, with 40.8% amongst the oldest age group. High BMI, older age and low education were all associated with diabetes in all settings. High levels of comorbidity existed within the diabetic population. Over 50% of diabetics in all countries reported having at least one chronic condition. In Kuwait and Saudi Arabia one in five diabetics reported having two or more co-morbidities. Treatment prevalence was above 80% across all socio-demographic categories.

**Conclusion:** The burden of diabetes, although high, is not uniform across populations in the four Gulf countries. Differential exposure to risk, such as unhealthy lifestyles, may be creating a disadvantage for certain populations and influencing the co-occurrence of chronic conditions. In response, a multifaceted and patient-centred approach is needed at all levels of health care to control and prevent non-communicable diseases.

**What is already known on this subject?**

Diabetes in the Gulf region is one of the highest in the world. However, comparative studies into the social determinants of diabetes are lacking. This study uses the World Health Survey Plus to provide evidence on the socio-demographic correlates of self-reported diabetes, treatment and co-morbidities in Kuwait, Oman, Saudi Arabia and the United Arab Emirates.

**What this study adds?**

The comparability of the data used across the four Gulf Cooperation Council countries sheds light on the underlying differences in prevalence. The high prevalence of obesity and co-occurrence of comorbidity amongst the diabetic population across the region is equally surprising, pointing towards a tailored approach to NCDs, and horizontal programming that strengthens the control of diabetes and co-occurring conditions in the region.

**INTRODUCTION**

Globally, there are 415 million currently estimated to be living with diabetes and this figure is set to rise to approximately 642 million by 2040.[1] Whilst the literature points to a need for more representative surveillance data on diabetes globally, reported figures suggest an upward trend over the last two decades in some GCC countries. Notably, in Saudi Arabia, diabetes prevalence increased from 9% to 22% in both males and females, between 1980 and 2008; and in Kuwait, prevalence increased from 10% to 17% in males and 9% to 15% in females over the same period.[2]

Diabetes is considered to be a multifactorial disease, caused by exposure to a combination of genetic and environmental risk factors.[3, 4] Whilst the global diabetes epidemic is linked to the changes associated with rapid economic development, such as increased urbanisation,[5] lifestyle-related factors include, but are not limited to, changes in diet, physical activity and tobacco smoking.[6-9]

Furthermore, poorer health outcomes are associated with inadequate access to treatment, as well as its improper compliance.[10] Despite substantial investments in health-care infrastructure during the past 25 years, the Gulf Cooperation Council (GCC) governments are still faced with the three drivers that will dramatically increase health-care demand in the region: population growth, aging, and health-related risk factors.[11, 12] Related to the latter, the ‘nutrition transition’ characterises a move towards greater consumption of energy-dense foods, high in saturated fat and salt.[13] The result is an increasingly obesogenic environment, which places the individual, and society, at greater risk of diabetes. In a recent systematic review, examining the prevalence of Type 2 diabetes in the Arab States of the Gulf, prevalence ranged between 4.3% in 1980 to 34.9% in 2009. Consistent with other studies,[14] diabetes increased with age, whilst urban residence was also associated with higher prevalence [15] In the case of Type 2 diabetes, however, obesity is the most commonly attributed risk factor. [16] The prevalence of Type 2 diabetes and obesity amongst nationals living in the GCC region is unusually high relative to the rest of the world. The reported obesity prevalence for GCC nationals stands at 40% - one of the highest in the world.[14] The implications are that healthcare and social costs associated with both diabetes and obesity will dramatically increase in the next decade. Furthermore, the co-occurrence of diabetes and other chronic conditions is common, which has further implications for the healthcare delivery system.[17]

A recent World Bank report indicates that, in 2012, Kuwait had the highest national GDP per capita of approximately USD51,264; compared to USD22,134 in Oman; USD25,303 in Saudi Arabia and USD42,086 in the United Arab Emirates (UAE). All were classified as high-income countries according to the report. [18] All countries have similar life expectancies at birth, in 2012, at 74.2, 76.1, 73.9 and 76.7; for Kuwait, Oman, Saudi Arabia and UAE, respectively. However, health care expenditure is generally lower than that of other high-income countries. For example, compared to the UK, whose national health expenditure is close to 9.7% of GDP, the GCC countries have much lower levels at: 2.7% in Kuwait; 2.3% in Oman; 3.7% in Saudi Arabia; and 3.3% in UAE. Across all GCC countries, health services are provided at free cost for nationals, whilst health insurance is available for expatriates (non-nationals), who constitute approximately 50% of the total population across the GCC countries in 2017. [19]

