








HbA1c, blood pressure, and cholesterol control in adults with diabetes: A report card for Kuwait

Abdullah Alkandari^{1*} , Unjali P Gujral² , Abdullah Bennakhi¹ , Sarah Qabazard¹ , Rihab Al-Wotayan³, Qais Al Duwairi¹, Hessa Al-Kandari^{1,3} , KM Venkat Narayan² , Monira Alarouj¹ 

¹Dasman Diabetes Institute, Kuwait City, Kuwait, ²Rollins School of Public Health, Hubert Department of Global Health, Emory University, Atlanta, GA, USA, and ³Ministry of Health, Kuwait City, Kuwait

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*Correspondence

Abdullah Alkandari
Tel.: 00965 2224 2999 (ext. 2253)
Fax: 00965 2249 2436
E-mail address:
abdullah.alkandari@dasmaninstitute.org

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ABSTRACT

Aim: To assess the level of glycemetic, blood pressure, and cholesterol control (the 'ABCs') nationally amongst adults with diabetes living in Kuwait.

Materials and Methods: Using data from two national cross-sectional surveys, the levels of risk factor control were assessed in 1,801 adults with diabetes, aged 18–82 years. Glycemic control was defined as HbA1c < 7%, blood pressure control as systolic and diastolic blood pressures of <140/90 mmHg, and non-HDL cholesterol control as <3.4 mmol/L.

Results: The percentage of adults with diabetes achieving control was 39.2% (95% CI, 37.0–41.5) for glycemia, 58.4% (95% CI, 56.0–60.7) for blood pressure, and 28.3% (95% CI, 26.3–30.4) for non-HDL cholesterol. The percentage of adults who were non-smokers was 77.6% (95% CI, 75.6–79.4). The percentage of adults with diabetes achieving control on all three risk factors was 7.4% (95% CI, 6.3–8.8), and only 5.8% (95% CI, 4.8–7.0) achieved ABC control and were nonsmokers. ABC control was 30% higher in women compared with men. Non-Kuwaitis were almost twice as likely to have uncontrolled ABC factors compared with Kuwaitis.

Conclusions: Only 1 in 13 people with diabetes in Kuwait achieved good control of glycemia, blood pressure, and cholesterol. Only 2 in 5 achieved glycemetic control, 6 in 10 blood pressure control, and 2 in 7 cholesterol control. A national diabetes quality improvement program is urgently needed to improve the quality of care and to prevent long-term complications.

INTRODUCTION

Diabetes affects 463 million people worldwide¹. The Middle East and North Africa (MENA) region is especially at risk. As of 2019 there were approximately 55 million people living with diabetes in the MENA region, and this number is expected to increase by 96% to 108 million by 2045¹. The prevalence of diabetes is high in Kuwait, where two national cross-sectional studies reported the adult diabetes prevalence to be 19%^{2,3}. Furthermore, a recent analysis indicated that adults with diabetes in Kuwait are more likely to have multiple chronic co-

morbidities, including hypertension and cardiovascular disease, compared with individuals without diabetes⁴. Diabetes is therefore a serious public health problem in Kuwait, with mounting socioeconomic and human costs. It is estimated that Kuwait spends more than \$1,000 a year per adult with diabetes each year¹.

The Diabetes Control and Complications Trial (DCCT) and the United Kingdom Prospective Diabetes Study (UKPDS) found that improved glycemetic control can reduce both microvascular and macrovascular complications in patients with diabetes^{5,6}. Subsequent studies have shown that in addition to glycemetic control, improved blood pressure and lipid control also improved health outcomes in patients with diabetes^{6,7},

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especially when achieved in unison⁸. Conversely, smoking has been shown to increase the risk of cardiovascular death and mortality in patients with diabetes⁹. Therefore, the successful management of risk factors, including HbA1c, blood pressure, and non-HDL cholesterol (the 'ABCs'), as well as the cessation of smoking (the 'ABCDs'), is the benchmark of clinical care and population medicine for people with diabetes¹⁰. Evidence from several high-income nations also indicate that effective control of ABCDs is feasible^{11–13} and that benchmarking and monitoring of the quality of care and attention to diabetes care quality improvement can reduce the rates of complications and death in people with diabetes at the population level¹⁴.

We have previously reported that the percentage of Kuwaiti adults with diabetes treated with glucose-lowering medication who achieved glycemic control was 34.5%¹⁵. However, the proportion of adults with diabetes in Kuwait that are achieving target care goals across all cardiovascular risk factors remains unclear. Therefore, we assessed the level of glycemic, blood pressure, cholesterol control, and smoking status in adults with diabetes living in Kuwait.

