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Assessing the prevalence of non-communicable diseases and their modifiable risk factors in primary healthcare: retrospective analysis of annual health screening in the United Arab Emirates

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ABSTRACT

Objectives Non-communicable diseases (NCDs) and their associated risk factors are becoming increasingly prevalent worldwide. NCDs are both a health burden and an economic burden, but many can be prevented by public health interventions that include screening and treatment. The primary objective was to determine the prevalence of NCDs pre-diabetes, suspected diabetes, hypertension and high total cholesterol (TC)/high-density lipoprotein (HDL) ratio, as well as the prevalence of high cardiovascular risk (CVR) in the United Arab Emirates (UAE). The secondary objective was to assess modifiable risk factors for NCDs and investigate correlations between these risk factors and age, sex and emirate of residence.

Design A health screening programme (HSP) for the early detection and treatment of NCDs was launched in 2021 to screen, diagnose and treat NCDs. This retrospective cross-sectional study analysed HSP data collected from April 2021 to December 2023.

Setting Primary healthcare centres in the UAE.

Participants 34 290 participants in the HSP who were screened for the first time.

Results Of the participants, 60.4% were female, and 51.8% were 18–39 years old. Pre-diabetes was found in 17.3% (95% CI, 16.9% to 17.7%), suspected diabetes type 2 in 6.1% (95% CI, 5.8 to 6.3), hypertension in 13.9% (95% CI, 13.5% to 14.3%), and high TC/HDL ratio in 8.1% (95% CI, 7.8% to 8.4%). A high CVR was found in 11.5% (95% CI, 11.1% to 11.8%) of overall participants and 52.5% (95% CI, 50.5% to 54.5%) of people with diabetes. The OR of high CVR was 11.95 for suspected diabetics. Modifiable risk factors, such as smoking, physical inactivity, overweight and obesity, were all associated with age and sex; in addition, age and sex interacted in their effect on these factors.

Conclusion The prevalence of the four NCDs and high CVR was high in the northern emirates. High CVR was especially common among people with diabetes. A large majority of participants had one or more modifiable risk factors. Age, sex and their interaction correlated strongly with the modifiable risk factors. These results can guide the introduction of specialised preventive and curative services to enhance public health and well-being.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study strengths stem from the large number of participants, which resulted in very high accuracy and a high study power, and allowed us to identify very strong associations.
⇒ Cardiovascular risk (CVR) scores were based on the Systematic COronary Risk Evaluation (SCORE) tables for low-risk countries, which may not be the ideal SCORE tables for determining CVR scores in the northern emirates.
⇒ A point-of-care test was conducted to determine glucose, total cholesterol and high-density lipoprotein cholesterol, wheraas other studies have used different methods, making it harder to compare results.

INTRODUCTION

Non-communicable diseases (NCDs) and their associated risk factors are becoming increasingly prevalent worldwide. A systematic analysis of the global burden of disease found that between 1990 and 2013, the number of deaths from communicable, maternal, neonatal and nutritional causes decreased.[1] This decrease, in combination with an ageing world population, caused the number of deaths from NCDs to steadily increase from 27.0 million to 38.3 million worldwide.[1] For example, in 1990, the global mortality attributed to ischaemic heart disease was 5.7 million, while in 2019, it was 9.1 million. The global mortality attributed to cancer was 5.8 million in 1990, whereas in 2019, it was 10.1 million.[2]

In the United Arab Emirates (UAE), a nation of 9.4 million people in 2022,[3] four primary NCDs – cancer, diabetes, cardiovascular disease (CVD) and chronic respiratory illness – account for approximately 4800 deaths annually.[4] These four NCDs cause 55% of all deaths, with CVDs alone responsible for 34%. The chance of dying before the age of 70 from an NCD is around one in five.[4] In addition to the disease burden, NCDs impose an economic burden, not only through healthcare expenditure but also through the loss of economic productivity of the patients. The economic burden of NCDs in the UAE was estimated at US$10.9 billion per year, which was 2.7% of the gross domestic product.[4]

Many NCDs can be prevented by public health interventions that include screening and treatment. An analysis of six algorithms for estimating CVD risk concluded that routine testing for CVR factors to assess risk score is the best approach to CVD risk evaluation.[5] In the Danish Cardiovascular Screening trial, which included >46 000 men aged 65–74 years, comprehensive population screening for CVD was cost-effective.[6] However, systematic reviews have found that general health checks and screening for risk factors alone are insufficient to decrease CVD burden.[7 8] Appropriate treatment, intervention and follow-up of the high-risk population are also required.

For the four main NCDs, the WHO recommends interventions that reduce the effects of the modifiable key risk factors: tobacco, harmful alcohol use, unhealthy diet and physical inactivity.[9] The WHO advises countries to develop national targets and indicators and link these with a national multisectoral policy for preventing and controlling NCDs.[9] The UAE's Ministry of Health and Prevention adopted the WHO's advice in 2017 and increased spending on the prevention and control of NCDs to decrease the NCD burden.[4] Therefore, various initiatives and strategies were developed to decrease the prevalence of NCDs and modifiable risk factors.[4] One of the strategies was to launch the e-Etmnan Health Screening Programme (HSP) for the early detection and treatment of NCDs. The e-Etmnan HSP is a digital healthcare programme that uses a combination of software, hardware, data analysis, digital patient education and patient support systems. Launched in 2021, the program aims to provide an integrated approach to screening, diagnosing and treating NCDs using state-of-the-art technology. The e-Etmnan HSP includes a patient registry, a risk assessment tool to identify patients who are at risk and a referral system to ensure that patients receive timely and appropriate treatment.

This study evaluated data collected during the first 33 months since the implementation of e-Etmnan in the northern UAEs. The primary objective of the study was to determine the prevalence of pre-diabetes, suspected diabetes, hypertension and dyslipidaemia and assess the prevalence of high CVR, which is the risk of death within 10 years due to a CVD. The secondary objective was to determine the prevalence of modifiable NCD risk factors, such as physical inactivity, overweight, obesity and smoking, and investigate correlations of these risk factors with age, sex and emirate of residence.