To our knowledge, however, there have been no comparative studies estimating the distribution of diabetes in GCC countries. The aim of this paper was to estimate the prevalence and correlates of self-reported diabetes, its comorbidities, and associated healthcare service access: in Kuwait, Oman, Saudi Arabia and UAE; by using nationally representative, and comparative populations from the World Health Survey Plus.

**DATA AND METHODS**

**Study population and data**

The World Health Survey Plus (WHS+) were conducted across five Gulf Cooperation Council (GCC) countries including Kuwait, Qatar, Oman, Saudi Arabia and UAE, between 2008 and 2009, with the technical support of the World Health Organisation. Owing to differences in methodology, the Qatar survey was omitted from the final analysis. In all four remaining countries, the survey covered both the national and non-national adult populations, producing nationally representative samples. With the exception of Kuwait, where simple random sample was used, a 3-stage sample design was implemented. Clusters (enumeration areas) were randomly selected with probability proportion to size (PPS); a fixed sample of households was randomly selected from each cluster and eligible individuals (18+ years old) were selected using Kish-tables. In both Oman and Saudi Arabia the sample was stratified by place of residence, and in UAE and Kuwait, the sample was stratified by national and non-national. In each selected household, face-to-face interviews were conducted with the head of the households or the most knowledgeable person and the selected eligible individual. The individual questionnaire covered their demographic and socioeconomic background; in-depth questions on health status; chronic conditions; and utilization of the health system. The sample sizes for the four countries in our analyses were: Kuwait (n=3828), Oman (n= 4717), Saudi Arabia (n=8629), and the United Arab Emirates (n=2569).

**Measures and variables**

In this analysis we have used self-reported diabetes alongside other chronic conditions (angina, arthritis, asthma, chronic lung disease, depression, hypertension and stroke) which were ascertained through responses to the questions, “Have you ever been diagnosed with…?” Respondents were also asked whether they were currently using treatment for the self-reported chronic conditions. The *treatment of diabetes* was examined in the results by asking “whether they had used insulin, or other blood sugar lowering medications, within the last two weeks?”.

The demographic variables included were participant’s *age, sex, nationality, marital status,* and *residence* (living in an ‘*urban*’ or ‘*rural*’ area; not available for Kuwait as all areas are classified as urban). Social and economic variables included *highest* *level of education achieved (primary school, secondary school, higher education)*. A wealth index score, based on a principal components analysis of assets for each household, was developed; this was the preferred method due to the presence of high missing data on expenditure and income. Using the wealth index score, a *wealth* variable was generated by grouping wealth into three equally sized groups: *poor, average* and *rich*. Body Mass Index (BMI) was included as a behavioural risk variable. Both height and weight were measured three times for each individual; all three measurements were then used to calculate an average BMI based on weight/ height 2. If an individual had a BMI of less than 25 they were classified as *normal*; between 25-30, *overweight*; and above 30, *obese.*

**Statistical Analyses**

To compare prevalence rates across heterogeneous populations, age and sex standardized prevalence were computed using the WHO age and sex standard population. Logistic regression was applied to examine the association between diabetes and selected socio-economic characteristics and behavioural variable. For the analysis of comorbidity, Zero-Inflated Poisson (ZIP) models were used to examine the associations between the presence of diabetes, explanatory variables and the number of comorbidities as excess zeros (over dispersion) amongst comorbidities were exhibited. All analyses were weighted using the survey-specific design weight and clustering using STATA version 13 [20]. All tables report both the *odds ratios (ORs)* Incidence Rate Ratios (IRRs) and 95% CIs, where applicable.