MATERIALS AND METHODS

Surveys

Data on adults with diabetes aged 18–82 years from two nationally representative cross-sectional studies were pooled and analyzed: the Eastern Mediterranean Approaches to Non-Communicable Diseases (EMAN) and the Kuwait Diabetes Epidemiology Program (KDEP). The two surveys were pooled to ensure a large diabetes population including a non-Kuwaiti sample. The two surveys have been described in detail previously^{2,3}, and are outlined in Table S1.

Briefly, EMAN was conducted by the Ministry of Health in collaboration with the World Health Organization (WHO) in 2014. The target population was Kuwaiti adults aged 18–69 years residing in all six governorates in Kuwait. The survey utilized the WHO STEP-Wise Approach to Surveillance methodology¹⁶. Data were collected between March and September 2014 by a multidisciplinary team of health care workers in three consecutive steps: (i) a demographics and medical history questionnaire, (ii) physical measurements, and (iii) blood biochemistry measurements. The Kuwaiti Public Authority for Civil Information (PACI) provided a randomly selected sample of 4,391 Kuwaiti adults aged 18–69 from a sampling frame stratified by sex and age. The number of participants who completed the first two steps was 3,915 (89.2%) and the number of participants who completed all three steps, including HbA1c and fasting plasma glucose measurements, was 2,561 (65.4%). The sex and age distribution of the participants who completed all three steps were comparable to those who only completed steps 1 and 2 (Table S2).

The KDEP was conducted by Dasman Diabetes Institute between 2011 and 2014. While EMAN only sampled Kuwaiti adults, KDEP sampled Kuwaiti and non-Kuwaiti adults aged 18–82 years, residing in all six Kuwaiti governorates. The KDEP

utilized a slightly modified version of the WHO STEP-Wise Approach to Surveillance methodology. Data were collected between April 2011 and June 2014 by a multidisciplinary team of health care workers in four consecutive steps: (i) a demographics questionnaire, (ii) diet, lifestyle, and medical and family history, (iii) physical measurements, and (iv) blood biochemistry measurements. A random sample, stratified by age, sex, and nationality was provided by PACI. The number of participants who completed steps 1–3 was 5,291 (85.1% response rate). The number of participants who completed all four steps, including an HbA1c fasting plasma glucose measurement was 4,947 (79.6%). The mean age of KDEP participants who completed all four steps, including a blood sample, was identical to those who only completed steps 1–3 (Table S2). However, participants who did not complete all four steps in KDEP were 68.0% male, compared with 56.1% in participants who did complete all four steps.

Measurements

Height, weight, blood pressure, and waist circumference measurements were obtained for participants in both studies. In EMAN, height and weight were measured using an electronic Growth Management Scale. In KDEP, calibrated portable electronic scales were used to measure weight and inflexible bars were used to measure height. The body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Waist and hip circumference were measured using a non-stretch tape in both studies. A clinical mercury sphygmomanometer and a stethoscope with a universal cuff was used to measure blood pressure in EMAN, while an Omron HEM-907XL digital sphygmomanometer was used in KDEP. Blood pressure was measured three times in both studies. The average of the second and third reading or the average of the first and second if a third measurement was not taken was recorded and used in EMAN. For KDEP, the average of the three readings was recorded and used.

In EMAN, a blood sample was taken following a 12 h overnight fast. Blood glucose and lipid profiles were assessed using an Auto-analyzer Architect at the clinical laboratories of the Kuwait Cancer Control Center. In KDEP, blood samples were taken following a 10 h overnight fast. Blood glucose and lipid profiles were assessed at the clinical laboratories of the Dasman Diabetes Institute using a Siemens Dimension RXL chemistry analyzer, except for HbA1c which was measured using a Variant Device.

Definitions

The prevalence of diabetes in both surveys has been reported previously^{2,3}. Diabetes was defined using the WHO criteria of fasting plasma glucose (FPG) ≥ 7 mmol/L or HbA1c $\geq 6.5\%$ (48 mmol/mol)¹⁷. Participants were considered to have diabetes if they met either the FPG or the HbA1c criteria, or if they self-reported a previous diagnosis of diabetes with concurrent prescribed glucose-lowering medication. Undiagnosed diabetes was defined as a survey measured FPG ≥ 7 mmol/L or HbA1c

≥6.5% without a previous self-reported diagnosis. Participants who self-reported a previous diabetes diagnosis but did not report receiving any treatment for diabetes and recorded a FPG <7 mmol/L and a HbA1c <6.5%, were considered to be false-positives and reclassified as having either normal glycemia or pre-diabetes based on their FPG or HbA1c value.

