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Urban–rural differences in the prevalence of diabetes mellitus among 25–74 year-old adults of the Yangon Region, Myanmar: two cross-sectional studies

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ABSTRACT

Objectives To investigate the association between urban–rural location and the occurrence of diabetes mellitus (DM) in the Yangon Region, and to estimate the proportion of urban and rural participants already diagnosed with DM, and of those, the proportion under treatment and under control.

Design Two cross-sectional studies, using the WHO STEPs methodology.

Setting The Yangon Region of Myanmar, urban and rural areas.

Participants Men and women, aged 25–74 years, included during the study period from September–November 2013 (urban) and 2014 (rural areas) (n=1372). Institutionalised people, physically and mentally ill person, monks and nuns were excluded.

Results The age-standardised prevalence of DM was 12.1% in urban and 7.1% in rural areas (p=0.039). In urban areas, the prevalence of DM was lowest in the highest educational groups (p<0.001). There were no differences in DM prevalence between gender or income levels. In rural areas, those who were physically inactive had a low intake of fruit and vegetable and were overweight/obese had a higher DM prevalence than others. In a logistic regression, the OR for DM in rural compared with urban areas was 0.38 (0.22, 0.65), adjusted for sociodemographic variables and behavioural risk factors. In urban areas, 43.1% of participants had the experience of receiving blood glucose measurements by a doctor or health worker, and 61.5% of all cases of DM were already diagnosed, 78.7% were under treatment and 45.8% were under control. The corresponding proportions in rural areas were 26.4%, 52.4%, 78.1% and 32.0%, respectively.

Conclusion The prevalence of DM in the Yangon Region was high, and significantly higher in urban than in rural areas. More health services are needed to serve this population with a large proportion of undiagnosed diabetes. Preventive measures to halt and reduce the prevalence of DM are urgently needed.

Strengths and limitations of this study

- The study followed the internationally recommended WHO STEP protocol.
- A national reference laboratory was used for the investigation of fasting plasma glucose.
- Both urban and rural areas were included.
- Because the results were from only one region of Myanmar, the results might not be generalised to the entire Myanmar population.

INTRODUCTION

Urbanisation influences lifestyle and socioeconomic position and is one of the drivers of a country's health transition.[1 2] The advantages of urbanisation include better access to healthcare services, education and social services.[2] On the other hand, adverse changes such as nutrition transition with an increase in the consumption of saturated fats and sugar and a more sedentary lifestyle are reported worldwide.[3] The net effect of urbanisation is an epidemiological transition towards increasing rates of obesity and non-communicable diseases (NCDs), including diabetes mellitus (DM) type II.

According to the WHO, DM was the sixth most important cause of global deaths in 2015.[4] In 2017, there were 146 million people with DM in rural areas, while 274 million people lived with DM in urban areas.[5] The global prevalence of DM is estimated to increase from 8.8% in 2015 to 10.4% in 2040, equaling 642 million people.[5] In the WHO South-East Asia Region (SEAR), the number of people living with DM increased from 17 to 96 million between 1980 and 2014.[6] Half of the world's people with diabetes are now living in the SEAR and the Western Pacific Region.[6]

In Myanmar, the prevalence of behavioural and metabolic risk factors for NCD, such as heavy alcohol consumption, tobacco use,

a sedentary lifestyle, obesity and hypertension, is high among 15–64 year-old citizens in 2009.[7] In 2012, NCDs led to 59% of total deaths in Myanmar.[8] In 2004, the prevalence of DM in residents between the ages of 25 and 64 years in the Yangon Region was 8.1%.[9] In 2014, the national prevalence of DM in the same age range was 10.5%.[10] Despite an increase in the prevalence of NCDs, there is still a limited amount of research on NCDs and its risk factors in Myanmar.