METHODS

Study design

A retrospective cross-sectional observational design was used to analyse data from the medical records of de-identified individuals who attended the e-Etmnan service in a primary healthcare centre (PHC) setting. Data were collected from all individuals who were registered at the PHCs in the northern Emirates Ajman, Dubai, Fujairah, Ras Al Khaimah and Sharjah, over 33 months between 1 April 2021 and 31 December 2023. The Research Ethics Committee of the Ministry of Health and Prevention granted ethical approval for the use of patient information for this study (Reference no. MOHAP/DXB-REC/F.M.M /No.43/2024).

All individuals registered with an electronic medical record at Emirates Health Services who were ≥18 years old and had an Emirati ID were sent an SMS or email with a uniform resource locator (URL) inviting them to participate in the e-Etmnan HSP. A QR code leading to the same URL invitation was also printed on posters at 72 PHCs and was available on the Emirati Health Services website. The invitations to participate were sent out yearly.

When the individuals opened the URL, they were asked to consent to participate in a yearly health screening. If they agreed, they were then asked to complete the Early Detection and Prevention Unit (EDPU) Risk Assessment Questionnaire. The 75-item questionnaire can be found in the online supplemental materials. Participants were subsequently contacted to schedule a visit to an EDPU unit at a PHC. Alternatively, people could walk into a PHC directly. Once the participants arrived at one of the 10 participating PHCs (online supplemental table 1), they were registered on the EDPU platform. If they had not yet completed the EDPU Risk Assessment Questionnaire, they were asked to complete it at an EDPU booth at the PHC.

Measurements

After the intake, participants met with a nurse who would take basic measurements, including blood pressure, height and weight. The nurse would also take a drop of blood to perform a point-of-care test using the FDA-cleared CardioChek PA Analyzer (PTS Diagnostics, Whitestown, IN) that measured the participant's glucose, total cholesterol (TC), and high-density lipoprotein (HDL) cholesterol and calculated the TC/HDL ratio. Each participant was then seen by a general practitioner (GP) who would determine whether additional analyses were needed, such as a full blood analysis or a stool test for faecal occult blood to screen for colorectal cancer, and whether the participant should be referred to a GP or specialist for treatment. The EDPU workflow is illustrated in figure 1. The GP discussed the results of the tests in a follow-up telephone call.

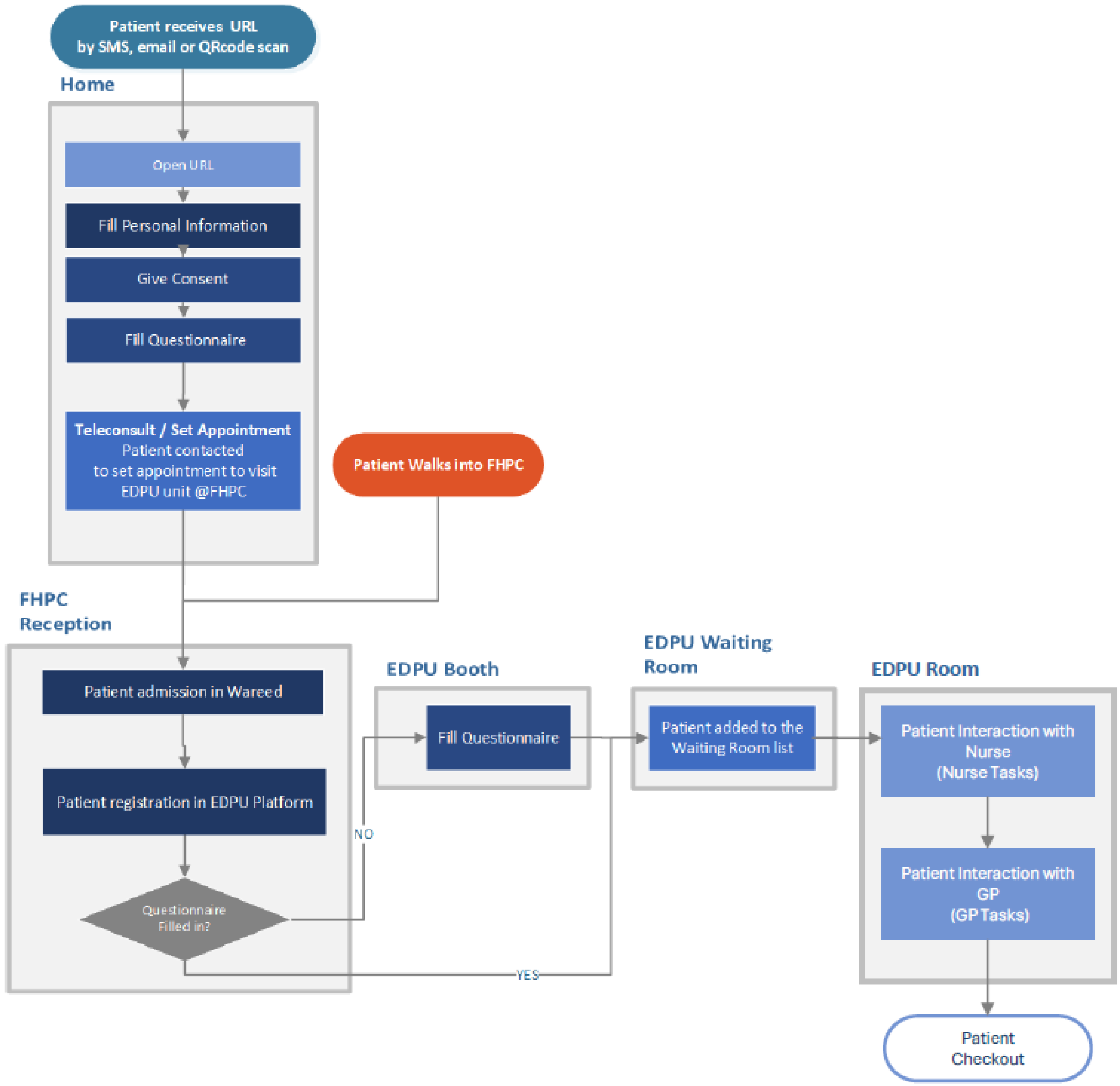

Figure 1 EDPU process workflow. EDPU, Early Detection and Prevention Unit; GP, general practitioner; PHC, primary healthcare centre; FHPC, family health promotion centre.