Glycemic, blood pressure, and lipid control were defined using the American Diabetes Association's (ADA) recommended targets. Glycemic control was defined as HbA1c <7% (<53 mmol/mol). A less stringent HbA1c <8% (<64 mmol/mol) was also considered¹⁸. Blood pressure control was defined as systolic and diastolic blood pressures of <140/90 mmHg. A more stringent target of <130/80 mmHg was also considered¹⁹. Lipid control was defined as a non-HDL cholesterol <3.4 mmol/L (<130 mg/dL). A lipid control definition of low-density (LDL) <2.6 mmol/L (100 mg/dL) was also considered. Current smoking status was self-reported. ABC control was defined as HbA1c <7%, blood pressure < 140/90 mmHg, and non-HDL cholesterol <3.4 mmol/L. ABCD control was defined as control of the ABC factors in addition to not being a current smoker. Normal weight was defined as a BMI <25 kg/m², overweight was defined as a BMI 25.0–29.9 kg/m² and obesity was defined as a BMI ≥30 kg/m²²⁰. An elevated waist-hip ratio was defined as ≥0.9 in men and ≥0.85 in women²¹.

Statistical analysis

Statistical analyses were performed using GraphPad Prism and IBM SPSS Statistics 25. Sample weights were applied independently for each survey. Sample weights were calculated as the product of the sample selection weight (population *n*/sample *n*), the non-response weight (1/response rate), and the population weight (population proportion/sample proportion), as described previously^{2,3}. For EMAN, sample weights were calculated for Kuwaiti men and women for four age-groups (18–29, 30–44, 45–59 and 60–69 years). For KDEP, sample weights were calculated for Kuwaiti men, Kuwaiti women, non-Kuwaiti men, and non-Kuwaiti women for four age groups (18–29, 30–44, 45–59, and 60–82 years).

Weighted levels of glycemia, hypertension, and dyslipidemia control were reported as percentages with corresponding 95% confidence intervals (CI), and were estimated by sex, age, nationality, and treatment status. Treatment status for diabetes, hypertension, or dyslipidemia were self-reported. Treatment for diabetes was defined as individuals prescribed oral glucose-lowering drugs, insulin, or both. Weighted levels of control of all three ABC factors were also estimated, as were the levels of control of all four ABCD factors. Continuous variables were presented as mean ± standard deviation. Factors associated with uncontrolled glycemia, blood pressure, non-HDL cholesterol, ABC, and ABCD were determined using binary logistic regression. Models included sex, nationality, age, obesity status, waist-hip ratio, treatment status, and smoking (smoking was not included for ABCD).

RESULTS

The total number of adults with diabetes in this pooled analysis was 1,801; 494 from EMAN and 1,307 from KDEP. Details on the characteristics of the populations are provided in Table 1: 58.9% male, 56.5% Kuwaiti nationals; mean age 50.1 years (±10.7). The majority were obese (59.0%) and the mean BMI was 32.0 kg/m² (±6.3). Approximately two-thirds of adults with diabetes self-reported a previous diagnosis (67.5%) and were under treatment (65.5%); the rest were survey. The proportion of adults with diabetes and self-reported hypertension was 43.3%, and 37.0% were being treated for hypertension. A similar proportion self-reported a diagnosis of dyslipidemia (42.3%), however, only 30.3% were being treated. Over a fifth (21.2%) of adults with diabetes were current smokers.

The percentage of adults with diabetes achieving an HbA1c <7% was 39.2% (95% CI, 37.0–41.5, Figure 1a). Only 35.7% (95% CI, 31.3–40.3) of participants who were on glucose-lowering medication achieved an HbA1c <7%, compared with 40.6% (95% CI, 38.0–43.2) of untreated adults with diabetes.

