Type 2 diabetes care for patients in a tertiary care setting in UAE: a retrospective cohort study

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DECLARATIONS

Competing interest
None declared

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LA-H collected the data. YC and LA-H analysed the data. LA-H, YC and AM

Summary

Objective We aimed to examine the quality of type 2 diabetes mellitus (T2DM) care in Al-Ain, in the United Arab Emirates (UAE).

Design A retrospective cohort study from 2008 to 2010.

Setting A diabetes centre located in a tertiary care hospital in Al-Ain, UAE.

Participants People with T2DM receiving care from the diabetes centre.

Results 382 Emirates patients with T2DM were included in the analysis. Overall in 2010, proportions of people with T2DM reaching the following targets were: glycated haemoglobin (HbA1c) 41%, low-density lipoprotein (LDL) 72%, systolic and diastolic blood pressure (SBP/DBP) 47% and 73%, respectively. There was a significant improvement from 2008 to 2010, respectively, in the mean for the following: (1) HbA1c (8.5% [95% confidence interval, CI: 8.33–8.67] versus 7.5% [95% CI: 7.36–7.63]); (2) LDL (2.60 mmol/L [95% CI: 2.51–2.70] versus 2.27 mmol/L [95% CI: 2.21–2.33]); and (3) SBP (133.1 mmHg [95% CI: 131.7–134.4] versus 131.0 [95% CI: 130.1–131.9]). Glycaemic and lipid control were similar in men and women; however, HbA1c levels in men and women aged 60+ years were significantly lower by (0.7% [$P = 0.01$] versus 0.8% [$P < 0.001$], respectively) than for those aged between 18 and 39 years.

Conclusion This study demonstrates that there is encouraging progress in diabetes care in Al-Ain, UAE as reflected by the overall improvement in the mean of HbA1c, LDL and SBP, and the increase in the number of people reaching the target for the same indicators from 2008 to 2010. The results however show that there is scope for additional enhancement of care, especially for better glycaemic control among young patients and better SBP control among men.

Introduction

The United Arab Emirates (UAE) has the second highest prevalence of diabetes worldwide (90% of cases of diabetes are of type 2),[1] and it is one of the International Diabetes Federation's 'top 10' countries for diabetes prevalence in 2010 and in 2030.[1] Several studies in developed countries

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Reviewer

Abbas Mansour

have reported unsatisfactory care provided to people with diabetes based on evidence-based quality of care standards such as in the UK,[2–4] USA[5–7] and Australia.[8] Similar findings were also found in developing countries such as Lebanon[9] and Egypt.[10–12] Furthermore, disparities in diabetes care and their association with age, gender, deprivation and ethnicity have been investigated by many studies in western countries (e.g., refs[8,13–15]).

In the UAE, only a few studies have assessed diabetes care,[16–18] and no studies have investigated its association with the age and gender of patients. Improvement in diabetes care relies largely on examining and evaluating the quality of care provided to people with diabetes. This study was carried out to examine the quality of type 2 diabetes mellitus (T2DM) care in a diabetes centre located in a tertiary hospital in Abu-Dhabi, UAE in 2008, 2009 and 2010. The quality of T2DM care was examined by using quality indicators, both process and intermediate outcomes of care, in accordance with American Diabetes Association (ADA) targets 2012.[19] Specifically we aimed to: (1) assess process and intermediate outcomes of care with particular attention to glycaemic, lipid and blood pressure control, (2) identify any improvement in the quality indicators between 2008 and 2010, and (3) investigate the relationship between age or gender and the quality of T2DM care.

Methods

Study design and setting

This is a retrospective cohort study carried out at a diabetes centre located in a tertiary healthcare setting in Al-Ain, UAE. Al Ain is the third largest city in the UAE and has a population of about 400,000.[20] This hospital was chosen to represent Emirates with T2DM in Al-Ain for a number of reasons. Firstly, it is the first hospital in Al-Ain that started computerizing patients' medical records, and the records are available on an electronic database from 2008, making assessment of any improvement in diabetes care from 2008 onwards feasible. Also, it has a specialist centre that provides care for people with diabetes through a multidisciplinary team, and it aims to follow international standards for the management of diabetes adapted from ADA guidelines.

Sample selection and size

Data for this study was collected from randomly selected medical records of people with T2DM who visited the centre during the period from January 2008 to December 2008.

Patients were eligible for inclusion if they were aged ≥18 years, who had been diagnosed with T2DM and attended the centre for more than one year. Patient demographic characteristics such as age, sex and duration of diabetes were collected using a data collection sheet (see Appendix A). Other characteristics related to the lifestyle including weight, smoking and physical activity, and the existence of co-morbidities such as hypertension and hyperlipidaemia were collected as well. Relevant clinical data including the measurements of blood glucose, pressure and lipids were retrieved by reviewing each electronic medical record.

The calculated sample size was 384, based on estimating a proportion 'P' with specified precision. This allowed us to calculate a 95% confidence interval for P that is expected to be about 50% (0.50) with a margin of error not greater than 5%.

Study variables

The quality indicators used for this report were in accordance with the ADA guidelines for the management of T2DM.

Process of T2DM care indicators

For this study, the main process indicators were the proportion of people with T2DM who had glycated haemoglobin (HbA1c), lipids including low-density lipoprotein (LDL) and blood pressure including systolic and diastolic blood pressure (SBP/DBP) measured during 12-months follow-up in the diabetes centre for the consecutive years from 2008 to 2010. Also, frequency of performing these measurements within one-year follow-up was assessed for the same period.