**RESULTS**

The standardised prevalence of diabetes is highest in Kuwait 15.3% (13.9% – 16.8%), followed by the UAE 13.2% (11.4% – 15.2%), Saudi Arabia 10.5% (9.6% – 11.4%) and Oman 8.5% (7.4% – 9.8%). The prevalence of diabetes by social, demographic, economic and behavioural risk factors are presented in Table 1. Across all countries, diabetes prevalence increased significantly by age and decreased by level of education. Diabetes prevalence was highest amongst nationals in all countries, except for Oman. By wealth, the patterns were fairly consistent: diabetes prevalence was highest amongst the wealthiest and lowest amongst the poorest. The exception was in Saudi Arabia, where there was less distinction between the average and richest categories. Furthermore there was a gradient in BMI such that diabetes prevalence was highest amongst those with high BMI, as expected.

[Insert Table 1]

Table 2 shows the adjusted Odd Ratios (ORs) for the association between diabetes and age, sex, BMI, wealth and education. Age was significantly associated with diabetes across all countries. BMI was also significantly associated with self-reported diabetes; ORs increased by category of BMI. In all countries, education was negatively associated with self-reported diabetes. No significant association was shown by sex in all countries. Similarly, there appeared to be no distinct gradient in wealth.

[Insert Table 2]

Treatment levels are shown in Table 3, which were high across all countries, overall, and by the background characteristics. The percentage of diabetics reporting treatment ranged from 51.1% (those from a highest education category living in the UAE) to approximately 98.2% (those from the age category 18-29 in Oman). Age was found to be statistically significant across the countries, although there was no clear consistent gradient. Treatment was also similar amongst nationals versus non-nationals, across all countries, except for the UAE. In the UAE, however, there was a wealth gradient in treatment: being treated for diabetes was more strongly associated with being in the wealthiest group.

[Insert Table 3]

Table 4 shows the prevalence of self-reported non-communicable disease, and extent of comorbidities, by diabetes status. The co-occurrence of other chronic conditions was most common for diabetics in comparison to non-diabetics. The differential between the two groups was highest for hypertension and arthritis. For example, prevalence of hypertension was 52.1% in Kuwait, 35.8% in Oman, 40.5% in Saudi Arabia, and 41.1% in UAE, for diabetics; *versus* 7.3% in Kuwait, 6.9% in Oman, 5.0% in Saudi Arabia, and 7.2% in UAE, for non-diabetics.

Over half of all diabetics reported having another chronic disease. In Kuwait, comorbidity was absent in approximately 76.5% of non-diabetics, compared to 28.6% of diabetics (Table 4). Across all countries, the distribution of individuals with at least one other comorbidity was similar. Over one in five diabetics in Kuwait and Saudi Arabia reported two or more co-morbidities.

[Insert Table 4]

Table 5 shows results from the ZIP model investigating the association of number of chronic comorbidities with diabetes and other concomitant variables. The presence of diabetes is associated with an excess of comorbidities, and the incidence of comorbidities increases with age, is higher among females and lower among non-nationals. None of the socio-economic variables are associated with number of comorbidities.

 [Insert Table 5]

**DISCUSSION**

There were several notable discussion points, which add to the previous literature on diabetes in the respective GCC countries. First, there was a relatively wide variation in the estimated prevalence of diabetes across the GCC countries, even after controlling for differences in population age structure. In all countries the standardised prevalence of diabetes was high, as expected [21], but the fact that there is a wide variation in diabetes prevalence between the four GCC countries involved in this study indicate that a one-fit policy option may not guarantee effectiveness in the prevention of diabetes in these four countries; rather that each country should test the transferability and the applicability of each policy before implementation. Second, consistent with the literature, the co-occurrence of chronic conditions with diabetes was high.[22-23] This may be explained by the shared lifestyle risk factors, notably inadequate nutrition and lack of physical activity: particularly those related to the cardio-metabolic cluster (e.g. angina, hypertension, stroke) where the prevalence difference between the diabetic, versus the non-diabetic, population was highest.[24] One study finding further supports this possible explanation; even after controlling for diabetes, higher BMI was more positively associated with co-occurring chronic conditions. The World Health Organisation states that “diabetes management should be integrated with management of other NCDs” [p.54, 25], and this study confirms that this strategy is required within these GCC countries. This necessitates an integrated health system with clear referral pathways between health providers and levels of care.