Table 1 | Characteristics of adults with diabetes in EMAN and KDEP

	Pooled population		EMAN		KDEP	
	N	%	N	%	N	%
N	1801	100%	494	27.4%	1,307	72.6%
Male	1,060	58.9%	210	42.5%	850	65.0%
Age						
18–44	511	28.4%	185	37.4%	326	24.9%
45–59	946	52.5%	219	44.3%	727	55.6%
60+	344	19.1%	90	18.2%	254	19.4%
Nationality						
Kuwaiti	1,011	56.5%	494	100%	517	39.9%
Non-Kuwaiti	780	43.6%	0	0%	780	60.2%
Current smoker	382	21.2%	84	17.0%	298	22.8%
Married	1,554	86.8%	385	78%	1,169	90.2%
Education						
Less than high school	538	30.2%	176	37.0%	362	27.7%
High school	433	24.3%	101	21.2%	332	25.4%
University	811	45.5%	199	41.8%	612	46.9%
BMI category						
BMI <25 kg/m ²	158	8.9%	43	9.2%	115	8.8%
BMI 25–29.9 kg/m ²	567	32.1%	129	27.7%	438	33.6%
BMI ≥30 kg/m ²	1,044	59.0%	293	63.0%	751	57.6%
Diabetes						
Self-reported diagnosis	1,215	67.5%	293	59.3%	922	70.5%
Self-reported treatment	1,179	65.5%	275	55.7%	904	69.2%
Hypertension						
Self-reported diagnosis	780	43.3%	212	42.9%	568	43.5%
Self-reported treatment	667	37.0%	186	37.7%	481	36.8%
Dyslipidemia						
Self-reported diagnosis	762	42.3%	195	39.5%	567	43.4%
Self-reported treatment	545	30.3%	156	31.6%	389	29.8%