Variables

Body mass index (BMI) was expressed in kg/m^2. A healthy BMI was defined as a BMI ≥18.5 to <25, overweight as ≥25 to <30, and obesity as ≥30. Physical inactivity was defined as <30 min of exercise each day. Blood pressure was measured three times, and the readings were averaged. Hypertension was defined by a blood pressure of ≥140/90 mm Hg with either a systolic pressure of ≥140 mm Hg or a diastolic pressure ≥90 mm Hg. Pre-diabetes, also known as impaired fasting glucose, was defined as a fasting blood glucose (FBG) of 100–125 mg/dL or a blood glucose level between 140 and 199 mg/dL for non-fasting patients based on the definition by the American Diabetes Association (ADA).[10] Suspected diabetes was defined as a one-time FBG of ≥126 mg/dL or a one-time blood glucose level ≥200 mg/dL for non-fasting patients based on the definition by the ADA.[10] As a proxy for dyslipidaemia, a high TC/HDL ratio was determined. A TC of >200 mg/dL was considered high, an HDL of <40 mg/dL as low and a TC/HDL ratio >5.0 as high.

Cardiovascular risk assessment

CVR, which indicates the risk of death within 10 years due to CVD, was determined based on the Systematic COronary Risk Evaluation (SCORE) system,[11] which is recommended by the European Society of Cardiology.[12] To determine the CVR, six risk categories were first assessed based on answers from the EDPU Risk Assessment Questionnaire (online supplemental figure 1), and the CVR score was then assessed using the flow chart in online supplemental figure 2. For example, when an individual disclosed in the questionnaire that he/she had type 2 diabetes, the risk category was D+ (online supplemental figure 1). If any other risk factor is also present (A, B, C, E or F), this individual is automatically assigned a high CVR (online supplemental figure 2). If an individual has risk category D+without any of the other risk factors, further analyses are performed to assess CVR. A CVR of ≥10% was considered high.

Data management and statistical analyses

All questionnaire data were stored and analysed in the EDPU Microsoft SQL Server. The Microsoft SQL Server, among others, controls access and encrypts all data to ensure compliance with the European Union's General Data Protection Regulation.[13] Categorical variables were presented as frequencies and percentages. Numerical variables were presented as mean with SD, range and median. Prevalence data were presented by frequency, percentage and 95% CI.

Pearson correlation coefficients were determined to assess correlation (r). A correlation of r<0.3 was considered as none or very weak, 0.3<r <0.5 as weak, 0.5<r <0.7 as moderate and r>0.7 as strong. The χ^2 test of independence with Yates' continuity correction was used to assess the association between two categorical variables. A p-value<0.05 was considered significant.

Logistic regression was used to determine the OR of high CVR because of the binary outcome for CVR. Logistic regression was also used to model the binary outcome variables (ie, physical inactivity, smoking, overweight and obesity) based on one or more predictor variables (sex, age and emirate of residence). A p-value<0.05 was considered significant. The Akaike information criterion was used to determine which regression model had the best balance between goodness of fit and model complexity.

Patient and public involvement

Patients or the public were not involved in the design, conduct, reporting or dissemination of the study.

RESULTS

Participants

In the 33-month period assessed, approximately 250 000 individuals were invited through various channels (eg, SMS and email) to participate in the e-Etmnan programme. They were asked to complete the online EDPU Risk Assessment Questionnaire and schedule an appointment at a PHC. The PHCs also received walk-ins who completed the questionnaire at an EDPU booth.

In total, 34 290 individuals were screened for the first time. Of these, 60.4% (n=20 716/34,290) were female, and individuals aged 18–39 years formed the largest age group (n=17 780; 51.8%). Demographic parameters are provided in table 1. Over-representation of women in the various age groups increased slightly with age, with 59.2% aged 18–39 year, 60.6% aged 40–49, 62.9% aged 50–59 and 63.9% aged ≥60. Regarding nationality, 91.3% were Emirati, 4.2% were Omani and the remaining participants had 54 other nationalities, each accounting for <0.6%.

Table 1 Demographics of the 34 290 participants

Variable	Attributes	N (%*)
Sex	Female	20 716 (60.4)
	Male	13 574 (39.6)
Age group (years)	18–39	17 780 (51.9)
	40–49	9409 (27.4)
	50–59	4502 (13.1)
	≥60	2599 (7.6)
Emirate of residence†	Abu Dhabi	123 (0.4)
	Ajman	3575 (10.4)
	Dubai	2506 (7.3)
	Fujairah	5456 (15.9)
	Ras Al Khaimah	8379 (24.4)
	Sharjah	14 012 (40.9)
	Umm Al Quwain	239 (0.7)

*Percentages indicate the proportions among the 34 290 participants.
†The health screening programme was implemented starting in Sharjah and gradually rolled out to other emirates over the 33-month study period. Therefore, in some emirates, more individuals participated than in others.
N, number.

The participants had a mean age of 39.5 (SD 13.0) years, a mean weight of 76.7 (SD 18.3) kg and a mean BMI of 28.8 (SD 6.7) kg/m^2. The clinical parameters assessed by the nurse are presented in table 2. After the meeting with a nurse, all participants were seen by a GP.