If poorly controlled, DM may lead to long-term complications, such as diabetes retinopathy, lower limb amputation, renal failure and cardiovascular diseases.[6] Diabetes retinopathy is particularly prevalent among people with a long duration of DM and a low socioeconomic status.[11] Controlling DM significantly reduces the risk of cardiovascular diseases in patients with DM.[12] Moreover, the rate of amputation in patients with DM is reduced up to 40%–60% if DM is properly controlled.[13]

This study aims to investigate the association between urban–rural location and the occurrence of DM in 25–74 year-old male and female citizens of the Yangon Region, and to estimate the proportion of urban and rural participants already diagnosed with DM, and of those, the proportion under treatment and under control.

Population and methods

Based on the WHO STEPwise approach for the surveillance of NCDs risk factors,[14] this study is a household-based, cross-sectional study in urban and rural areas of selected townships in the Yangon Region conducted from September to November 2013 and 2014, respectively. The survey had all three STEPs,: (1) questionnaires related to sociodemographic characteristics, dietary and sedentary lifestyle habits and history of DM, (2) physical measurements of height and weight and (3) laboratory investigation for fasting plasma glucose (FPG).

Sampling

Men and women between the ages of 25 and 74 participated in the study. Buddhist monks and nuns, institutionalised people and military persons were not invited, while people who were judged to be too physically or mentally ill to participate were not eligible. According to the WHO sample size calculator for the STEP survey,[14] with a level of marginal error of 0.05, a design effect of 1.5 and an expected response rate of 80%, we would need a sample of 500 in each study (urban and rural) for risk factors with a prevalence of approximately 10%, such as low physical activity, and approximately 90% such as low fruit and vegetable consumption.[15] For risk factors with a prevalence of 20%–25%, such as male smoking and overweight, we would need a sample size of 1000.[15] With regard to risk factor prevalence and practical circumstances, we appraised the sample size of 800 in each study to be adequate. Sample size calculations were done disjointedly for the urban and the rural survey, and to be able to perform subgroup analyses by gender.

A multistage cluster sampling was used. First, six townships from urban areas and six townships from rural areas were randomly selected among 45 townships of the Yangon Region. In the second stage, we listed all the wards (urban township units) in the six selected urban townships and all the villages (rural township units) in the six selected rural townships. Based on the unit of wards and villages, five wards from each selected urban township and five villages from each selected rural township were randomly selected. The total number of wards and villages was 60. From each selected ward and village, 26–27 households were randomly chosen. After selecting households, we listed the eligible household members, and one was randomly invited to participate in this study. The data collection was done during the daytime on the first day, and the blood sample collection was done the next morning. If the selected respondent was away from the home during the data collection time, we made an appointment with him/her the next day, most often right after the blood sample collection was done. There were 1608 invitees in this study, with an equal distribution of gender (804 from urban and 804 from rural areas). The total number of participants who accomplished STEPs 1 and 2 were 1486, with 755 (94%) from urban areas and 731 (91%) from rural areas. For all three STEPs, 693 (86%) from urban areas and 679 (83%) from rural areas were accomplished. The primary reasons given for not participating in STEPs 1 and 2 were ‘not willing’ and ‘not having time’, while ‘afraid to be involved in the blood sampling procedure’ was the primary reason for STEP 3. Thirteen pregnant women (3 urban and 10 rural) were excluded because maternal physiological changes in pregnancy might impact on the estimates. There were no differences between those who completed STEPs 1 and 2 only and all 3 STEPS, in terms of age, location and educational level.

Data collection and measurement

The questionnaires were translated into the Myanmarian language from the WHO STEPs Instruments V.2.1.[14] Data were collected by the principle investigator and four research assistants (medical doctors). The research assistants were recruited via the Myanmar Medical Association, and underwent a 2-day training with technical input from the Department of Medical Research (Lower Myanmar). The first day of training highlighted how to communicate with the respondents, how to obtain informed consent and how to conduct questionnaires. During the second day, the correct measuring methods for all three STEPs were in focus, in accordance with the standardised methods of WHO guidelines. The standardisation of instruments was carried out before and during the training. A pretest was conducted for STEPs 1 and 2 with the research assistants, and questions were also clarified. The same procedure was followed for the urban (2013) and rural (2014) survey, although with new research assistants in the rural survey.