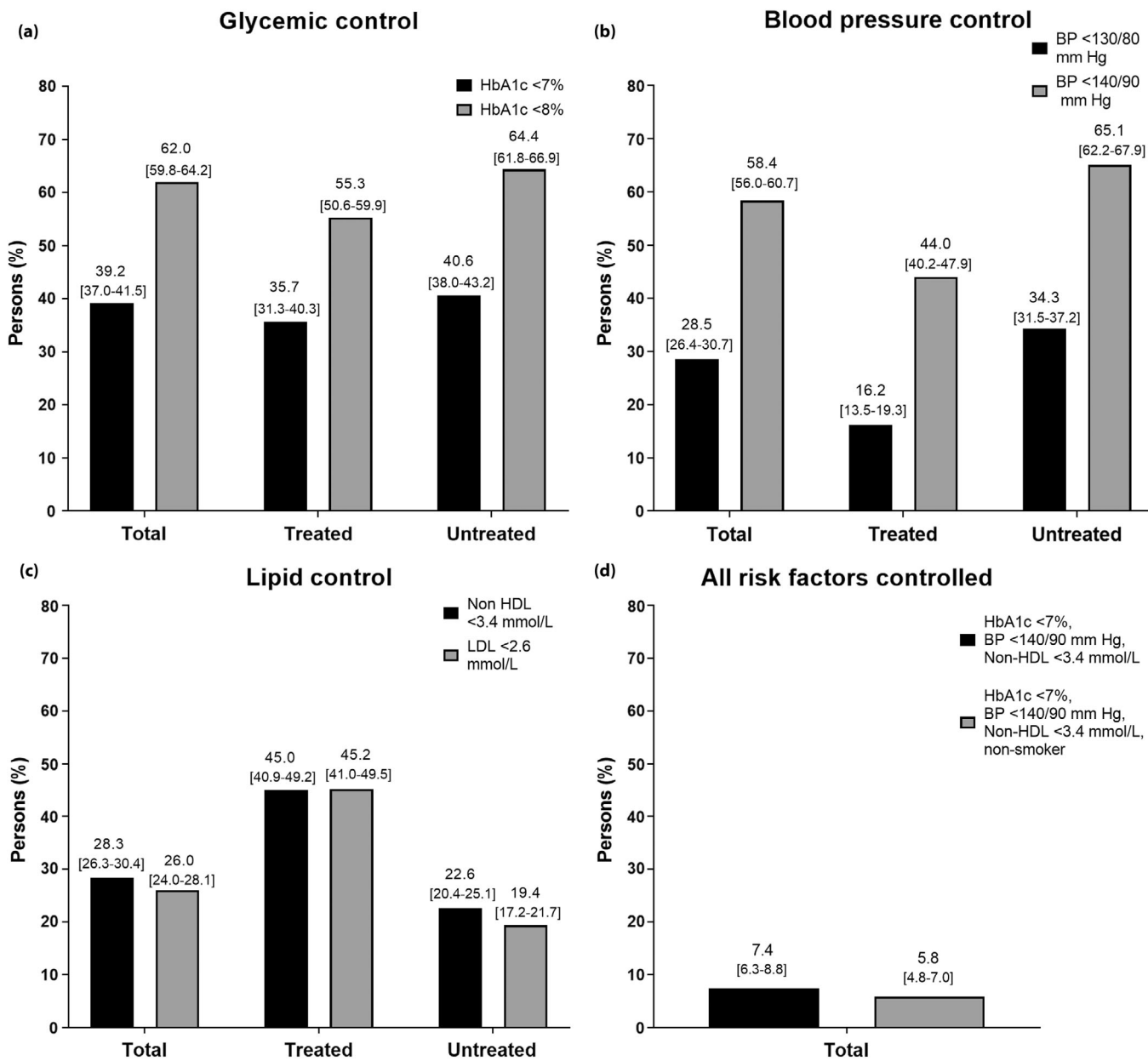


Figure 1 | The percentage (with 95% CIs) of adults with diabetes who achieved (a) glycemic, (b) blood pressure, (c) lipid control, and (d) all risk factor control.

Using a less stringent HbA1c (<8%) definition of glycemic control, 62.0% (95% CI, 59.8–64.2) achieved the target overall, including 55.3% (95% CI, 50.6–59.9) of treated participants, and 64.4% (95% CI, 61.8–66.9) of untreated participants. The percentage of adults with diabetes who achieved a blood pressure control of <140/90 mmHg was 58.4% (95% CI 56.0–60.7), and was 44.0% (95% CI, 40.2–47.9) in those treated for hypertension compared with 65.1% (95% CI, 62.2–67.9) in those untreated for hypertension. The percentage of adults who achieved blood pressure control using a more stringent <130/80 mmHg target was 28.5% (95% CI, 26.4–30.7), and was

16.2% (95% CI, 13.5–19.3) in those who were treated for hypertension and 34.3% (95% CI, 31.5–37.2) in those who were untreated. The percentage of adults with diabetes who achieved non-HDL cholesterol control (<3.4 mmol/L) was 28.3% (95% CI, 26.3–30.4), and was 45.0% (95% CI, 40.9–49.2) in those treated for dyslipidemia and 22.6% (95% CI, 20.4–25.1) in those untreated for dyslipidemia. A similar percentage of adults with diabetes achieved LDL cholesterol control (<2.6 mmol/L). Overall, 26.0% (95% CI, 24.0–28.1) achieved LDL cholesterol control, including 45.2% (95% CI, 41.0–49.5) of those under treatment and 19.4% (95% CI, 17.2–21.7) of those who did not

receive treatment. Non-smoking was achieved by 77.6% of participants (95% CI, 75.6–79.4).

The percentage of adults with diabetes who achieved control in all three ABC risk factors (HbA1c < 7%, blood pressure < 140/90 mmHg and non-HDL cholesterol < 3.4 mmol/L) was 7.4% (95% CI, 6.3–8.8). The percentage of adults who achieved ABCD control (ABC plus nonsmoking) was 5.8% (95% CI, 4.8–7.0). The level of ABC risk factor control in men with diabetes was 7.1% (95% CI, 5.6–8.8), which was lower than the 9.2% (95% CI, 7.2–11.6) control in women with diabetes (Table 2). The percentage of men with ABCD control was 4.6% (95% CI, 3.5–6.1), which was almost half of the 8.4% (95% CI, 6.6–10.8) of women with ABCD control. Younger adults with diabetes had higher levels of ABC control than older adults. The ABC control was 9.2% (95% CI, 6.9–12.1) in those aged 18–44 compared with 5.9% (95% CI, 4.5–7.6) and 7.6% (95% CI, 5.2–10.9) in those aged 45–59 years and 60 years or more, respectively. The level of ABC control in Kuwaiti nationals with diabetes was 10.2% (95% CI, 8.4–12.4) compared with 5.2% (95% CI, 3.9–7.0) amongst non-Kuwaiti nationals living in Kuwait.

Figure 2 illustrates the percentage of adults with diabetes who achieved control in 0, 1, 2, 3, or 4 ABCD risk factors. The percentage of adults who did not achieve control in any of these four factors was 3.4% (95% CI, 2.7–4.4). The percentage of adults who achieved control in one factor was 27.7% (95% CI, 25.6–29.8), two factors was 37.9% (95% CI, 35.6–40.2), and three factors was 25.3% (95% CI, 23.3–27.4). The percentage of adults achieving control in at least two risk factors was 68.9% (95% CI, 66.7–71.1), and of at least three risk factors was 31.1% (95% CI, 28.9–33.3).