In addition, a non-weighted process of care score (NWPOC) was calculated following a model proposed and undertaken by Gulliford and Mahabir in Trinidad and Tobago.[21] We used the four measurements listed above: HbA1c, LDL, SDP, DBP for each patient, with each measurement documented given an equal

weighting; hence a patient could have a potential maximum score of four. Then the diabetes centre was given an average score based on the number of patients selected from the centre.

Intermediate outcomes of T2DM care indicators

Outcomes of T2DM care were assessed using intermediate outcomes of care. The assessment was based on whether the desired target level for the following measurements were met in accordance with ADA guidelines (HbA1c < 7%, LDL < 2.6 mmol/L, SBP < 130 mmHg and DBP < 80 mmHg). Proportions of people with T2DM reaching the required targets for these measurements at each year for the consecutive years from 2008 and 2010 were calculated.

Also, using four-variable outcome of care score (4vOOC), following the same model proposed and undertaken by Gulliford and Mahabir in Trinidad and Tobago,[21] the outcome of care score was calculated based on the number of targets that were achieved yearly by each patient for the four targets described above. A score was given for each patient from zero (no targets achieved) to four (all targets achieved), and the average score was calculated for the diabetes centre.

Statistical analyses

Descriptive summary of patients characteristics in each sex at the baseline index visit were presented as means and standard deviations (SD) for continuous and normally distributed variables, and as counts and proportions for categorical variables. A *t*-test was conducted for comparison of means of continuous variables between sexes and chi-squared tests were used for testing differences in proportions for categorical variables.

The means (SD) and 95% confidence intervals (CI) of intermediate outcomes of care (Hba1c, LDL, SBP and DBP) for all patients were calculated for each year from 2008 to 2010. Using the figure at year 2008 as an index, a paired *t*-test was conducted to compare means at 2009 and 2010 with means at 2008 separately, with an aim to detect significant changes across years.

To benchmark the quality of T2DM care in this study with the ADA guidelines for T2DM management, patients were grouped by sex and three age groups, namely (1) 18–39, (2) 40–59 and (3) 60 and over. Proportions of those that reached the ADA target for each intermediate outcome in each year were calculated. Chi-squared tests were then performed to compare whether these proportions were statistically different across years in each age group and each sex.

Since in this study the repeated intermediate outcomes measurements were performed for the same individual at every year during the period 2008–2010, a multilevel linear regression model was built to detect any rate of change of intermediate outcomes across years and the associations between each outcome and accountable covariates during this period. Occasions (in this study this is yearly) were set as level 1 while individuals were set as level 2 in this model. We used a random-coefficient model, which allows the effect of covariates to vary by intercept and the slope. A time variable was also included in the model. A set of covariates was included in each model and likelihood ratio tests were performed for comparisons of nested models, while HbA1c estimates were used to compare non-nested models. Residuals of each model were examined by plotting a histogram to see whether the residuals were normally distributed. A few observations were detected as outliers in each model and hence were excluded from the ultimate analyses. STATA 11 (College Station, TX, USA) was used for all the analysis.

Results

General characteristic of the study sample

Data from 384 people with T2DM was extracted from medical records, of whom 382 patients were included in the analysis after excluding two patients whose data on lipid and blood pressure measurements was not available for the period from 2008 to 2010. Descriptive statistics are displayed in Table 1. Of these 382 patients, 55% were women ($n = 209$) and the average age was 51 years. There was no significant difference in age between men and women.

Process of T2DM care

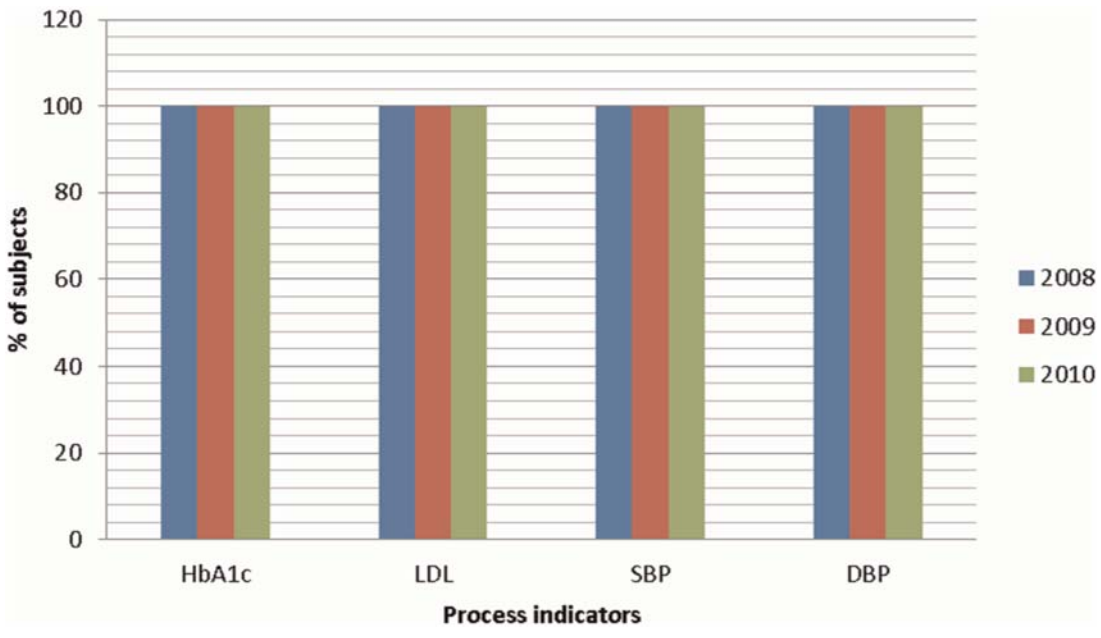
As shown in Figure 1, high achievement rates of recording of HbA1c, LDL, and SBP and DBP during one year of care for the following years: 2008, 2009 and 2010 were found. Three hundred