After completing STEPs 1 and 2, we requested the participant to fast overnight for a blood drawing the next morning at the nearby health facility or meeting point. A venous blood sample was collected in the glucose tube with fluoride and stored in cold boxes with ice and transported to the National Health Laboratory, a reference laboratory of the Ministry of Health. The FPG level was investigated on plasma from whole blood with the enzymatic reference method with hexokinase, using reagents of COBAS from Roche Diagnostics, Indianapolis, USA. Biochemical analysis was started within 3 hours after blood samples were taken.

Variables

Age was defined as the completed years of age. Educational level was defined by both total number of year in school and highest educational level and categorised into: no formal education (0 year), primary education (1–5 years), secondary education (6–11 years) and higher education (≥12 years). Daily income was calculated from the whole household income divided by the total number of household members. Income was converted from Myanmar Kyats into United States Dollars (USD). Exchange rate of 1USD was 953.8 Myanmar kyats as of 5 November 2013. Cut-off values for poverty was used as defined by World Bank: 1.90 and 3.10 USD/day, for extreme poverty and moderate poverty, respectively.[16]

Daily smokers were defined as those who currently used tobacco daily, whereas current alcohol drinkers were defined as those who have drunk alcohol at least once over the last 30 days. A low intake of fruit and vegetable was defined as <5 servings/day, according to WHO guidelines.[14] Approximately 80 g of fruit or vegetable was defined as a standard serving. Show cards were used for the approximation of serving size. Physical activity calculation was based on the activity at work, transportation and at recreation time and household activity. Show cards were used to categorise the type of physical activity involved. In accordance with WHO guidelines, a low physical activity was defined as <3 days of vigorous-level activity of at least 20 min/week, or <5 days of moderate-level activity (minimum of 600 metabolic equivalent task (MET) minutes) per week, using standard METs.[14]

Body mass index (BMI) was calculated from weight and height (kg/m^2), overweight was defined as a BMI of 25–29.9 kg/m^2 and obesity as a BMI of ≥30 kg/m^2.[14] DM was defined as a FPG level ≥7 mmol/L and/or self-reported diabetes.[17] Self-reported DM was noted as that which is diagnosed by a medical doctor or other health personnel. Diabetes under treatment was defined as taking oral hypoglycaemic agents or insulin treatment for DM. DM under control was defined as FPG level <7 mmol/L while under treatment of DM. Impaired FPG was defined as FPG between 6.1 and 6.9 mmol/L.[17]

Statistical methods

Epidata V.3.1 was used for data entry and we did double data entry. STATA/IC V.14.0 was used for the data analysis. A multiple logistic regression was performed to explore the associations between urban–rural location and DM. Based on a directed acyclic graph (DAG), age, education, income and gender were found to be confounders and should therefore be adjusted for in order to obtain the total effect of urban–rural location on DM. Low physical activity, intake of fruit and vegetable, alcohol consumption, smoking, BMI and waist circumference were all found to be mediators, and thus adjusted for in order to find the direct effect of location on DM. BMI and intake of fruit and vegetable were included as continuous variables, other variables in categories. Based on the different stages of sampling units of the study population using 2014 Myanmar Census data, we declared the complex design by using 'svyset' and analysed the data after the prefix 'svy'. Using direct standardisation method based on the study population, we calculated the age standardised prevalence in this study for major risk factors. We used χ^2 tests and the nptrend command to assess urban rural differences in sociodemographic and behavioural variables (table 1) and prevalence of DM (table 2), with the statistical significance set to a p value <0.05. We also used the Wald test (table 2) to identify differences in proportions within the urban and rural areas.

RESULTS

The gender distribution in the study was about the same in the urban and rural settings, with half of the participants being women. The mean age of the study population was 42.8 years, with rural participant being slightly younger than urban participants. The educational level of the participants was higher in urban than in rural areas (26.6% vs 5.5% in the higher education level), and the proportion living on <1.9 USD/day was highest in the rural areas (65.8% vs 42.7% in urban) (table 1).