In binary logistic regression models, after adjusting for age, sex, and nationality, the only factor associated with uncontrolled glycemia (HbA1c \geq 7%) was the waist-hip ratio (Table 3). Adults with an elevated waist-hip ratio were almost twice as likely to have uncontrolled glycemia as adults with a normal waist-hip ratio (AOR = 1.96, 95% CI 1.52–2.53). In contrast, sex, nationality, age, obesity, smoking, and treatment status were all significantly associated with uncontrolled blood

pressure (BP \geq 140/90 mmHg). Non-Kuwaitis (AOR = 2.33, 95% CI 1.85–2.93) and adults treated for blood pressure (AOR = 2.30, 95% CI 1.81–2.92) were more than twice as likely to have uncontrolled blood pressure as Kuwaitis and untreated adults, respectively. Nationality, smoking, and treatment status (with anti-lipid medication) were also associated with uncontrolled non-HDL cholesterol levels (non-HDL \geq 3.4 mmol/L). Non-Kuwaitis were twice as likely to have uncontrolled cholesterol as Kuwaitis (AOR = 1.99, 95% CI 1.57–2.53). A non-Kuwaiti nationality was also associated with poor control of all three ABC factors (AOR = 1.95, 95% CI 1.29–2.94). Men were significantly more likely to have all four ABCD factors uncontrolled (AOR = 1.71, 95% CI 1.10–2.66).

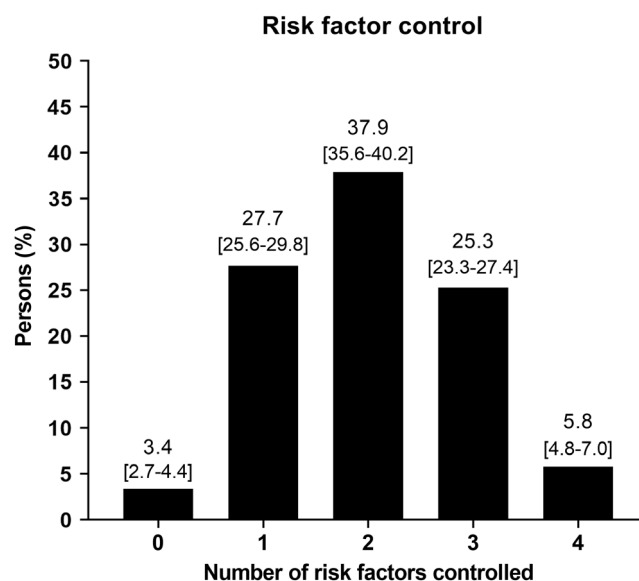


Figure 2 | The percentage (with 95% CIs) of adults with diabetes who achieved control in 0, 1, 2, 3, or 4 risk factors.

Table 2 | Achievement of HbA1c, blood pressure, non-HDL cholesterol, ABC, nonsmoking, and ABCD targets by demographic

	HbA1c < 7%	BP < 140/90 mmHg	Non-HDL < 3.4 mmol/L	ABC	Nonsmoker	ABCD
Total	39.2 [37.0–41.5]	58.4 [56.0–60.7]	28.3 [26.3–30.4]	7.4 [6.3–8.8]	77.6 [75.6–79.4]	5.8 [4.8–7.0]
Sex						
Male	37.9 [35.1–40.9]	56.9 [53.9–60.0]	29.5 [26.8–32.3]	7.1 [5.6–8.8]	69.5 [66.7–72.2]	4.6 [3.5–6.1]
Female	39.5 [36.1–43.1]	63.8 [60.1–67.3]	32.3 [29.0–35.8]	9.2 [7.2–11.6]	92.8 [90.8–94.5]	8.4 [6.6–10.8]
Nationality						
Kuwaiti	38.8 [35.8–41.8]	65.8 [62.7–68.8]	39.2 [36.2–42.2]	10.2 [8.4–12.4]	82.4 [79.9–84.6]	7.6 [6.0–9.5]
Non-Kuwaiti	38.4 [35.0–41.8]	52.6 [49.1–56.1]	19.8 [17.2–22.8]	5.2 [3.9–7.0]	74.9 [71.8–77.8]	4.5 [3.2–6.1]
Age						
18–44	44.0 [39.8–48.4]	66.7 [62.4–70.9]	24.1 [20.6–28.0]	9.2 [6.9–12.1]	71.8 [67.8–75.5]	6.8 [4.9–9.5]
45–59	35.1 [32.1–38.2]	56.8 [53.6–60.0]	27.8 [25.0–30.7]	5.9 [4.5–7.6]	77.4 [74.6–79.9]	4.6 [3.4–6.1]
60+	38.7 [33.7–43.9]	40.5 [35.3–45.9]	38.7 [33.7–43.9]	7.6 [5.2–10.9]	87.8 [83.9–90.8]	6.0 [3.9–9.1]