Table 1
Demographic characteristics of participants

	All patients (n = 382)	*Male (n = 173)*	*Female (n = 209)*	*P value*
Age	51 (16.3)	50.7 (15.6)	51.2 (16.9)	0.8
Age group				
18–29	48 (12.6%)	17 (9.8%)	31 (14.8%)	
30–39	49 (12.8%)	27 (15.6%)	22 (10.5%)	
40–49	85 (22.2%)	43 (24.9%)	42 (20.1%)	
50–59	89 (23.3%)	35 (20.2%)	54 (25.8%)	
60–69	48 (12.6%)	27 (15.6%)	21 (10.1%)	
70+	63 (16.5%)	24 (13.9%)	39 (18.7%)	0.08
Medications				
Oral anti-DM drugs	194 (50.8%)	89 (51.45%)	105 (50.2%)	0.82
Oral anti-DM drugs + insulin	174 (45.6%)	80 (46.2%)	94 (45.0%)	0.81
Anti-lipid drug	348 (91.1%)	158 (91.3%)	190 (90.9%)	0.89
Anti-BP drug	312 (81.7%)	146 (84.4%)	166 (79.4%)	0.21
Aspirin	323 (84.6%)	146 (84.4%)	177 (84.7%)	0.94
Clopidogrel	51 (13.4%)	26 (15.0%)	25 (12.0%)	0.38
Lifestyle factors				
Smoking	74 (19.4%)	73 (42.2%)	1 (0.48%)	<0.01
Physical activity	77 (20.2%)	35 (20.2%)	42 (20.1%)	0.97
Complications				
Coronary heart disease	43 (11.3%)	30 (17.3%)	13 (6.2%)	<0.01
Hypertension	252 (66.0%)	105 (60.7%)	147 (70.3%)	0.05
Hyperlipidemia	188 (49.2%)	79 (45.7%)	109 (52.2%)	0.21

DM, diabetes mellitus, BP, blood pressure

Figure 1
Process measures performed each year in the study cohort: 2008–2010



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and eighty-two subjects had the above listed indicators measured three times annually for the consecutive years from 2008 to 2010 (see Appendix B).

Also, we calculated NWPOC (process) score for the diabetes centre, and the score was 4 for each year including 2008, 2009 and 2010.

Outcomes of T2DM care

We calculated 4vOOc (outcome) score for the diabetes centre as seen in Appendix C. The mean of the score increased gradually from 2008 to 2010, respectively (2.27 [95% CI: 2.18–2.37] versus 2.62 [95% CI: 2.52–2.71]) (see Appendix C).

Outcomes of glycaemic care and relation with age and/or gender

On average, there was a significant improvement in the glycaemic control in the following years 2008, 2009 and 2010 based on the mean average of HbA1c as outlined in Table 2. Comparing the reduction in the HbA1c level with the baseline data from 2008 with 2010, respectively, a substantial improvement was found: 8.5% (95% CI 8.33–8.67) versus 7.5% (95% CI 7.36–7.63); $P < 0.001$. For HbA1c, overall as seen in Figure 2, only 41% of the total number of participants reached the required target at 2010, compared with 20% at 2008.

The proportions of patients who reached the HbA1c target were not significantly different between women and men respectively in each year (22% versus 18%, $P = 0.3$ at 2008, 28% versus 25%, $P = 0.5$ at 2009, and 41% versus 42%, $P = 0.9$ at 2010) (see Appendix D). However, both genders had significant improvement in reaching the target across the years as outlined in Table 3.

Similarly, proportions of people with T2DM who reached the target increased across years at each age group for both genders as highlighted in Table 3. However, significant differences of these proportions across the three years were only found in the older age groups (>40 years old) for both sexes. At younger ages among men and women, there were no significant differences of these proportions, although borderline significance ($P = 0.059$) was found among males aged 18–39 years. Notably, in 2010 the lowest proportion of participants 26% (increased from 11% at 2008) achieving the HbA1c target was among women aged 18–39 years.

In men, the annual average reduction of HbA1c level was 0.5% (95% CI:−0.56 to −0.43, $P < 0.001$) as shown in Table 4. Generally, HbA1c levels of people aged 60+ were significantly lower than for those aged 18–39 years by roughly 0.7% (95% CI: −1.19 to −0.14, $P = 0.01$) during this period, but not for those aged 40–59.

Similarly to men, the annual average reduction of HbA1c level was 0.5% (95% CI:−0.57 to −0.44, $P < 0.001$) in women as highlighted in Table 5. In the same line, comparing with the 18–39 age group, women who were in successive age ranges including those between 40 and 59 and above 60 years, respectively, had significantly lower HbA1c level on average 0.49% (95% CI: −0.98 to −0.004, $P = 0.05$) and 0.77% (95% CI: −1.31 to −0.23, $P < 0.01$).

In men, prescribing oral anti-hypoglycaemic drugs was associated with an approximately 4.2% (95% CI: −0.85 to −0.01, $P = 0.05$) reduction in the HbA1c levels as recognized in Table 4. However, this association was not significant among women.