The age standardised prevalence of DM was higher in urban (12.1%) than in rural (7.1%) areas (p=0.039) with no gender differences (data not shown in table). The prevalence of DM increased with age, except in the highest age group in rural areas (table 2). In urban areas, the prevalence of DM was highest among those with lower education. Current smokers and current alcohol drinkers had a lower prevalence of DM than others. In rural areas, those who were physically inactive had a low intake of fruit and vegetable and were overweight or obese had a higher prevalence of DM than others. Mean FPG level in urban and rural areas, with standard age distribution, were 5.7 and 5.4 mmol/L, respectively (p=0.010) (data not shown in the table). The age-standardised prevalence of participants with impaired FPG were 14.3% in urban and 6.9% in rural areas (p=0.018) (data not shown in the table).

Among the participants, 43.1% of those in urban and 26.4% of those in rural areas had a previous experience of receiving a blood glucose measurement by a doctor or health worker (figure 1A,B). Among all DM participants, 61.5% in urban and 52.4% in rural areas were already

Table 1 Sociodemographic characteristics of urban and rural 25–74 year-old participants from the Yangon Region, Myanmar

	Urban (n=693) N (%)	Rural (n=679) N (%)	Total (n=1372) N (%)	P values*
Gender				0.794
Male	339 (48.9)	342 (50.4)	681 (49.6)	
Female	354 (51.1)	337 (49.6)	691 (50.4)	
Age group, years				0.005
25–34	123 (17.8)	136 (20.0)	259 (18.9)	
35–44	144 (20.8)	172 (25.3)	316 (23.0)	
45–54	160 (23.1)	167 (24.6)	327 (23.8)	
55–64	164 (23.7)	142 (20.9)	306 (22.3)	
65–74	102 (14.7)	62 (9.1)	164 (12.0)	
Education level				0.000
No formal education	18 (2.6)	68 (10.0)	86 (6.3)	
Primary education	189 (27.4)	452 (66.6)	641 (46.8)	
Secondary education	301 (43.4)	122 (17.9)	423 (30.8)	
Higher education	185 (26.6)	37 (5.5)	222 (16.2)	
Daily income† (n=1293), USD/day				0.000
<1.9	296 (42.7)	447 (65.8)	743 (54.2)	
1.9–3.09	141 (20.4)	111 (16.4)	252 (18.4)	
≥3.1	197 (28.4)	101 (14.9)	298 (21.7)	
Current smoker				0.001
Yes	126 (18.2)	178 (26.2)	304 (22.2)	
No	567 (81.8)	501 (73.8)	1068 (77.8)	
Current alcohol drinker				0.014
Yes	91 (13.1)	125 (18.4)	216 (15.7)	
No	602 (86.9)	554 (81.6)	1156 (84.3)	
Physical activity, MET/week				0.370
>600	604 (87.2)	605 (89.1)	1209 (88.1)	
<600	89 (12.8)	74 (10.9)	163 (11.9)	
Fruit and vegetable consumption, servings/day				0.000
≥5	118 (17.0)	20 (2.9)	1 (10.1)	
<5	575 (83.0)	657 (97.1)	1232 (89.9)	
Body mass index				0.000
Overweight	214 (31.0)	160 (23.6)	374 (27.3)	
Obesity	94 (13.6)	50 (7.4)	144 (10.5)	
Central obesity				0.543
Yes	262 (37.8)	245 (36.1)	507 (36.9)	
No	431 (62.2)	434 (63.9)	432 (63.1)	

*χ^2 and nptrend.
†79 missing due to refusal to answer.
MET, metabolic equivalent task.

diagnosed. Being woman and having secondary education compared with primary level were associated with awareness of DM. Awareness of DM did not differ between age groups, income groups or with being overweight or not. Among the known cases of DM, approximately three-fourths of the participants were under treatment, with no rural–urban difference. However, the proportion of controlled cases was higher in urban (45.8%) than in rural (32.0%) areas (figure 1A,B).