Prevalence of the four non-communicable disease

The prevalence of four NCDs—pre-diabetes, type 2 diabetes, hypertension and high TC/HDL ratio—was determined. Based on the point-of-care blood test, 17.3% (95% CI, 16.9% to 17.7%; n=5937) of the participants had pre-diabetes, and 2330 (6.8%) had suspected diabetes (either type 1 or 2).

Based on the answers to the questionnaire, 3553 participants (10.4%) reported having diabetes, and when asked which type, 2288 (64.4% of the 3553) answered type 2, 875 (24.6% of the 3553) were uncertain and 390 (11.0% of the 3553) answered type 1. As in general, people who do not know their diabetes type have type 2, and 90% of global diabetes cases are type 2 according to the International Diabetes Federation,[14] we assumed that 89% of our participants (all minus 11% of type 1) with suspected diabetes based on the blood test had type 2 diabetes. Consequently, the estimated prevalence of suspected type 2 diabetes was 6.1% (95% CI, 5.8% to 6.3%; n=2074) of participants. The prevalence of both pre-diabetes and suspected diabetes type 2 was similar between women and men and increased with age (table 3).

Table 2 Clinical parameters of the 34 290 participants

Variable	Mean (SD)	Median (IQR)
Age, years	39.5 (13.0)	39 (29–47)
Height, cm	163.1 (9.5)	162 (156–170)
Weight, kg	76.7 (18.3)	75.0 (64.0–87.0)
BMI, kg/m^2	28.8 (6.7)	28.1 (24.6–32.3)
Systolic blood pressure, mmHg	119.9 (14.4)	119 (110–129)
Diastolic blood pressure, mmHg	74.0 (9.6)	73 (67–80)
Fasting glucose concentration, mg/dL	99.5 (35.0)	93 (82–107)
TC, mg/dL	172.7 (42.2)	169 (143–198)
HDL, mg/dL	54.9 (15.9)	53 (43–64)
TC/HDL ratio	3.3 (1.1)	3.1 (2.5–3.9)

TC, total cholesterol.BMI, body mass index; HDL, high-density lipoprotein; IQR, interquartile range; SD, standard deviation.

Hypertension was detected in 13.9% (95% CI, 13.5% to 14.3%) of the participants. Hypertension increased with age and was more prevalent in men (17.2%; 95% CI, 16.6% to 17.9%) than in women (11.8%; 95% CI, 11.3% to 12.2%) (table 3). Based on the answers to the questionnaire, 4285 (12.5%) participants reported having hypertension, of which 3654 (85.3% of the 4285) were taking hypertension medication. In 2369 of the individuals taking hypertension medication, no hypertension was detected during the clinical screening, indicating their hypertension was under control.

A high TC/HDL ratio was found in 8.1% (95% CI, 7.8% to 8.4%) of the participants; a high ratio was more prevalant in men (14.2%; 95% CI, 13.6% to 14.8%) than in women (4.2%; 95% CI, 3.9% to 4.4%), and this was attributable to men having much higher rates of low HDL and slightly lower rates of high TC than women (table 3).

Prevalence of high cardiovascular risk

The CVR was determined for 34 255 of the 34 290 participants. A high CVR was found in 11.5% (95% CI, 11.1% to 11.8%) of the overall participants. The prevalence of a high CVR increased with age but did not vary by sex. Among the non-diabetic participants, a high CVR was present in 8.5% (95% CI, 8.2% to 8.8%), whereas among participants with suspected diabetes, this was much more common at 52.5% (95% CI, 50.5% to 54.5%) (table 4). Suspected diabetes and high CVR were significantly associated (χ^2=4148.6, df=1, p<2.2e-16). For individuals with suspected diabetes, the OR of high CVR was 11.95.

Prevalence of modifiable risk factors

We assessed the prevalence of the modifiable risk factors physical inactivity, overweight, obesity and smoking in the participants. Physical inactivity and smoking were self-reported in the EDPU Risk Assessment Questionnaire, whereas overweight and obesity were assessed based on BMI.

Physical inactivity was reported by 58.4% (95% CI, 57.9% to 59.0%), and this was similar between the age groups, except for the group aged ≥60 years, in which physical inactivity was 65.4% (95% CI, 63.6% to 67.3%). Women also reported much more physical inactivity (66.9%; 95% CI, 66.2% to 67.5%) than men (45.6%; 95% CI, 44.8% to 46.4%). Smoking was reported by 14.1% (95% CI, 13.7% to 14.5%), with an over 22-fold difference between women (1.5%; 95% CI, 1.4% to 1.7%) and men (33.3%; 95% CI, 32.5% to 34.1%). People aged 50–59 and ≥60 reported less smoking than people aged 18–39 and 40–49 years (table 5).

Of all participants, 34.5% (95% CI, 34.0% to 35.0%) were overweight, and 37.7% (95% CI, 37.2% to 38.2%) were obese. More men than women were overweight (40.2% vs 30.8%), whereas more women than men were obese (40.5% vs 33.5%). In addition, among younger people, especially among those aged 18–39 years, and those aged 40–49 years, obesity was less common than among older people (50–59 and ≥60 years) (table 5).

Most participants (90.5%) had one or more modifiable risk factors. No risk factors were found in 9.5% (n=3256), 41.2% (n=14 133) had one, 44.3% (n=15 197) had two and 5.0% (n=1704) had three modifiable risk factors (online supplemental table 2). Note that having four risk factors was not possible, as participants could not be included in both the overweight and obesity categories.

Correlation of modifiable risk factors with age, sex and emirate of residence

We determined whether there were correlations between the modifiable risk factors and age, sex and emirate of residence (table 6).

For smoking, a weak negative correlation (r=−0.45), with a strong association (χ^2=6817.8, df=1, p<2.2e-16), was found with sex; men were much more likely to smoke. Logistic regression modelling found that smoking was associated with sex and age, with older individuals smoking less, whereas the interaction between sex and age also had a significant effect. The best model included sex, age and the interaction between sex and age (online supplemental table 3).