Third, there were some similarities in the associations of social, economic and behavioural factors. Unlike many high-income countries (HICs), where an inverse social gradient exists, there is a positive gradient between doctor-diagnosed diabetes and wealth in GCC countries. This suggests that the underlying drivers of diabetes confer a disadvantage amongst the wealthy. Previously believed to be a ‘disease of affluence’ in developing countries, the literature reporting the wealth association within the GCCs is limited, however. Therefore, the study provides unique evidence to suggest a socioeconomic gradient that merits further investigation.[26] Fourth, as expected, there is a consistent relationship with age, with the odds of an individual, aged over 60 reporting diabetes, far exceeding those of younger ages, which suggests that tackling diabetes should be a response to the increasing ageing population. Fifth, BMI was significantly associated with diabetes, in all countries, although the gradient was less apparent in the UAE, even after controlling for other factors. Rather than there being a consistent story throughout the region, this points to a complexity in understanding the determinants, and further points to unique political, social and economic contexts within the GCC region. Finally, it was encouraging to note a lack of social gradient related to the treatment of diabetes, indicating that at the population level, there may more equitable across the four countries than previously expected. In contrast to previous discourse claiming that non-nationals are disadvantaged in terms of health-care access, diabetes treatment was similar for both nationals and non-nationals in all countries (with the exception of the UAE). [27]

One strength of the study included the comparability of the data across the GCC countries, as well as the use of validated anthropometric measures; allowing for the variation of diabetes and its correlates to be estimated within these four countries. To date, there have been no studies comparing the distribution of diabetes and its comorbidities across GCC countries. These estimates, however, reflect the time of data collection and it’s expected that levels of diabetes have increased since.[28] Furthermore, in different areas of the Middle East and North Africa (MENA) region, it is estimated that up to 50% of diabetics are unaware of their condition.[29] Therefore caution must be used when interpreting this and the rest of the results, as these study only the diagnosed population, which may be very different in characteristics from the undiagnosed population. This issue is also true for the estimates of comorbidities reported here, which are also based on doctor-diagnosed conditions. Differential health access in different population groups may also be responsible for the variations in diabetes between groups. Furthermore, certain population groups may have been excluded from the survey, such as domestic workers or those working in labour camp. Although the levels recorded from the surveys analysed here are likely to be an underestimate, the results indicate that behaviour and socio-economic status are closely related to reported diabetes status in all settings. A further limitation was also the lack of information about the diabetes (e.g. Type), which would also help to identify the priority areas for the health care system.

This study provides evidence of a multimorbid population amongst those living with diabetes in the GCC countries. For these countries, the accumulation of risk may be creating a disadvantage amongst diabetic populations which commonly suffer from co-occurring chronic conditions. Therefore, health systems in the GCC need to respond by providing continuous care; that not only tackles diabetes care, but triggers earlier prevention for, and care of, other common co-occurring conditions. These may be directly related to the causes of diabetes, such as cardiovascular disease [25], or a consequence of the disease, such as depression.[30] Furthermore, for diabetes patients specifically, failure to adhere to treatment results in poor health outcomes.[31] Proper self-management can improve diabetes control, although such practice is also dependent upon the availability of, and access to, trained personnel.[32] Although treatment of diabetes appeared to be high across all groups, previous evidence suggests that in Saudi Arabia, Kuwait, and the United Arab Emirates diabetes care is poor, evidenced by poor glycaemic control and common diabetes complications.[33] Health systems in the GCC therefore need to be optimally orientated to provide diabetes care within the community through the appropriate primary care facilities; considering possible barriers to access for non-nationals, who constitute a high proportion of the total population across the region. Amongst this population, however, health insurance is still not mandatory across the GCC, which could potentially undermine national efforts to screen, and therefore reduce the population impact, of diabetes altogether. This includes promoting fair and equitable access to both screening and treatment, particularly for populations that may be at greater risk. In GCC countries, the mortality rate from NCDs is still one of the highest in the world.[34-35] This is primarily due to the unhealthy lifestyles, including physical inactivity, high caloric diet, lack of focus on health prevention and disease management, weak primary health care infrastructure, and inadequate treatment options to manage NCDs and their complications.[17, 36-39] Despite both national and regional efforts to prevent NCDs, few countries in the GCC region are committed to respond to tackle diabetes with the urgency required. National policies and planning should tackle the shared determinants of diabetes and their common comorbidities, including collaborating with the private sector and special interest groups in order to limit the availability of unhealthy food and improve the environment. To tackle this, a multifaceted and patient-centred approach is needed at all levels of health care to control and prevent NCDs.[40]