Table 3 presents the odds ratio (OR) of DM in rural, compared with urban dwellers. In the crude model, the OR of DM was lower in rural dwellers compared with urban dwellers (OR=0.41 (95% CI 0.22 to 0.79)). The adjusted total effect of location on DM was essentially similar to the

Table 2 Age-standardised prevalence of diabetes mellitus among 25–74 year-old citizens in the Yangon Region, Myanmar

	Urban		Rural		Total		
	N (%)	95% CI	N (%)	95% CI	N (%)	95% CI	P values*
Sociodemographic risk factors							
Gender							0.468
Male	60 (11.1)	6.6 to 18.1	27 (5.6)	3.3 to 9.3	87 (8.6)	5.4 to 13.4	
Female	62 (13.2)	9.2 to 18.7	34 (8.3)	5.3 to 12.9	96 (11.4)	8.4 to 15.1	
P values†	0.227		0.228		0.127		
Age group, years							0.000
25–34	3 (1.0)	0.1 to 9.4	1 (0.5)	0.0 to 9.0	4 (0.8)	0.1 to 4.3	
35–44	10 (6.5)	3.5 to 11.8	9 (4.9)	2.7 to 8.7	19 (6.1)	4.2 to 8.6	
45–54	23 (14.1)	9.0 to 21.2	19 (12.8)	8.1 to 19.8	42 (13.3)	10.2 to 17.2	
54–64	50 (33.2)	19.2 to 50.8	21 (15.1)	6.1 to 32.7	71 (25.9)	15.7 to 39.4	
65–74	36 (40.0)	22.9 to 59.9	11 (14.3)	6.0 to 30.5	47 (31.6)	18.1 to 49.2	
P values†	0.035		0.012		0.002		
Educational level							0.323
No formal education	8 (37.7)	33.0 to 42.7	12 (11.9)	10.1 to 14.0	20 (14.2)	11.4 to 7.5	
Primary education	38 (12.9)	8.9 to 18.5	32 (5.7)	3.7 to 8.6	70 (9.1)	6.6 to 12.6	
Secondary education	58 (10.1)	5.8 to 17.2	14 (11.9)	8.4 to 16.6	72 (9.9)	6.5 to 14.8	
Higher education	36 (5.7)	3.4 to 9.3	3 (12.6)	9.7 to 16.2	21 (5.8)	3.8 to 8.8	
P values†	<0.001		0.025		0.001		
Daily income‡ (n=1293), USD/day							0.441
<1.9	53 (11.9)	8.2 to 17.1	40 (6.8)	4.6 to 10.1	93 (9.5)	7.3 to 12.2	
1.9–3.09	29 (16.1)	11.0 to 23.1	8 (7.9)	4.9 to 12.3	37 (12.7)	8.9 to 17.7	
≥3.1	29 (9.9)	7.5 to 12.9	11 (9.6)	4.9 to 17.9	40 (9.8)	7.7 to 12.5	
P values†	0.269		0.366		0.599		
Behavioural risk factors							
Current smoker							
Yes (n=304)	15 (8.6)	5.8 to 12.6	10 (4.5)	2.4 to 8.5	25 (5.7)	3.4 to 9.4	0.002
No (n=1068)	107 (12.7)	8.7 to 12.6	51 (9.1)	6.6 to 12.6	158 (11.3)	8.7 to 14.5	
P values†	0.08		0.075		0.003*		
Current alcohol drinker							0.002
Yes (n=216)	9 (7.8)	5.3 to 11.6	6 (2.9)	1.4 to 6.1	15 (6.6)	3.9 to 10.7	
No (n=1156)	113 (12.4)	8.1 to 18.5	55 (7.8)	5.6 to 10.7	168 (10.6)	7.8 to 14.3	
P values†	0.031		0.02		0.013		
Physical activity, MET/week							0.000
≥600 (n=1209)	95 (11.7)	7.4 to 18.2	41 (5.7)	3.8 to 8.4	136 (9.4)	6.5 to 13.4	
<600 (n=163)	27 (10.8)	9.4 to 12.4	20 (21.8)	12.4 to 35.4	47 (13.4)	9.8 to 17.9	
P values†	0.689		0.021		0.144		
Fruit and vegetable consumption, servings/day							0.584
≥5 (n=138)	19 (11.7)	8.9 to 15.2	1 (2.9)	–	20 (10.3)	7.1 to 14.7	
<5 (n=1232)	103 (12.4)	8.2 to 18.1	60 (7.3)	5.8 to 9.2	163 (10.2)	7.7 to 13.5	
P values†	0.684		0.001		0.983		
Metabolic risk factors							
Body mass index							0.000
Normal (n=851)	57 (9.2)	7.0 to 11.9	30 (4.9)	2.6 to 8.7	87 (7.4)	5.6 to 9.4	
Overweight(n=374)	40 (13.2)	8.3 to 20.3	16 (8.7)	5.8 to 12.8	56 (11.0)	7.7 to 15.3	
Obesity (n=144)	24 (17.3)	12.2 to 24.0	15 (29.2)	22.1 to 37.4	39 (18.6)	15.3 to 22.5	
P values†	0.046		0.004		0.001		