Table 2
Mean values of clinical indicators: 2008–2010

Clinical indicator	*2008 mean*	*95% CI*	*2009 mean (SD)*	*95% CI*	*2010 mean (SD)*	*95% CI*	*P value (09 vs. 08)*	*P value (10 vs. 08)*
HbA1c (%)	8.50	(8.33–8.67)	8.16	(8.0–8.3)	7.50	(7.36–7.63)	<0.001	<0.001
LDL (mmol/L)	2.60	(2.51–2.70)	2.48	(2.4–2.5)	2.27	(2.21–2.33)	<0.0001	<0.001
SBP (mmhg)	133.1	(131.7–134.4)	133.9	(132.6–135.2)	131.01	(130.1–131.9)	0.13	<0.001
DBP (mmhg)	77.3	(76.4–78.0)	77.9	(77.3–78.7)	76.61	(76.0–77.2)	0.07	0.11

HbA1c, glycated haemoglobin; LDL, low-density lipoprotein; SBP, systolic blood pressure; DBP, diastolic blood pressure; CI, confidence interval

Figure 2
Proportions of subjects reaching the intermediate outcomes: 2008–2010

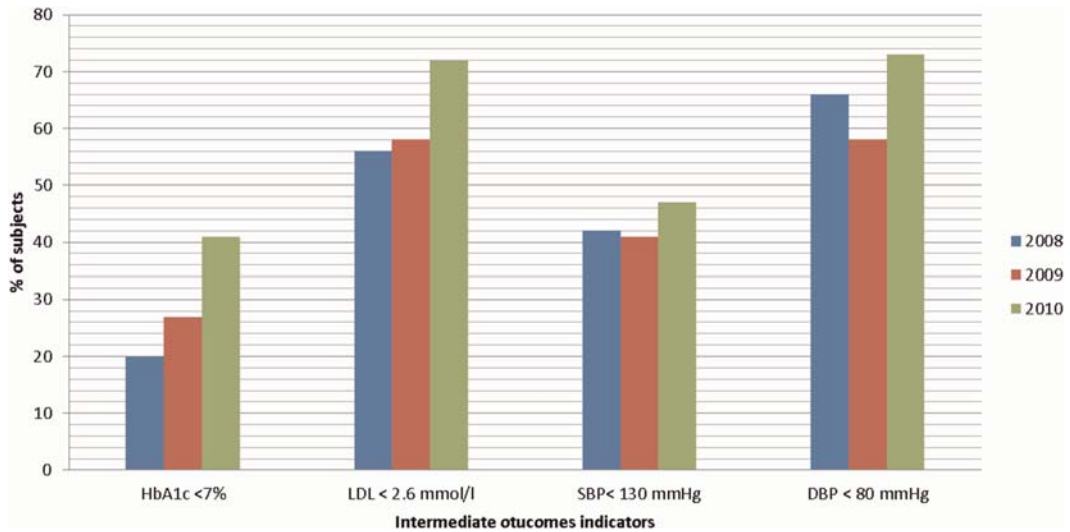

Table 3
Proportions of people with T2DM reached ADA targets: 2008–2010 by sex and age groups

Clinical indicator (ADA target)	*Male (n = 173)*				*Female (n = 209)*			
	18–39 (n = 44)	*40–59 (n = 78)*	*60+ (n = 51)*	*Total*	*18–39 (n = 53)*	*40–59 (n = 96)*	*60+ (n = 60)*	*Total*
HbA1c (<7%)								
2008	25%	12%	22%	18%	11%	26%	25%	22%
2009	25%	22%	31%	25%	19%	33%	28%	28%
2010	45%	32%	53%	42%	26%	46%	47%	41%
P value	0.059	<0.01	<0.01	<0.001	0.14	0.02	0.03	<0.001
LDL (<2.6mmol/L)								
2008	52%	53%	61%	55%	55%	53%	63%	56%
2009	61%	55%	65%	60%	47%	58%	63%	57%
2010	66%	76%	78%	74%	70%	71%	68%	70%
P value	0.42	<0.01	0.13	<0.01	0.056	0.04	0.80	<0.01
SBP (<130 mmhg)								
2008	50%	37%	33%	39%	43%	49%	40%	45%
2009	36%	37%	25%	34%	51%	46%	47%	47%
2010	52%	42%	29%	41%	53%	51%	52%	52%
P value	0.27	0.75	0.69	0.32	0.59	0.77	0.44	0.39
DBP (<80 mmhg)								
2008	77%	62%	69%	68%	70%	65%	60%	65%
2009	73%	45%	45%	52%	68%	60%	60%	62%
2010	77%	72%	69%	72%	79%	72%	73%	74%
P value	0.85	<0.01	0.02	<0.001	0.39	0.24	0.21	0.02

ADA, American Diabetes Association; T2DM, type 2 diabetes mellitus, HbA1c, glycated haemoglobin; LDL, low-density lipoprotein; SBP, systolic blood pressure; DBP, diastolic blood pressure; CI, confidence interval

Table 4
Results from multilevel modelling on the rate of changes in clinical outcomes for men: 2008–2010

	β	*P value*	*95% CI*	
Hba1c				
Year	−0.50	<0.001	−0.56	−0.43
Age				
40–59	−0.16	0.53	−0.64	0.33
60+	−0.67	0.01	−1.19	−0.14
Oral hypoglycaemic drugs	−4.2	.05	−.85	−.01
Oral hypoglycaemic drugs and insulin	.46	.12	−.21	1.12
LDL				
Year	−0.15	<0.001	−0.20	−0.10
SBP				
Year	−1.02	0.01	−1.80	−0.24
Anti-BP drugs	6.70	<0.01	2.55	10.85
DBP				
Year	0.03	0.91	−0.55	0.62
Anti-BP drugs	3.65	<0.01	1.26	6.04