Table 3 | Factors associated with uncontrolled glycemia, blood pressure, non-HDL cholesterol, ABC, and ABCD†

Variable	HbA1c ≥7%		BP ≥140/90 mmHg		Non-HDL ≥34 mmol/L		ABC uncontrolled		ABCD uncontrolled	
	AOR	P	AOR	P	AOR	P	AOR	P	AOR	P
Male	1.01 [0.81–1.27]	0.91	1.61 [1.27–2.05]	<0.001	0.87 [0.68–1.12]	0.28	1.16 [0.76–1.75]	0.50	1.71 [1.10–2.66]	0.02
Aged ≥50 years	1.17 [0.95–1.44]	0.14	1.72 [1.38–2.15]	<0.001	0.84 [0.67–1.07]	0.16	1.31 [0.87–1.97]	0.20	1.25 [0.79–1.98]	0.33
Non-Kuwaiti	1.10 [0.89–1.36]	0.37	2.33 [1.85–2.93]	<0.001	1.99 [1.57–2.53]	<0.001	1.95 [1.29–2.94]	<0.001	1.52 [0.96–2.40]	0.07
Under treatment	1.22 [0.96–1.56]	0.10	2.30 [1.81–2.92]	<0.001	0.42 [0.33–0.53]	<0.001	0.67 [0.45–1.01]	0.06	0.84 [0.54–1.32]	0.46
Current smoker	0.86 [0.68–1.10]	0.23	0.53 [0.41–0.69]	<0.001	1.54 [1.15–2.08]	<0.001	0.90 [0.56–1.44]	0.65	–	–
BMI ≥30 kg/m ²	1.03 [0.84–1.26]	0.79	1.28 [1.03–1.59]	<0.001	0.90 [0.72–1.14]	0.38	1.27 [0.86–1.87]	0.23	1.28 [0.83–1.97]	0.27
Elevated waist-hip ratio	1.96 [1.52–2.53]	<0.001	1.10 [0.83–1.47]	0.51	1.34 [1.01–1.78]	0.04	1.71 [1.11–2.64]	0.01	1.54 [0.94–2.51]	0.09

†Odds ratio with 95% confidence intervals were adjusted for age, sex, and nationality. Treatment was with glucose-lowering medication for HbA1c, blood pressure lowering medication for BP, anti-lipids medication for non-HDL, and any one of the preceding three for ABC and ABCD.

DISCUSSION

The results of our analyses indicate that most individuals living with diabetes in Kuwait receive less than optimal diabetes care. Overall, only 39.2% of participants had well controlled HbA1c, 58.4% had well controlled blood pressure, and 28.3% had well controlled non-HDL cholesterol. Furthermore, only 7.4% of participants with diabetes were well controlled on all three measures, and 5.8% met all three measures and were also nonsmokers. Evidence indicates that appropriate diabetes control can significantly lower the risk of microvascular and macrovascular complications as well as mortality in individuals with diabetes^{6,22,23}. Therefore, there is substantial room for improvement in diabetes care in Kuwait, and such improvement may lead to extensive long term health benefits and improvements in the quality of life.

Previous studies have reported that glycemic control amongst Kuwaiti individuals with diabetes is low^{15,24}. Our study confirms these findings and adds that the achievement of diabetes care targets for blood pressure and lipids is also lacking. We found that while the achievement of target care goals was poor amongst the entire sample, there were differences by sex, age, and nationality. The percentage of women who achieved all target care ABCD goals was almost twice that compared with men. While sex was not significantly associated with glycemic and lipid control, men were 1.6 times more likely to have uncontrolled blood pressure than women, and smoking rates were four times higher in men compared with women. Additionally, there was a higher proportion of those who did not achieve adequate care goals amongst individuals who were aged 45 and older compared with those who were under age 45. There was also a greater percentage of inadequate care amongst those aged 45–59 years old compared with those aged 60 and over.

Our results are similar to findings from the United States in that those who are middle aged have poorer control than those who are elderly²⁵. However, in our study we found that those who were elderly had an overall worse glycemic control than the youngest age group of 18–44 years, which is contrary to previous findings^{25,26}. While those in the youngest age group have the most to benefit from adequate diabetes care due to their longer life span and the potential longer duration of disease, additional efforts should also be focused on improving diabetes care targets for those who are middle aged and elderly in Kuwait.