Continued

Table 2 Continued

	Urban		Rural		Total		
	N (%)	95% CI	N (%)	95% CI	N (%)	95% CI	P values*
Central obesity							0.000
Yes (n=507)	73 (17.3)	13.4 to 22.0	40 (10.7)	8.1 to 14.1	113 (14.1)	12.1 to 16.5	
No (n=865)	49 (9.8)	5.6 to 16.8	21 (4.6)	2.8 to 7.3	70 (7.6)	4.6 to 12.3	
P values†	0.001		0.006		0.000		

*χ^2 and nptrend.
†Wald test.
‡79 missing due to refusal to answer.
MET, metabolic equivalent task.

crude effect (OR=0.39 (0.20 to 0.76)), whereas additional adjusting for mediators (direct effects) did not change the estimates (OR=0.38 (0.22 to 0.65)).

DISCUSSION

The prevalence of DM was 12.1% in urban and 7.1% in rural areas, and the difference was not explained by socioeconomic and behavioural risk factors. The proportion of participants who had checked their blood glucose level was higher in urban than in rural areas, as well as the proportion of diagnosed cases under control.

We followed the internationally recommended WHO STEPS protocol, both for the urban and the rural studies. The data collection was performed at the same time of calendar year in both areas to avoid any seasonal variation, and the response rates in both studies were high. We used a national reference laboratory for the investigation of FPG. Blood was collected, sent to the national laboratory and analysed the same day. Institutionalised people, monks and nuns and mentally ill persons were excluded from the study, as they might have a lifestyle different from that of the general population, for example, regarding physical activity and eating habits. The exclusion of these persons might have led to an overestimation or underestimation of the results.

According to the 2014 Myanmar Population and Housing Census Report,[18] the proportion being literate in the Yangon population was 97.2% in urban and 95.2% in rural areas. Even though numbers are not directly comparable to our data and the difference was not large, this reflects a higher educational level in urban areas.

Limitations of the study include possible information bias. When answering questions on, for example, alcohol consumption, participants may under-report their consumption or report inaccurately, due to traditional views. DM was assessed only by FPG in our study, oral glucose tolerance tests (OGTT) or measurement of haemoglobin A1c was not done because of limited resources such as time and human resources. WHO recommends to use OGTT in addition to FPG, as up to 30% of DM cases may remain undetected by using FPG alone.[17] Thus, some DM cases might not have been diagnosed in our study, and this could have attenuated the results. Also, even though all blood samples were analysed within 3 hours, some reduction in FPG may have occurred during transport, diminishing the number of DM cases in our sample. There were relatively few DM cases in our sample. Although we had questions regarding the treatment of DM such as insulin or oral hypoglycaemic agents, questions concerning other ways to control DM were not