T2DM, type 2 diabetes mellitus; HbA1c, glycated haemoglobin; LDL, low-density lipoprotein; SBP, systolic blood pressure; DBP, diastolic blood pressure; BP, blood pressure, CI, confidence interval
Multilevel model was adjusted for age group, oral T2DM drugs intake (Y/N), oral T2DM drugs with insulin (Y/N), antihypertension drugs intake (Y/N), antihyperlipidaemia drugs intake (Y/N) smoking (Y/N), physical activity (Y/N), coronary heart disease (Y/N), hyperlipidaemia (Y/N), hypertension (Y/N) and duration of diabetes (in years). All binary independent variables were using negative responses as references (Y = 1, N = 0). For age group, group 18–39 was used as a reference
For multilevel analysis using HbA1c as a dependent variable, one observation was treated as an outlier (id = 215) and excluded from the model
For multilevel analysis using SBP as a dependent variable, two observations were treated as outliers (id = 58 and id = 109) and excluded from the model
For multilevel analysis using DBP as a dependent variable, one observation was treated as an outlier (id = 56) and excluded from the model

Outcomes of lipid care and relation with age and/or gender

The mean of LDL improved significantly as seen in Table 2 between 2008, 2009 and 2010. The average level of LDL was 2.60 mmol/L (95% CI: 2.51–2.70) at 2008, which then decreased to 2.27 mmol/L (95% CI: 2.21–2.33) in 2010. For LDL overall, as seen in Figure 2, 72% of the total number of participants reached the required target at 2010, compared with 56% at 2008.

Among 173 men, proportions that reached the target for LDL increased consistently for the consecutive three years. Though only significant differences were detected at age group 40–59, of which patients who reached the target increased from 53% at 2008 to 76% at 2010 ($P < 0.01$). Similar results were found among women; a significant elevation in the number of women achieving the target between 2008 and 2010, respectively, was present, 53% to 71% ($P = 0.04$). Non-significant differences were found for either young or old age groups in each sex, though for women aged 18–39 years old, borderline significant difference was found ($P = 0.056$). In 2010, although it was not statistically significant compared with women, men had the highest proportion of subjects achieving the targets of LDL (73.99%versus 69.86%, $P = 0.4$, respectively).

In both sexes, an average reduction of LDL level at a yearly rate was 0.15 mmol/L (95% CI: −0.2 to −0.1, $P < 0.001$) as outlined by Tables 4 and 5. No significant differences between age groups were reported.

Blood pressure control and relation with age and/or gender

In terms of blood pressure, using figures at 2008 as a baseline, there were no significant differences for the mean DBP level during the three years as outlined in Table 2. However, range of 95% confidence intervals for mean DBP level at year 2009 and 2010 did not overlap; hence, it can be concluded that a significant reduction was found for these two years. For SBP, although a significant reduction was seen from 2008 to 2010, it was minor.

In 2009 and 2010, respectively, overall women were more successful achieving the ADA targets for SBP compared with men (47% and 52%, $P < 0.01$ versus 34% and 41%, $P = 0.04$) (see Appendix D). Nevertheless, no significant differences were found for the proportions of those who reached the SBP target during the three consecutive years from 2008 to 2010 as shown in Table 3. Similarly to SBP, in 2009 as outlined in Appendix D, a higher proportion of women reached the DBP target than men (62% versus 52%, $P = 0.05$), but in 2010 the proportions between sexes were quite similar (74% female versus 72% male, $P = 0.7$).

Table 5
Results from multilevel modelling on the rate of changes in clinical outcomes for women: 2008–2010.

	β	*P value*	*95% CI*	
HbA1c				
Year	−0.51	<0.001	−0.57	−0.44
Age				
40–59	−0.49	0.05	−0.98	−0.004
60+	−0.77	<0.01	−1.31	−0.23
Oral hypoglycaemic drugs	−.005	0.99	−0.57	0.56
Oral hypoglycaemic drugs and insulin	0.33	0.41	−.48	1.15
LDL				
Year	−0.15	<0.001	−0.20	−0.10
SBP				
Year	−0.80	0.02	−1.47	−0.13
Anti-BP drugs	7.62	<0.001	4.25	11.0
Physical activity	−2.78	0.05	−5.53	−0.03
Duration of T2DM (years)	0.68	<0.01	0.29	1.06
DBP				
Year	−0.71	<0.001	−1.20	−0.22
Anti-BP drugs	3.92	<0.01	1.69	6.14
Physical activity	−1.76	0.057	−3.58	0.05

T2DM, type 2 diabetes mellitus; HbA1c, glycated haemoglobin; LDL, low-density lipoprotein; SBP, systolic blood pressure; DBP, diastolic blood pressure; BP, blood pressure; CI, confidence interval
Multilevel model was adjusted for age group, oral T2DM drugs intake (Y/N), oral T2DM drugs with insulin (Y/N), antihypertension drugs intake (Y/N), antihyperlipidaemia drugs intake (Y/N), physical activity (Y/N), coronary heart disease (Y/N), hyperlipidaemia (Y/N), hypertension (Y/N) and duration of diabetes (in years). All binary independent variables were using negative responses as references (Y = 1, N = 0). For age group, group 18–39 was used as a reference
For multilevel analysis using LDL as a dependent variable, one observation was treated as an outlier (id = 249) and excluded from the model
For multilevel analysis using SBP as a dependent variable, one observation was treated as an outlier (id = 315) and excluded from the model
For multilevel analysis using DBP as a dependent variable, two observations were treated as outliers (id = 313 and id = 31) and excluded from the model

For women, the proportions of those meeting the SBP target increased gradually from 2008 to 2010; however, among those aged 40–59 years a drop in this proportion was detected between 2008 and 2009 (49% versus 46%; respectively) as seen in Table 3. At 2010, more than half of the women had met the SBP target (52%). In particular, older men (60+) had the lowest SBP target-met at 2010 (29%) followed by (42%) of men aged 40–59 years. Similar results were found for DBP; however, reductions of target-met subjects in men aged 40–59 and (60+) were seen from 2008 to 2009 (reduced by 17% and 24%, respectively).