We also found differences in achievement of targeted care goals by nationality in our sample. There was a higher proportion of care targets across all parameters amongst those who were Kuwaiti compared with non-Kuwaiti residents, who are predominately migrants from other Middle Eastern countries or from South or South East Asia. Non-Kuwaitis were twice as likely to have uncontrolled blood pressure, non-HDL cholesterol levels, and ABC factors, and were 1.5 times as likely to have uncontrolled ABCD factors than Kuwaiti citizens. While the reasons behind this are not clear, a previous study noted that while 92% of Kuwaiti nationals were registered in the primary health care center system, which is the basis of most primary care in the country, only 62% of migrants from other Middle Eastern

countries, and 39% of migrants from Asian countries were registered in the system²⁷. Therefore, a lack of access to care may be a reason for poorer diabetes control amongst non-Kuwaiti nationals in Kuwait. Another possible factor is that the age of onset of diabetes and hypertension is lower in Asian expatriates in Kuwait than in Kuwaiti nationals²⁸.

Studies from the United States have examined differences in population subgroups in meeting targeted goals for diabetes care and have noted that disease severity may be a marker for poor achievement. A study examining national estimates on the percentage of people with diabetes who meet ABC goals in the United States found that individuals not taking glucose lowering medications were more likely to achieve an HbA1c <7.0%²⁵. Similarly, results from the Look Ahead (Action for Health in Diabetes) trial found that those not taking hypertensive medication were more likely to achieve blood pressure goals²⁹. These results are in line with our study results in that those who were untreated for diabetes and hypertension were more likely to achieve HbA1c and blood pressure goals compared with those who were treated. However, further exploration of the relationship between the duration of disease and achievement of control targets is necessary to better understand this relationship amongst people with diabetes in Kuwait.

The strengths of our study include the representative, population based, random sampling design, and the use of standardized methods of two surveys based on WHO methodology, and the inclusion of KDEP allowed for the assessment of diabetes care targets in expatriates living in Kuwait. However, as the EMAN survey only included Kuwaiti nationals, the sample used in this present analysis oversampled Kuwaiti nationals. Over half of the study's population were Kuwaiti, who account for only 30% of the overall Kuwaiti population. Additionally, neither study distinguished between type 1 and type 2 diabetes and the surveys did not collect information on the duration of diabetes which may impact the ability to achieve control targets.

Although unified glycemic, blood pressure, and lipid control in adults with diabetes in Kuwait is very low, the rates are similar to estimates from Europe where 6.5% of participants with diabetes achieved all three targets³⁰. However, they lag behind estimates from the United States, where 22.2% of individuals with diabetes achieved all three targets between 2015–2018¹³. Risk factor control was only 7.3% in the United States in 2000³¹, and the three-fold increase in the preceding decades was accompanied by large reductions in the incidence of a broad spectrum of diabetes related complications in the country³². These results were likely due to advances in acute clinical care, improvements in the healthcare system, and health promotion and education efforts aimed at people with diabetes, paralleled with diabetes prevention efforts. Diabetes and other non-communicable diseases were the cause of 72% of deaths in Kuwait in 2016³³. Improved risk factor control in Kuwait could likewise reduce the rates of diabetes related morbidity and mortality in the population.

In summary, the level of risk factor control in individuals with diabetes living in Kuwait is suboptimal. Only 1 in 13

adults with diabetes achieved good control of glycemia, blood pressure, and cholesterol. Only 2 in 5 achieved good glycemic control, 6 in 10 good blood pressure control, and 2 in 7 good cholesterol control. While all subgroups had suboptimal care, special attention may need to be focused on expatriate populations, those who are middle aged or elderly, as well as those who are receiving treatment and may have increased disease severity. Clear gaps still exist between the knowledge of effective methods to reduce the risk of complications in individuals with diabetes and their implementation in clinical practice. Improvements in care will involve modifications at the patient, provider, and health care system level. This calls for a national diabetes quality improvement program in Kuwait.

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DISCLOSURE

The authors declare no conflict of interest.

Approval of the research protocol: EMAN was approved by the Kuwaiti Ministry of Health Standing Ethics Committee for the Coordination of Medical and Health Research. KDEP was approved by the Ethical Review Committee at the Dasman Diabetes Institute.

Informed consent: Both EMAN and KDEP adhered to the Declaration of Helsinki ethical standards. In both studies, a written, informed consent was obtained from each participant prior to their inclusion.

Registry and the registration no. of the study/trial: N/A.

Animal studies: N/A.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1 | Outlines of the EMAN and KDEP surveys

Table S2 | Sex and age of participants who completed all steps of EMAN and KDEP compared with those who did not