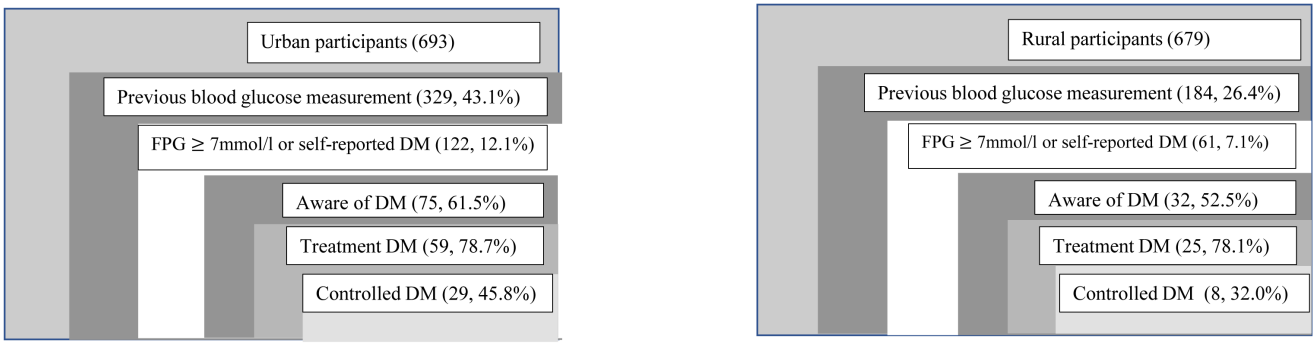

Figure 1 (A)The prevalence of participants having had a blood glucose meausrement previous to our study (n, %), participants with DM, participants already aware of having DM, participants with DM under treatment and under controll among urban (A) and rural (B) participants (size of the rectangles are not proportionate to actual sample size). DM, diabetes mellitus; FPG, fasting plasma glucose.

Table 3 Odds ratio (OR) of DM in rural compared with urban dwellers among 25–74 year-old citizens in the Yangon Region, Myanmar, from logistic regression

	Crude model*	Model 1* adjusted total effect	Model 2* adjusted direct effect
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Location			
Urban	1	1	1
Rural	0.41 (0.22 to 0.79)	0.39 (0.20 to 0.76)	0.38 (0.22 to 0.65)

Model 1: adjusted for age, gender, income and education.
Model 2: additionally adjusted for smoking, fruit and vegetable intake, current alcohol consumption, low physical activity, BMI and waist circumference.
*79 participants with missing value for income excluded in all models.
BMI, body mass index; DM, diabetes mellitus.

included. The results were from one region in Myanmar, and hence might not be generalised to the entire population in Myanmar. However, perhaps the findings will be similar in other big cities and surrounding areas in Myanmar.

The prevalence of DM in the Yangon Region was comparable to global (8.8%) and SEAR (8.5%) estimates in 2015,[5] with a somewhat lower prevalence in rural areas and slightly higher in urban areas. A higher prevalence in urban than in rural areas is reported in most countries around the world.[5] Urbanisation is also associated with changes in eating habits, physical activity, smoking and alcohol consumption and is related to obesity and NCDs, such as DM.[2] Lifestyle changes preceding NCDs are influencing people in both urban and rural areas, but often earlier and more significantly in urban areas. Moreover, the DM prevalence reported in this article was lower than previously reported from the same study.[19] This is because the results in the present study were age-adjusted according to the population in the Yangon Region using 2014 Myanmar Census data, while previous studies have reported results age-adjusted according to the internal (Myanmar) standard population. The Yangon Region has a relatively young population, due to the migration of young people into Yangon for opportunities in education and employment. The prevalence of DM in the Yangon Region was generally increasing with age, which is in line with previous studies among Asian Indians and Chinese people,[20] as well as elsewhere.[5] In urban areas of the Yangon Region, DM was more prevalent among those with no formal and low levels of education than among those with a higher education. Notably, higher educational levels were mostly prevalent in urban areas, which may explain why this trend was not seen in rural areas. An educational gradient in DM has been reported in low-income, middle-income and high-income countries.[21] A low education may be associated with less access to healthcare services and information on DM, opportunities to lead a healthy life and individual lifestyle choices.[21]