**Conclusion**

The level of diabetes in the Gulf region is extremely high in comparison to many countries around the world. Health care systems in GCC member states are facing enormous challenges in meeting the increasing health care demands of diabetes and its comorbidities, especially due to population growth and ageing. Developing and implementing strategic plans to improve the care system in GCC states to ensure a comprehensive approach to diabetes and associated non-communicable diseases is recommended on an urgent basis. As such, plans should focus on shifting the service modality from hospital to primary care, from reactive to proactive services and from radar care to continuity of care.[41]

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**Competing Interests**

None declared

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**Table 1: Prevalence of self-reported diabetes by correlates (social, economic, demographic and behavioural risk factors)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   |   | **Kuwait** | **Oman** | **Saudi Arabia** | **UAE** |
|  | **n** | **Prevalence, % (CI)** | **n** | **Prevalence, % (CI)** | **n** | **Prevalence, % (CI)** | **n** | **Prevalence, % (CI)** |
| **Diabetes, standardised %** | 3828 | 15.3 (13.9 – 16.8) | 4717 | 8.5 (7.4 – 9.8) | 8629 | 10.5 (9.6 – 11.4) | 2541 | 13.2 (11.4 – 15.2) |
| **Age** | 18-29 | 1173 | 2.4 (1.5 - 3.7) | 1756 | 0.5 (0.2 - 1.6) | 2604 | 0.7 (0.4 - 1.2) | 680 | 1.4 (0.7 - 2.8) |
|  | 30-39 | 975 | 3.8 (2.6 - 5.5) | 1243 | 1.8 (1.0 - 3.2) | 2481 | 2.8 (2.1 - 3.7) | 834 | 4.5 (3.1 - 6.6) |
|  | 40-49 | 772 | 11.6 (9.4 - 14.3) | 751 | 8.1 (5.5 - 11.7) | 1875 | 7.7 (6.4 - 9.1) | 583 | 7.5 (5.3 - 10.5) |
|  | 50-59 | 535 | 26.2 (21.8 - 31.1) | 503 | 21.4 (16.6 - 27.2) | 969 | 18.7 (16.0 - 21.7) | 324 | 24.2 (18.4 - 31.0) |
|  | 60+ | 374 | 40.8 (34.9 - 47.0) | 464 | 18.3 (13.6 - 24.1) | 701 | 28.9 (25.4 - 32.7) | 158 | 38.1 (28.4 - 48.8) |
| **BMI** | <25 | 876 | 5.1 (3.7 - 7.0) | 2178 | 4.1 (3.0 - 5.5) | 3076 | 3.8 (3.1 - 4.7) | 386 | 6.6 (3.9 - 10.9) |
|  | 25-30 | 1270 | 9.2 (7.5 - 11.3) | 1382 | 6.7 (4.8 - 9.1) | 3111 | 7.4 (6.5 - 8.6) | 484 | 10.5 (7.6 - 14.2) |
|  | 30+ | 1168 | 18 (15.5 - 20.8) | 1007 | 9.3 (7.0 - 12.2) | 2295 | 10.3 (9.0 - 11.7) | 400 | 14.4 (10.5 - 19.3) |
| **Sex** | Male | 1743 | 10.2 (8.6 - 12.1) | 2451 | 6.5 (5.1 - 8.3) | 4923 | 7 (6.3 - 7.9) | 1207 | 9 (7.2 - 11.2) |
|  | Female | 2085 | 13.0 (11.4 - 14.8) | 2266 | 6.3 (5.0 - 7.6) | 3706 | 7.2 (6.3 - 8.3) | 1372 | 8.8 (7.0 - 11.0) |
| **Nationality** | National | 2518 | 14.0 (12.5 - 15.7) | 3771 | 6.3 (5.3 - 7.5) | 5609 | 8.5 (7.8 - 9.4) | 1208 | 12.9 (10.7 - 15.5) |
|  | Non-national | 1310 | 7.2 (5.7 - 9.2) | 946 | 6.7 (4.6 - 9.6) | 3020 | 4.5 (3.7 - 5.4) | 1371 | 5.4 (4.0 - 7.2) |
| **Wealth** | Poorest | 1183 | 9.4 (7.1 - 10.9) | 1813 | 5.2 (3.7 - 7.4) | 3446 | 5.6 (4.8 - 6.6) | 795 | 6.4 (4.3 - 9.2) |
|  | Average | 1159 | 11.6 (19.9 - 14.4) | 1830 | 6.2 (4.6 - 8.1) | 3468 | 8.2 (7.2 - 9.2) | 934 | 6.8 (5.1 - 8.9) |
|  | Richest | 1487 | 13.1 (11.8 - 16.1) | 1822 | 7.1 (5.6 - 9.1) | 1716 | 8.0 (6.7 - 9.6) | 851 | 13.6 (10.9 - 16.8) |
| **Education** | Primary or less | 525 | 31.5 (26.8 - 36.9) | 2214 | 10.7 (8.9 - 12.8) | 3320 | 11.6 (10.4 - 12.9) | 473 | 25.1 (20.4 - 30.4) |
|  | Secondary | 1942 | 9.7 (8.1 - 11.4) | 1825 | 2.2 (1.4 - 3.3) | 3338 | 4.2 (3.5 - 5.0) | 852 | 6.3 (4.6 - 8.5) |
|  | Higher than secondary | 1361 | 7.0 (5.7 - 8.6) | 678 | 6.3 (4.0 - 9.8) | 1971 | 4.5 (3.5 - 5.7) | 1255 | 4.7 (3.3 - 6.5) |
| **Marital status** | Currently married | 2714 | 12.4 (11.0- 14.0) | 3080 | 5.4 (4.0 - 7.2) | 6261 | 4.7 (3.8 - 5.7) | 2025 | 8.6 (7.2 - 10.3) |
|  | Not currently married | 1114 | 10.1 (8.2 - 12.3) | 1637 | 6.9 (5.7 - 8.5) | 2368 | 8.0 (7.3 - 8.9) | 554 | 9.8 (6.9- 13.8) |
| **Residence** | Urban |   | N/A | 2739 | 7.0 (5.8 - 8.5) | 7031 | 7.0 (6.4 - 7.7) | 1251 | 7.2 (5.5 - 9.4) |
|  | Rural |   | N/A | 1978 | 4.4 (3.5 - 5.6) | 1598 | 7.5 (6.0 - 9.2) | 1328 | 10.5 (8.7 - 12.8) |