For physical inactivity, a very weak correlation (r=0.21), with a strong association (χ^2=1525.5, df=1, p<2.2e-16), was observed with sex; women were more likely to be physically inactive. Logistic regression modelling found that physical inactivity was associated with sex, age and residence in Ras Al Khaimah, whereas the interaction between sex and age also had a significant effect. The best model included sex, age, emirate and the interaction between sex and age (online supplemental table 3).

Table 3 Prevalence of pre-diabetes, suspected diabetes type 2, hypertension and high TC/HDL ratio by age group and sex

		Pre-diabetes		Suspected diabetes type 2		Hypertension	
	N	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
All participants	34 290	5937	17.3 (16.9 to 17.7)	2074	6.1 (5.8 to 6.3)	4771	13.9 (13.6 to 14.3)
Age group (years)							
18–39	17 780	2354	13,2 (12.7 to 13.7)	367	2.1 (1.9 to 2.3)	1389	7.8 (7.4 to 8.2)
40–49	9409	1755	18.7 (17.9 to 19.4)	530	5.6 (5.2 to 6.1)	1438	15.3 (14.6 to 16.0)
50–59	4502	1117	24.8 (23.6 to 26.1)	575	12.8 (11.8 to 13.8)	1053	23.4 (22.1 to 24.6)
≥60	2599	711	27.4 (25.6 to 29.1)	603	23.2 (21.6 to 24.8)	891	34.3 (32.5 to 36.1)
Sex							
Female	20 716	3596	17.4 (16.8 to 17.9)	1205	5.8 (5.5 to 6.1)	2434	11.7 (11.3 to 12.2)
Male	13 574	2341	17.2 (16.6 to 17.9)	869	6.4 (6.0 to 6.8)	2337	17.2 (16.6 to 17.9)
Emirate of residence							
Abu Dhabi	123	22	17.9 (11.1 to 24.7)	6	5.1 (1.2 to 8.9)	8	6.5 (2.1 to 10.9)
Ajman	3575	378	10.6 (9.6 to 11.6)	214	6.0 (5.2 to 6.8)	491	13.7 (12.6 to 14.9)
Dubai	2506	605	24.1 (22.5 to 25.8)	279	11.1 (9.9 to 12.3)	350	14.0 (12.6 to 15.3)
Fujairah	5456	713	13.1 (12.2 to 14.0)	221	4.0 (3.5 to 4.6)	725	13.3 (12.4 to 14.2)
Ras Al Khaimah	8379	1403	16.7 (15.9 to 17.5)	567	6.8 (6.2 to 7.3)	1161	13.9 (13.1 to 14.6)
Sharjah	14 012	2788	19.9 (19.2 to 20.6)	824	5.6 (5.2 to 6.0)	1999	14.3 (13.7 to 14.8)
Umm Al Quwain	239	28	11.7 (7.6 to 15.8)	4	1.9 (0.1 to 3.6)	37	15.5 (10.9 to 20.1)
	N	High TC		Low HDL		High TC/HDL ratio	
		n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
All participants	34 290	7964	23.2 (22.8 to 23.7)	5236	15.3 (14.9 to 15.7)	2783	8.1 (7.8 to 8.4)
Age group (years)							
18–39	17 780	3239	18.2 (17.6 to 18.8)	2561	14.4 (13.9 to 14.9)	1190	6.7 (6.3 to 7.1)
40–49	9409	2789	29.6 (28.7 to 30.6)	1549	16.5 (15.7 to 17.2)	1001	10.6 (10.0 to 11.3)
50–59	4502	1420	31.5 (30.2 to 32.9)	688	15.3 (14.2 to 16.3)	440	9.8 (8.9 to 10.6)
≥60	2599	516	19.9 (18.3 to 21.4)	438	16.9 (15.4 to 18.3)	152	5.8 (4.9 to 6.8)
Sex							
Female	20 716	5041	24.3 (23.7 to 24.9)	1493	7.2 (6.9 to 7.6)	861	4.2 (3.9 to 4.4)
Male	13 574	2923	21.5 (20.8 to 22.2)	3743	27.6 (26.8 to 28.3)	1922	14.2 (13.6 to 14.7)
Emirate of residence							
Abu Dhabi	123	42	34.1 (25.8 to 42.5)	17	13.8 (7.7 to 19.9)	10	8.1 (3.3 to 13.0)
Ajman	3575	445	12.4 (11.4 to 13.5)	873	24.4 (23.0 to 25.8)	259	7.2 (6.4 to 8.1)
Dubai	2506	723	28.9 (27.1 to 30.6)	320	12.8 (11.5 to 14.1)	219	8.7 (7.6 to 9.8)
Fujairah	5456	939	17.2 (16.2 to 18.2)	863	15.8 (14.8 to 16.8)	415	7.6 (6.9 to 8.3)
Ras Al Khaimah	8379	2040	24.3 (23.4 to 25.3)	1297	15.5 (14.7 to 16.3)	741	8.8 (8.2 to 9.5)
Sharjah	14 012	3709	26.5 (25.7 to 27.2)	1824	13.0 (12.5 to 13.6)	1118	8.0 (7.5 to 8.4)
Umm Al Quwain	239	66	27.6 (21.9 to 33.3)	42	17.6 (12.7 to 22.4)	21	8.8 (5.2 to 12.4)

CI, confidence interval; HDL, high-density lipoprotein; n, number; TC, total cholesterol.

For overweight, the correlation assessment revealed very weak correlations. χ^2 tests revealed, however, a strong association with sex (χ^2=318.1, df=1, p<2.2e-16) and age group (χ^2=124.9, df=3, p<2.2e-16). Logistic regression modelling found that overweight was associated with sex and age, whereas the interaction between sex and age also had a significant effect. The best model included sex, age and the interaction between sex and age (online supplemental table 3).