Low physical activity is one of the main risk factors for DM[6] and was associated with DM in rural areas in our study. Only about 10% of participants were physically inactive, in urban areas. This low proportion may be an explanation as to why physical inactivity was not related to DM in urban areas. In the total sample, we found that smokers had a lower prevalence of DM than non-smokers. This is supported by results from a study among Chinese men, which reported an inverse association between smoking and newly diagnosed DM.[22] However, other studies have reported a positive association between smoking and metabolic syndrome.[23] In our study, no alcohol consumption was associated with a higher prevalence of DM. This is in accordance with the results of meta-analysis which show that moderate alcohol drinkers had a 30% reduction risk of DM compared with non-drinkers.[24] In Myanmar, the prevalence of alcohol drinkers was higher in rural than urban areas, and the majority were moderate drinkers.[19] Our study results are in line with the study in middle-aged and elderly Chinese people, showing that moderate alcohol drinkers had a lower risk of DM compared with non-alcohol drinkers.[25] The apparently protective effect of smoking and drinking can have several explanations. Operational definitions like current smoker and current alcohol drinker do not take into account the history of smoking or drinking of a participant. Some might have stopped unhealthy behaviours when getting a chronic disease like DM, while their healthy counterparts may have continued their habit of smoking and drinking. Also, a cross-sectional study cannot inform us of causal relationships, and there might be confounders to these associations not taken into account in the present study.

The proportion of participants who had their blood glucose checked by a doctor or health workers was higher in urban than in rural areas. This suggests that urban people have an easier access to healthcare facilities than rural participants and might be more aware of the benefits of screening for diabetes. Furthermore, among those with diagnosed diabetes, the proportion of controlled DM was higher in urban than in rural areas. This could also be associated with a better access to quality care, as well as with a higher education level and available information on DM and a healthy lifestyle.[21 26] The results indicate a considerable number of people living with undetected DM in Myanmar. Health assistants and midwives are the primary

healthcare givers for the rural DM people without specialists at the Rural Health Centre level,[27] while urban dwellers can at least consult a general practitioner.[28] In Myanmar, health insurance systems have yet to be established, so patients with DM need to spend out-of-pocket money for treatment. Hence, they may face a catastrophic financial condition and therefore fail to attend regular follow-ups and treatment.[28] A higher proportion of rural than urban dwellers lived on <1.9 USD/day. Consequently, they may have fewer opportunities to have a health check-up and thus more often live with uncontrolled DM.

In our study, the urban residents had higher odds of DM than rural dwellers, even after an adjustment for possible confounders. One possible explanation for this is an association between urban stress and DM. Urban residents face overcrowding, unemployment, poor housing, poverty, competition and cultural dislocation on a daily basis, thereby leading to stress conditions such as anxiety and depression.[29] Experiencing long-term stress has been shown to be associated with DM[30–33] due to increased levels of cortisol and decreased levels of sex hormones, disturbing the insulin function.[34–36] One study showed that stress was linked to undetected DM after controlling for a family history of DM, alcohol consumption, physical inactivity and a low level of education.[37] Another explanation is related to the foods that people consume. Urban Myanmar residents eat fast food and drink high caloric soft drinks and alcohol more frequently than rural dwellers.[28] This may be related to DM beyond the effect of the intake of fruit and vegetable, as we did not investigate food patterns in this study. Further studies, including diet and stress, are therefore warranted to help the differences in the urban and rural prevalence of DM. Another possible explanation for the urban rural difference in DM prevalence is air pollution. In urban areas of Yangon, a large proportion of residents use bus for transport, whereas in rural areas, such public transport services are not available.[38] Moreover, there are 20 industrial zones in Yangon urban region.[39] Average 24 hours PM_{10} in Yangon Region in 2012–2013 was 128 µg/m^3 (WHO standard 50 µg/m^3).[40] Several studies have reported that air pollutant factors such as PM_{10} and NO_2 had significant association with type II DM.[41–43] However, the excess prevalence of DM in our urban population is could not be explained by relatively small excess pollutants in Yangon in this study. Further studies like the relationship between air pollution and type II DM is recommended.

CONCLUSION

The prevalence of DM in the Yangon Region of Myanmar was high in urban areas. The results indicate a large number of undetected DM cases in the region, particularly in rural areas. More health services in Myanmar are needed to serve this population who have a large proportion of undiagnosed DM. Preventive measures to halt and reduce the prevalence of DM and its risk factors are urgently needed.

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