Footnote: Residence status not included in the Kuwait dataset. Diabetes prevalence was adjusted for age and sex according to the WHO Population Statistics.

**Table 2: Effect of correlates on self-reported diabetes: Odds ratio in multivariable analysis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | **Kuwait** | **Oman** | **Saudi** | **UAE** |
| **Age (OR)** 18-29 as reference | 30-39 | 1.8 (1.0 - 3.4) | 3.9 (0.9 - 15.8)  | 4.4 (2.3 - 8.4)\*\*\* | 4.6 (1.7 - 11.9)\*\*\* |
| 40-49 | 6.3 (3.7 - 10.6)\*\*\* | 18.0 (4.7 - 69.8)\*\*\* | 13.1 (6.9 - 24.8)\*\*\* | 7.9 (3.4 - 18.3)\*\*\* |
| 50-59 | 15.8 (9.4 - 26.7)\*\*\* | 56.2 (15.3 - 206.3)\* | 36.2 (19.3 - 68.0)\*\*\* | 28.0 (11.8 - 66.4)\*\*\* |
| 60+ | 28.8 (17.1 - 48.5)\*\*\* | 47.4 (13.7 - 163.4)\*\*\* | 58.3 (31.4 - 108.1)\*\*\* | 43.3(18.7 - 100.3)\*\*\* |
| **BMI (OR)**<25 as reference | 25-30 | 1.8 (1.2 - 2.7)\*\* | 1.5 (1.0 - 2.5) | 1.9 (1.4 - 2.5)\*\*\* | 1.6 (0.8 - 3.2) |
| 30+ | 3.7 (2.5 - 5.5)\* | 2.3 (1.4 - 3.5)\*\*\* | 2.5 (1.9 - 3.3)\*\*\* | 2.0 (1.0 - 3.9)\* |
| **Sex (OR)**Male as reference | Female | 1.2 (0.9 - 1.5) | 0.9 (0.7 - 1.3) | 0.9 (0.7 - 1.1) | 1.0 (0.7 - 1.5) |
| **Wealth (OR)**Poorest | Average | 0.9 (0.6 - 1.4) | 1.1 (0.7 - 1.8) | 1.2 (1.0 - 1.5)\* | 0.9 (0.5 - 1.5) |
| Richest | 0.9 (0.6 - 1.4) | 1.2 (0.7 - 2.0) | 1.2 (0.9 - 1.5) | 1.4 (0.8 - 2.3) |
| **Education (OR)**Primary education as reference | Secondary | 0.2 (0.2 - 0.3)\*\*\* | 0.2 (0.1 - 0.3)\*\*\* | 0.3 (0.3 - 0.4)\*\*\* | 0.2 (0.1 - 0.3)\*\*\* |
| Higher than secondary | 0.2 (0.1 - 0.2)\*\*\* | 0.4 (0.3 - 0.7)\*\* | 0.3 (0.3 - 0.5)\*\*\* | 0.2 (0.1 - 0.3)\*\*\* |