For obesity, a very weak correlation (r=0.20), with a strong association (χ^2=1194.4, df=3, p<2.2e-16) was observed with age; older people were more likely to be obese. Logistic regression modelling found that obesity was associated with sex and age, whereas the

Table 4 High CVR by age group, sex, emirate of residence and diabetes status

		High CVR	
	N	n	% (95% CI)
All participants	34255	3926	11.5 (11.1 to 11.8)
Age group (years)			
18–39	17 763	644	3.6 (3.4 to 3.9)
40–49	9398	956	10.2 (9.6 to 10.8)
50–59	4498	1036	23.0 (21.8 to 24.3)
≥60	2596	1290	49.7 (47.8 to 51.6)
Sex			
Female	20 701	2341	11.3 (10.9 to 11.7)
Male	13 554	1585	11.7 (11.2 to 12.2)
Emirate of residence			
Abu Dhabi	123	11	8.9 (3.9 to 14.0)
Ajman	3574	479	13.4 (12.3 to 14.5)
Dubai	2498	367	14.7 (13.3 to 16.1)
Fujairah	5449	544	10.0 (9.2 to 10.8)
Ras Al Khaimah	8378	1058	12.6 (11.9 to 13.3)
Sharjah	13 997	1448	10.3 (9.8 to 10.8)
Umm Al Quwain	236	19	8.1 (4.6 to 11.5)
Diabetes status			
Non-diabetic	31 925	2703	8.5 (8.2 to 8.8)
Suspected diabetic	2330	1223	52.5 (50.5 to 54.5)

CI, confidence interval; CVR, cardiovascular risk; n, number.

interaction between sex and age also had a significant but modest effect. The best model included sex, age and the interaction between sex and age (online supplemental table 3).

DISCUSSION

In this retrospective cross-sectional observational study, we analysed data collected during the first 33 months since the implementation of the e-Etmnan HSP in the northern emirates. The first objective showed that prediabetes was present in 17.3%, suspected diabetes type 2 in 6.1%, hypertension in 13.9%, a high TC/HDL ratio in 8.1% and a high CVR in 11.5% of participants. The second objective showed that the vast majority (>90%) had at least one of the modifiable risk factors: smoking, physical inactivity, overweight and obesity.

This study has several limitations. First, women were over-represented. This will have affected the overall prevalence of hypertension and high TC/HDL ratio, as well as the prevalence of the modifiable risk factors. We have, therefore, also provided these prevalences per sex to facilitate comparisons. Second, CVR scores were based on the SCORE tables for (European) low-risk countries,[11 15 16] which may not be the ideal SCORE tables to determine CVR scores for the populations of the northern emirates, as they may fall in a higher-risk category.[17] For future analyses, we should establish which SCORE table is the most appropriate to use in the UAE. Third, we used a point-of-care test for determining glucose, TC and HDL cholesterol, whereas other studies used different methods, making it harder to compare our results one-on-one with others. However, the point-of-care test has the important advantage of providing a non-invasive, low-cost test that allows on-the-spot counselling, thus facilitating an economical and rapid screening of large numbers of participants. Fourth, questions about shisha smoking were not included in the questionnaire, even though shisha smoking is common, especially among young men in the UAE, where 26%–39% of university students consider themselves current shisha smokers.[18 19] Not including shisha (waterpipe tobacco) smoking in the CVR assessment may have led to a slight underestimation of the proportion of individuals with a high CVR, particularly in the younger age group. Shisha smoking should be included in future questionnaires so that it can be included in the CVR calculation. Fifth, the prevalence figures from this first screening with the new e-Etmnan HSP may not fully represent the broader population of the northern emirates. Due to the absence of extensive regional data, direct comparisons are challenging. However, our findings underscore the importance of conducting comprehensive, population-based studies to better understand the NCD burden in this region and inform targeted public health interventions.

A strength of the study is the large number of participants. This results in a very high accuracy of the overall prevalences, with, at 95% CI, a very low margin of error (±3%). The large number of participants also resulted in a high power of the study, which allowed us to – despite weak correlations – identify very strong associations between the modifiable risk factors and age and sex.

Few other studies exist in which the four NCDs or the modifiable risk factors were analysed in the UAE. We did not compare our data with the national data in the UAE National Health Survey, as that included 13.6% Emirati,[20] whereas we included 91.3% Emirati. A large study by Abu Dhabi's Health Authority, the Weqaya study, that included over 50 000 participants, is the closest to national data that might be comparable, as it included at least 72% Emirati.[21]

Diabetes was found in 6.8% of our study participants, whereas in a retrospective study by Al-Shamsi *et al*, of 977 outpatients, diabetes was found in 42.8%,[22] a much higher percentage. However, their definition of diabetes differed from ours as it was defined as an HbA1c≥6.5% or receiving antidiabetic medications,[22] while we based diabetes on a one-time measurement of blood glucose levels, using thresholds in line with the ADA criteria.[10] As a result, we excluded individuals with known diabetes that was well-controlled with medication. However, even if we assume that all people who self-reported they had diabetes (10.4%, n=3553/34 290) were taking antidiabetic medication and had well-controlled diabetes, the percentage of