Among men, the average annual reduction of SBP was 1.02 mmHg (95% CI: −1.80 to −0.24, $P = 0.01$) as seen in Table 4. However, this yearly rate reduction was not significant for DBP. Women had a lower average reduction of SBP level at a yearly rate of 0.80 mmHg (95% CI: −1.47 to −0.13, $P = 0.02$) compared with men, whereas an average reduction of DBP level at a yearly rate was 0.71 mmHg (95% CI: −1.20 to −0.22, $P < 0.01$).

Unexpectedly, as outlined in Tables 4 and 5, women and men respectively who were prescribed anti-blood pressure drugs had higher points in their S/DBP (7.6 mmHg [$P < 0.001$] and 3.9 mmHg [$P < 0.001$] versus 6.7 mmHg [$P < 0.01$] and 3.7 mmHg [$P < 0.001$]).

Having regular physical activity was associated with lower S/DBP level in women although P values were borderline significant ($P = 0.05$ and 0.057, respectively). Also, for every one-year increase of the duration of T2DM, the SBP level for women increased by 0.68 mmHg ($P < 0.01$, 95% CI: 0.29–1.06).

Discussion

Our study found that with regard to process measures, these were generally well met in the study period 2008–2010, and the adherence rate for process measures was exceptional, as reflected by the high NWPOC score.

Our findings on the proportion of people with T2DM having their measurements performed at least once annually within one year of follow-up for the study period are comparable if not higher with other studies carried out in the Gulf region,[16,22–24] Middle East[10,25] and Western countries.[6] The management agreement signed in 2006 with Johns Hopkins Medicine International and Health Authority Abu-Dhabi (HAAD) and the increment in the number of departmental audits might be some of the reasons helped in improving the process of diabetes care in the centre.

Despite the high rate of testing in this study, sub-optimal management of glucose and SBP was present; more than 50% of the study

population did not achieve the desirable targets for the HbA1c and SBP in the following years: 2008, 2009 and 2010. For instance, in 2010, only 41% achieved the target of HbA1c and 47% meet the target of SBP. This finding reveals that excellent performance on process of diabetes care does not essentially translate into good metabolic control.[6] In 2010, however, high rates of achievements of the DBP and LDL goals were found (73% versus 72%, respectively).

We noted that for outcomes of glycaemic and SBP control, similar results are reported for other countries in the region, such as the Co-operation Council for the Arab States of the Gulf (GCC),[16,22–24,26–28] Lebanon[9] and Egypt.[11] Nevertheless, comparing our findings with some studies carried out in other GCC countries (e.g. for glycaemic control[23,28] and BP control[29]) the control of glucose and BP in this setting tends to be better. Still, high rate of blood pressure target achievement was attained in 83% of the sample of Afandi *et al.*;[16] the small sample (30 subjects) could be one of the reasons for this high achievement rate.

Comparing the findings with studies carried out in developed countries at various levels of healthcare, our results were consistent with a number of their findings. For instance, only 37% of the people with diabetes that participated in the NHANES 1999–2000 survey achieved the required target of HbA1c (<7%), and only 35.8% of participants reached the target of systolic blood pressure ≤130/80 mmHg.[30] In the UK, the target of HbA1c (≤7.5%) was achieved only in 43–48%, and the target of blood pressure (<140/85 mmHg) was achieved in 36–59%. In addition in the Netherlands, the goal of blood pressure 135/85 mmHg was achieved only among 20% of participants.[31] Notably, lipid control findings were equivalent with studies carried out elsewhere.[16,24] Also noteworthy was that participants in this study attained the target of LDL more successfully compared with people with diabetes in other Arab countries.[10,16,23,24,32]

Our findings revealed variation in diabetes outcomes of care between younger and older patients. Compared with older individuals, younger (<40 years old) patients do not have as good HbA1c profiles, and hence better glycaemic control was more common among people aged 40 and above. Although there were no significant differences of blood pressure level across age groups, during the three years, the proportion of those that reached the target was consistently higher in the younger age group than that of the older age group. Our findings concur with previous research that addressed the association between ageing and improved glycaemic control,[33–35] but an increment in the hypertension rate.[36]

In summary we found that glycaemic and lipid control tend to be similar between sexes, in line with studies carried out elsewhere;[13,33] still in this study, men had a slightly higher proportion of reaching the ADA targets. Unlike some other studies[8,37] that found women less successful in achieving the target goal for blood pressure, women performed better than men in this study on reaching the target of blood pressure, especially for the SBP in 2009 and 2010.

We note an encouraging progress with regard to intermediate outcomes of diabetes control including glycaemic and lipid between 2008 and 2010. This finding is in line with the progress in the developed countries such as UK and USA.[3–5] The UAE is following several objectives of the national strategy for the control of diabetes. Actions proceeding to implement two of these objectives are: (1) support continuous monitoring and evaluation of diabetes care and (2) improving and promoting the quality of diabetes care at three levels of healthcare system might help in improving both the process and outcomes of diabetes care in healthcare providing centres in the UAE.[38]

The multilevel model showed that there is an increment in the levels of SBP/DBP in individuals who had been prescribed pharmacological medications to regulate blood pressure. Similar results were found by Youssef *et al*.[10] in Egypt, as patients who were prescribed antihypertensive drugs had about 11 and 3 mmHg higher points in their S/DBP than those non-prescribed. Several reasons can contribute to the poor S/DBP control among this group, and might be related to the disease process itself[39] and to 'reverse causation' (i.e. patients on medication had higher blood pressure measurements to start with). There is also evidence which supports the important role of patient's related factors such as understanding of hypertension and its complications, and the importance of adherence to treatment.[40]

Complete investigation for the association between these variables was not performed in this study; however, non-adherence to the treatment is proposed to be one of the causes. Non-adherence is a common problem in all chronic conditions; principally it is problematic in T2DM and blood pressure due to the complexity of treatment regimens, including the use of combined drugs and the life-long duration of the disease.[41] The Canadian Coalition for Blood Pressure Control documented a non-compliance rate of 50% in its report.[42] As evidence showed that non-adherence to hypertension medications in T2DM is common; identifying variables that influence people with T2DM adherence to medications is essential.