**Footnote: All models adjusted for nationality, residence (governorate in Kuwait), and marital status.**

 **\* = p<0.05; \*\* = P<0.01; \*\*\* = P<0.001; NS = Not Significant**

**Table 3: Treatment of self-reported diabetes by correlates, shown as percentages**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Category** |  | **Kuwait** | **Oman**  | **Saudi Arabia** | **UAE** |
| Age |  | ***\**** | ***\**** | ***\**** | ***\**** |
| 18-29 | 89.7 (24) | 98.2 (7) | 61.1 (13) | 55.5 (12) |
| 30-39 | 69.8 (40) | 78.5 (23) | 85.5 (65) | 57.4 (37) |
| 40-49 | 81 (96) | 66.8 (59) | 89.8 (149) | 76.6 (50) |
| 50-59 | 91.5 (119) | 91.2 (97) | 89 (181) | 88.6 (77) |
| 60+ | 92.2 (143) | 84.8 (69) | 90.8 (208) | 83.3 (54) |
| BMI |  | *NS* | *NS* | *NS* | *NS* |
| <25 | 76.7 (42) | 84.7 (74) | 92.8 (120) | 73.9 (28) |
| 25-30 | 87.6 (110 | 85.9 (78) | 86 (223) | 87.7 (53) |
| 30+ | 89.3 (200) | 80.6 (88) | 89 (243) | 82.2 (51) |
| Sex |  | *NS* | *NS* | *NS* | *NS* |
| Male | 84.6 (166) | 81.2 (137) | 90.5 | 80.6 (109) |
| Female | 89.9 (256) | 85.2 (118) | 86.1 | 76.3 (121) |
| Nationality |  | *NS* | *NS* | *NS* | *\*\*\** |
| National | 88.6 (335) | 84.1 (207) | 88.6 (347) | 88.3 (155) |
| Non-national | 84.7 (87) | 80.9 (48) | 88.4 (269) | 57.8 (75) |
| Wealth |  | *NS* | *NS* | *NS* | *\*\** |
| Poorest | 88.5 (1313) | 90.5 (68) | 84 (199) | 58.9 (43) |
| Average | 88.7 (1230) | 72.6 (90) | 89.2 (290) | 76.4 (72) |
| Richest | 86 (1253) | 86.2 (97) | 90.8 (127) | 88.3 (115) |
| Education |  | *NS* | *NS* | *NS* | *\*\*\** |
| Primary or less | 93.4 (148) | 84.5 (187) | 89 (399) | 87.4 (120) |
| Secondary | 83.1 (179) | 83.9 (40) | 85.8 (135) | 88.6 (54) |
| Higher than secondary | 87.4 (95) | 76.4 (28) | 91.2 (82) | 51.1 (56) |
| Marital Status |  | *\*\** | *NS* | *NS* | *NS* |
| Currently married | 96.1 (117) | 79 (186) | 89 (117) | 83.1 (177) |
| Not currently married | 85 (305) | 84.8 (69) | 88.5 (499) | 77 (53) |
| Residence |  |  | *NS* | *NS* | *NS* |
| Urban | N/A $ | 83.6 (170) | 89.3 (505) | 71.2 (97) |
| Rural | N/A | 81 (85) | 85.7 (111) | 83.1 (133) |