Table 5 Prevalence of modifiable risk factors

		Physical inactivity		Overweight		Obesity		Smoking	
	N	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
All participants	34 290	20 039	58.4 (57.9 to 59.0)	11 827	34.5 (34.0 to 35.0)	12 936	37.7 (37.2 to 38.2)	4,837	14.1 (13.7 to 14.5)
Age group (years)									
18–39	17 780	10 321	58.0 (57.3 to 58.8)	5691	32.0 (31.3 to 32.7)	5203	29.3 (28.6 to 29.9)	2818	15.8 (15.3 to 16.4)
40–49	9409	5453	58.0 (57.0 to 59.0)	3,620	38.5 (37.5 to 39.5)	4,152	44.1 (43.1 to 45.1)	1,412	15.0 (14.3 to 15.7)
50–59	4502	2564	57.0 (55.5 to 58.4)	1,648	36.6 (35.2 to 38.0)	2,283	50.7 (49.2 to 52.2)	449	10.0 (9.1 to 10.8)
≥60 years	2599	1701	65.4 (63.6 to 67.3)	868	33.4 (31.6 to 35.2)	1298	49.9 (48.0 to 51.9)	158	6.1 (5.2 to 7.0)
Sex									
Female	20 716	13 850	66.9 (66.2 to 67.5)	6,377	30.8 (30.1 to 31.4)	8393	40.5 (39.9 to 41.2)	319	1.5 (1.4 to 1.7)
Male	13 574	6189	45.6 (44.8 to 46.4)	5,450	40.2 (39.3 to 41.0)	4543	33.5 (32.7 to 34.3)	4,518	33.3 (32.5 to 34.1)
Emirate of residence									
Abu Dhabi	123	74	60.2 (51.5 to 68.8)	47	38.2 (29.6 to 46.8)	39	31.7 (23.5 to 39.9)	19	15.4 (9.1 to 21.8)
Ajman	3575	2218	62.0 (60.5 to 63.6)	1190	33.3 (31.7 to 34.8)	1358	38.0 (36.4 to 39.6)	498	13.9 (12.8 to 15.1)
Dubai	2506	1639	65.4 (63.5 to 67.3)	916	36.6 (34.7 to 38.4)	1015	40.5 (38.6 to 42.4)	384	15.3 (13.9 to 16.7)
Fujairah	5456	3,255	59.7 (58.4 to 61.0)	1875	34.4 (33.1 to 35.6)	2209	40.5 (39.2 to 41.8)	696	12.8 (11.9 to 13.6)
Ras Al Khaimah	8379	4192	50.0 (49.0 to 51.1)	2867	34.2 (33.2 to 35.2)	3255	38.8 (37.8 to 39.9)	1033	12.3 (11.6 to 13.0)
Sharjah	14 012	8536	60.9 (60.1 to 61.7)	4844	34.6 (33.8 to 35.4)	4962	35.4 (34.6 to 36.2)	2165	15.5 (14.8 to 16.0)
Umm Al Quwain	239	125	52.3 (46.0 to 58.6)	88	36.8 (30.7 to 42.9)	98	41.0 (34.8 to 47.2)	42	17.6 (12.8 to 22.4)

CI, confidence interval; n, number; NCD, non-communicable disease.

diabetes in our study would only be 17.2% (6.8% suspected diabetes plus 10.4% self-reported diabetes). More importantly, the participants in the study by Al-Shamsi *et al* were all patients who presented to outpatient clinics, which are, by definition, less healthy than our participants who were invited to a health screening. In the UAE Healthy Future Study (UAEHFS), a prospective cohort study among 5167 UAE nationals, dysglycaemia, present in 11.7%, was defined as haemoglobin A1c (HbA1c) ≥5.7% or self-reported diabetes or receiving antidiabetic medications or an FBG of ≥100 mg/dL.[23] The criteria they used are similar to the ADA criteria for pre-diabetes and diabetes combined[10] and resulted in a lower percentage than the combined percentage of pre-diabetes and diabetes in our population (23.4%). Also, in the Weqaya study, 17.6% were found to have diabetes, which was defined as an HbA1c ≥6.5%0.[21] An important difference between our study and the studies referenced is that our aim was to screen large numbers of participants with a point-of-care test to assess baseline prevalences for future preventive measurements, whereas the HbA1c measurements in the studies referenced are generally used for diagnostic purposes and monitor treatment effect and are too costly and time-consuming for large screenings.

Table 6 Correlation coefficients of modifiable risk factors with age, sex and emirate of residence

Risk factor	Age	Sex	Emirate of residence
Physical inactivity	0.02	0.21	−0.02
Smoking	−0.05	−0.45	0.01
Overweight	0.07	−0.10	0.00
Obesity	0.20	0.07	−0.03

Pearson correlation coefficients were determined to assess correlation (r).

Hypertension was found in 13.9% of our study participants, whereas in the study by Al-Shamsi *et al*, hypertension was found in 34.2%.[22] Factors that may contribute to this considerable difference in prevalence can be that their definition of hypertension also included individuals using hypertensive medications and that the average age of their participants (49.7 years)[22] was much higher than that of our participants (39.5 years). The age difference explains a large part of the difference in hypertension prevalence, as hypertension is known to increase with age because the arteries become more rigid over time. This is illustrated by the stepwise increase in hypertension prevalence (from 7.8% to 34.3%) with age in our study. In the UAEHFS, hypertension was present in 22.4% of the participants,[23] a much higher prevalence than in our study, even though the UAEHFS included younger individuals (18- to 40-year-olds; mean age, 25.7 years (SD 6.2)) who would be expected to have low risk of hypertension. Among the 18- to 39-year-olds in this study (mean age, 29.5 years (SD 6.4)), only 7.8% had hypertension, and the prevalence of hypertension increased significantly in every older age group. An explanation for this difference may be that the UAEHFS's definition of hypertension also included self-reported hypertension and taking blood-pressure-controlling medication, thus also including participants in whom the hypertension is under control.[23] However, we did not include self-reported hypertension, as the purpose of the HSP is to identify and treat individuals who are not already known with an NCD. In addition, they defined hypertension as having two consecutive blood pressure readings of ≥140 mm Hg systolic and/or ≥90 mm Hg diastolic,[24] which may result in a slightly lower prevalence than the definition we used, as that was based on the recommendation by the American College of Cardiology and the American Heart Association of averaging at least two readings,[25] and we averaged three readings. In the Weqaya study, where the mean age of the participants (36.8 years) was similar to that of our participants (39.5 years), 23.1% were found to have hypertension[21]; however, that study included, similar to the UAEHFS study, also self-reported hypertension. Among the individuals who were prescribed, based on our questionnaire, medication to control their hypertension, 2369 did not have high blood pressure at the clinical screening. This would bring the proportion of individuals with hypertension to 20.8% (n=7140). This proportion is more in line with the UAEHFS (22.4%) and Weqaya study (23.1%).