'Clinical inertia', an issue associated with healthcare professionals, was also suggested to be another reason not only for this paradox, but also for the sub-optimal control of HbA1c and blood pressure in this study. Phillips *et al.*[43] have defined clinical inertia in the comprehensive review they carried out as a failure of the healthcare professionals to initiate or optimize therapy when indicated. Therefore, for people with uncontrolled blood pressure who are already on pharmacological treatment, regular review for the drugs prescribed is essential. More research should focus on clinical inertia and the pattern of drug usage and their correlation with metabolic control in the UAE.

Implications of the study

This study provides useful baseline data about the quality of T2DM care in a diabetes centre, at a tertiary healthcare setting in Al-Ain. Results from this study are comparable with other studies elsewhere; however, there is still scope for further improvement.

Identifying differences in diabetes care provided to different age groups and gender demonstrated in the study would assist healthcare professionals, and policy planners and makers in addressing the problem and planning for quality improvement enterprises. It is worrying that younger Emirates with T2DM had worse glycaemic control than older patients; given that the risk for both micro and macrovascular complications over a long period of time would increase. Hence, further investigation for the sub-optimal outcome of care among this group is needed to optimize the care provided.

As diabetes management relies on great extent on the patient's lifestyle, the use of interventions that are multifaceted and holistic in approach would be helpful in addressing the underlying causes of unhealthy lifestyle among people with diabetes.[44] For instance, educational interventions targeting the young population should be realistic, non-judgemental and focus on coping strategies.[44]

At the diabetes centre level, supporting, monitoring and evaluation of the diabetes care are highly recommended to tackle any difference in care and to improve and promote the quality of diabetes. As more than 70% of the UAE population is composed of expatriates that come from all over the world, future research should target this group as well, to investigate the quality of diabetes care and optimize its management.

Limitations

There are limitations to our study, principally that the analysis was performed at a single centre in the Al-Ain. The results of this study, however, are likely to be representative of care provided in other diabetes centres in Al-Ain, given the similarity in organizational structure, followed guidelines, physician training and similar patient characteristics. Another caveat is the use of medical records to assess the care provided to people with T2DM that depend on the quality of documentation and might not necessarily reflect the actual care delivered or outcomes.

Data on body mass index (BMI), patient's experience of their care and quality of life was not possible to collect in this study; therefore, they were not included in the statistical analysis. Studying the association between variables such as BMI and outcome of T2DM care is essential; hence we recommend future studies to consider investigating this association.

Our results also stated that there was worse blood pressure control among people with T2DM, who had been prescribed both anti-blood pressure drugs, were limited by lack of detailed information on: individual drugs, the cumulative doses and duration of treatment of each drug as they can interact with other factors influencing blood pressure control. Meanwhile, for people with T2DM with poor metabolic control, there is

a call for reviewing the drugs profile and putting emphasis on improving the patients' adherence on drug use in the centre.

Conclusion

This study demonstrates that there is encouraging progress in the diabetes care reflected by the overall improvement in the mean of HbA1c, LDL and SBP, and the increment in the number of people reaching the target for the same indicators listed above for the consecutive years from 2008 to 2010. However, the results have shown that there is scope for further improvement, especially for a better glycaemia control among young patients and a better SBP control among males. Findings from this study can help healthcare professionals, policy-makers and planners in the UAE in comparing performance and planning for quality improvement initiatives.