**$ - Footnote: ‘NS’ – not significant**

**Table 4: Presence of self-reported non-communicable disease by diabetic status**



**Table 5: Incident Rate Ratios (IRR) for the number of co-morbidities by socioeconomic and demographic factors**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Number of comorbidity | **Kuwait** |  |  |  | **Oman** |  |  |  | **Saudi Arabia** |  |  | **UAE** |   |   |
| IRR | 95%CI |   | IRR | 95%CI |   | IRR | 95%CI |   | IRR | 95%CI |
| **Age group (years)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 30-39 | 1.45 | (1.06 | 1.97) |  | 1.71 | (1.11 | 2.65) |  | 1.37 | (1.19 | 1.59) |  | 1.70 | (1.07 | 2.72) |
|  | 40-49 | 1.80 | (1.38 | 2.37) |  | 4.26 | (3.00 | 6.06) |  | 1.85 | (1.59 | 2.15) |  | 1.89 | (1.14 | 3.11) |
|  | 50-59 | 2.80 | (2.14 | 3.67) |  | 5.68 | (3.95 | 8.17) |  | 3.22 | (2.76 | 3.76) |  | 2.21 | (1.32 | 3.70) |
|  | 60+ | 3.23 | (2.44 | 4.27) |  | 9.75 | (6.97 | 13.64) |  | 4.33 | (3.71 | 5.05) |  | 4.50 | (2.76 | 7.32) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **BMI** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Overweight | 1.13 | (0.87 | 1.46) |  | 1.22 | (0.97 | 1.52) |  | 1.04 | (0.93 | 1.16) |  | 1.09 | (0.75 | 1.60) |
|  | Obese | 1.41 | (1.10 | 1.80) |  | 1.47 | (1.10 | 1.96) |  | 1.54 | (1.38 | 1.71) |  | 1.79 | (1.20 | 2.69) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Sex** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Female | 1.35 | (1.16 | 1.58) |  | 1.31 | (1.07 | 1.61) |  | 1.18 | (1.08 | 1.29) |  | 1.32 | (1.00 | 1.75) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Nationality** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Non-national | 0.58 | (0.44 | 0.76) |  | 0.43 | (0.32 | 0.59) |  | 0.75 | (0.67 | 0.83) |  | 0.81 | (0.56 | 1.17) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Education** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Secondary/High | 1.01 | (0.85 | 1.20) |  | 0.87 | (0.62 | 1.23) |  | 0.81 | (0.72 | 0.90) |  | 0.78 | (0.55 | 1.11) |
|  | College+ | 0.75 | (0.61 | 0.92) |  | 0.89 | (0.66 | 1.22) |  | 0.69 | (0.61 | 0.79) |  | 0.86 | (0.57 | 1.30) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Marital Status** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Currently married | 1.04 | (0.87 | 1.24) |  | 0.89 | (0.71 | 1.12) |  | 0.94 | (0.85 | 1.04) |  | 0.95 | (0.71 | 1.27) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Wealth** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Average | 0.99 | (0.81 | 1.21) |  | 1.27 | (1.03 | 1.57) |  | 1.15 | (1.02 | 1.30) |  | 1.20 | (0.81 | 1.79) |
|  | Richest | 1.04 | (0.83 | 1.30) |  | 1.10 | (0.87 | 1.39) |  | 1.30 | (1.13 | 1.48) |  | 1.12 | (0.72 | 1.75) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Constant** | 0.31 | (0.21 | 0.45) |  | 0.07 | (0.05 | 0.11) |  | 0.18 | (0.15 | 0.22) |  | 0.18 | (0.08 | 0.40) |
|  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| **inflate** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Diabetic | -28.32 | -29.06 | -27.57 |  | -35.59 | -36.6 | -34.56 |  | -- | -- | -- |  | -21.84 | -23.01 | -20.67 |
|  | Constant | -0.38 | -0.69 | -0.08 |  | -1.23 | -2.0 | -0.47 |  | -1.27 | -1.56 | -0.97 |  | -0.64 | -1.32 | 0.05 |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

Footnote: ‘--‘ the ZIP results for Saudi produced wider CIs due to model instability; Missing BMI were excluded from the model