As a proxy for dyslipidaemia, a high TC/HDL ratio was used, and this high ratio was noted in 8.1% of our participants. Other studies used very different definitions of dyslipidaemia, making it impossible to compare results. For instance, in the UAEHFS, with a very broad definition of dyslipidaemia, the prevalence was 62.7%,[23] whereas in the study by Al-Shamsi *et al*., the TC/HDL ratio was assessed; however, the prevalence of a high ratio was not determined,[22] and the Weqaya study did not include the TC/HDL ratio.[21]

We found a high CVR to be present in 11.5% of the participants. In Abu Dhabi, a high CVR was previously reported in 4.5% of 2621 40- to 70-year-olds without diabetes or known CVD.[26] Although we included all adults ≥18 years old, the mean age of our participants (39.5±13.0) was similar to that of their subjects (40.2±8.4), so there is not a large difference in that aspect. The major difference between the studies is the exclusion of participants with either CVD or diabetes in the Abu Dhabi study. Indeed, if we only look at our non-diabetics subgroup, high CVR is present in a much smaller proportion (8.5%), so if we were to exclude known CVD, the proportion with high CVR would doubtless be even lower and approaching the results from the Abu Dhabi study. No other studies from the UAE analysed the presence of high CVR. Of the neighbouring countries, only in Oman has the prevalence of high CVs been analysed with SCORE, and there it was found to be present in 6.6% of diabetic patients ≥40 years old in 2008,[27] which seems extremely low compared with the 52.5% in our suspected diabetic patients. Part of the difference may be explained by the study period, as the study in Oman was based on data gathered in 2008, 15 years before our study, while the prevalence of high CVR increased significantly (60% for women, 120% for men) in the 17 years prior (1991 to 2008),[27] and may have increased further since.

The vast majority of individuals (over 90%) had at least one of the modifiable risk factors analysed. The prevalence of the most common one, physical inactivity (present in 58.4%), was similar to the 62.5% reported for the UAE based on the WHO's 2008 data.[28] Current smoking was reported by 14.1% of participants, which was slightly higher than the 11.6% reported in the Weqaya study,[21] and slightly lower than the 17.1% reported by Al-Shamsi *et al*.[22] That last study, however, considered the history of smoking and mainly included men, which inevitably resulted in a higher percentage. When comparing smoking in men and women directly, the percentages are very similar: 33.3% and 1.5% in our study and 34.0% and 1.2% in the study by Al-Shamsi, respectively. The 2008 WHO data also reported current smoking and found it to be 7.2% in the UAE.[28] Obesity and overweight are increasing global public health challenges that affect quality of life, morbidity and mortality. Especially high-income Arab countries (such as the UAE) have alarmingly high rates of overweight, ranging from 58% to 79%, and obesity, ranging from 22% to 43%.[28] We found 34.5% of the participants to be overweight and 37.7% to be obese. This is in line with the Weqaya study, where 31.9% were found to be overweight and 35.4% obese.[21]

An important discovery was that in addition to age and sex, the interaction between age and sex also strongly correlated with each of the modifiable risk factors we analysed (physical inactivity, smoking, overweight and obesity). In other words, the effect of age on each of these risk factors varied by sex. This must be kept in mind when developing preventive programmes tailored to different age groups and sexes to optimise their effectiveness.

Several of the characteristics, such as the prevalence of pre-diabetes and hypertension, differed between the emirates. Although the UAE has about 88% immigrants,[29] with a wide range of nationalities, these did not contribute much to this study, as 91.3% of the participants were Emirati. The differences in characteristics may instead be due to variations in, for instance, diet and genetic makeup of the Emirati. We did not find other studies reporting health characteristics for individual emirates, so this study provides unique insights that may be important for prevention programmes.

The UAE's Ministry of Health and Prevention has adopted the WHO's advice to develop national targets and indicators and a policy for preventing and controlling NCDs.[4] One of the strategies was to launch the e-Etmnan HSP, which is a valuable tool for early detection and treatment of NCDs and assessment of modifiable risk factors in large numbers of patients. The HSP will help inform the Emirati Health Services of the current health situation, aid in the development of prevention programmes, set goals for prevention programmes and monitor the effect of such programmes. A promising result of such a preventive programme was observed after the introduction of a yearly health screening of adults in neighbouring Qatar, which was followed by, among others, counselling, advice and treatment. That programme resulted, from 2017 to 2019, in a prevalence reduction of hypertension and diabetes and the risk factors smoking and obesity (physical inactivity was not assessed).[30] In general, investing in NCD control generates major health and financial gains, as reported by the WHO.[31] The data presented in the current study can be used as baseline data for future analyses. For participants in the programme, this is a convenient and fast way to undergo a yearly personal health assessment.

CONCLUSION

The prevalence of the NCDs pre-diabetes, diabetes type 2, hypertension and high TC/HDL ratio was high in the northern emirates. A high CVR was present in 11.5% of participants and was especially common among people with diabetes. A large majority of participants had one or more of the modifiable risk factors: physical inactivity, smoking and overweight or obesity that contribute to these NCDs. Age and sex were found to correlate strongly with each of the modifiable risk factors; moreover, age and sex interact in their effect on these modifiable risk factors. To reduce the burden of NCDs, government initiatives should emphasise public awareness and education, regulate unhealthy food options, improve infrastructure to promote physical activity and enforce smoke-free policies. Additionally, strengthening data collection and analysis to monitor health outcomes and adapt strategies based on evidence is recommended.

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