References

1 International Diabetes Federation (2011). *IDF Diabetes Atlas*, 4th ed. International Diabetes Federation, 2011. See http://www.diabetesatlas.org/ (last accessed March 2012)
2 Khunti K, Gadsby R, Millet C, Majeed A, Davies M. Quality of diabetes care in the UK: comparison of published quality of-care reports with results of the quality and outcomes frame work for diabetes. *Diabet Med* 2007;**24**:1436–41
3 Calvert M, Shankar A, McManus RJ, Lester H, Freemantle N. Effect of the quality and outcomes framework on diabetes care in the United Kingdom: retrospective cohort study. *BMJ* 2009;**338**:b1870
4 Millett C, Car J, Eldred D, *et al.* Diabetes prevalence, process of care and outcomes in relation to practice size, caseload and deprivation: national cross-sectional study in primary care. *J R Soc Med* 2007;**100**:275–83
5 Saaddine JB, Cadwell B, Gregg EW, *et al.* Improvements in Diabetes Processes of Care and Intermediate Outcomes: United States, 1988–2002. *Annals of Internal Medicine* 2006;**144**:465–74
6 Grant RW, Buse JB, Meigs JB. Quality of Diabetes Care in U.S. Academic Medical Centers: Low rates of medical regimen change. *Diabetes Care* 2005;**28**:337–442
7 Chenung BM, Ong KL, Cherny SS, *et al.* Diabetes prevalence and therapeutic target achievement in the United States, 1999 to 2006. *Am J Med* 2009;**122**:443–53
8 Gray J, Millet C, O'Sullivan C, Omar RZ, Majeed A. Association of age, sex and deprivation with quality indicators for diabetes: population-based cross sectional survey in primary care. *J R Soc Med* 2006;**99**:576–81
9 Akel M, Hammadeh. Quality of diabetes care in a university health care center in Lebanon. *Int J Qual Health Care* 1999;**11**:517–21
10 Youssef A, El Mahalli A, Akl O, Zaghloul A. Quality of diabetes care in primary care setting in Egypt: an example of health sector reform in developing countries. *J Egypt Public Health Assoc* 2006;**81**:301–20
11 El-Shazly M, Abdel-Fattah M, Zaki A, *et al.* Health care for diabetic patients in developing countries: a case from Egypt. *Public Health* 2006;**114**:276–81
12 Abou El-Enein N, Abnolfotouh M. An audit of diabetes care at 3 centres in Alexandria. *East Mediterr Health J* 2008;**14**:636–46
13 Hippisley-Cox J, Pringle M, Cater R, Coupland C, Meal A. Coronary heart disease prevention and age inequalities: the first year of the National Service framework for CHD. *Br J Gen Pract* 2005;**55**:369–75
14 Bebb C, Kendrick D, Stewart J, *et al.* Inequalities in glycemic control in patients with Type 2 diabetes in primary care. *Diabetic Med* 2005;**22**:1364–71
15 Guthrie B, Emslie-Smith A, Morris AD. Which people with Type 2 diabetes achieve good control of intermediate outcomes? Population database study in a UK region. *Diabet Med* 2009;**26**:1269–76
16 Afandi B, Ahmad S, Saadi H, *et al.* Audit of a diabetes clinic at Tawam hospital, United Arab Emirates, 2004–2005. *Ann N Y Acad Sci* 2006;**1084**:319–24
17 Khattab M, Swidan A, Farghaly M, *et al.* Quality improvement program for diabetes care in family practice settings in Dubai. *East Mediterr Health J* 2007;**13**:492–504
18 Alhyas L, McKay A, Balasanthiran A, Majeed A. Quality of type 2 diabetes management in the states of the Co-operation Council for the Arab States of the Gulf: a systematic review. *PLoS One* 2011;**6**(8):e22186
19 American Diabetes Association ADA. Standards of medical care in diabetes- 2012. *Diabetes Care* 2011;**35**:s1–s63
20 Al-Ain City Municipality. See (http://am.abudhabi.ae/PublicPortal/Home.aspx (last accessed April 2012).
21 Gulliford MC, Mahabir D. A five-year evaluation of intervention in diabetes care in Trinidad and Tobago. *Diabet Med* 1999;**16**:939–45
22 Al-Hussein F. Diabetes control in a primary care setting: a retrospective study of 651 patients. *Ann Saudi Med* 2008;**28**:267–71
23 Kharal M, Al-Hajjaj A, Al-Ammri M, *et al.* Meeting the American Diabetes Association standards of diabetic care. *Saudi J Kidney Dis Transpl* 2010;**21**:678–85
24 Saadi H, Carruthers SG, Nagelkerke N, *et al.* Prevalence of diabetes mellitus and its complications in a population-based sample in Al-Ain, United Arab Emirates. *Diabetes Res Clin Pract* 2007;**78**:369–77
25 Wong K, Ho S, Chao David. A retrospective review of the quality of diabetes care in public primary care clinics in Hong Kong-do disparities of care exist? *Fam Pract* 2011;**0**:1–7
26 Al-Kaabi J, AL-Maskari F, Saadi H, *et al.* Assessment of dietary practice among diabetic patients in the UAE. *J Soc Diabetes Res* 2008;**5**:110–5
27 Al-Elq A. Current practice in the management of patients with type 2 diabetes mellitus in Saudi Arabia. *Saudi Med J* 2009;**30**:1551–6
28 Eledrisi M, Alhaj B, Rehmani R, Alotaibi M, Musafa M. Quality of diabetes care in Saudi Arabia. *Diabetes Res Clin Pract* 2007;**78**:145–6
29 Al-Khaja KA, Sequeira RP, Damanhori AH. Evaluation of drug therapy and risk factors in diabetic hypertensives: a

study of the quality of care provided in diabetic clinic in Bahrain. *J Eval Clin Pract* 2005;**11**:121–31
30 Thomas J, Edward W, Joel E, Jinan B. Is glycemic control improving in US adults? *Diabetes Care* 2008;**31**:81–6
31 Goundswarrd A, Stolk R, Zuithoff P, Rutten EHM. Patients characteristics do not predict poor glycaemic control in type 2 diabetes patients treated in primary care. *Eur J Epidemiol* 2004;**19**:541–454
32 Akbar D . Sub-optimal post prandial blood glucose level in diabetics attending the out-patient clinic of a university hospital. *Saudi Med J* 2003;**24**:1109–12
33 Bebb C, Kendrick D, Stewart J, *et al.* Inequalities in glycemic control in patients with Type 2 diabetes in primary care. *Diabet Med* 2005;**22**:1364–71
34 Koro C, Bourgeois N, Bowlin S, Fedder D, Glycemic control from 1988 to 2000 among US adults diagnosed with Type 2 diabetes. *Diabetes Care* 2004;**27**:17–20
35 Guthric B, Emslic Smith A, Morris AD. Which people with Type 2 diabetes chive good control of intermediate outcomes? Population database study in a UK region. *Diabet Med* 2009;**26**:1269–76
36 Hypertension in Diabetes Study Group. HDS 1: Prevalence of hypertension in newly presenting type 2 diabetic patients and the association with risk factors for cardiovascular and diabetic complications. *J hypertns* 1993;**11**:309–17
37 Hippisle-cox J, O' Hanlon S, Coupland C. Association of deprivation, ethnicity, and sex with quality indicators for diabetes: population based survey of 53000 patients in primacy care. *BMJ* 2004;**329**:1267
38 Fikri M. Ministry of Health United Arab Emirates. *The Magnitude of Diabetes in UAE. National Diabetes Strategy and Achievement*. See http://www.moh.gov.ae (last accessed April 2012)
39 Rosenstock IM. Understanding and enhancing patient compliance with diabetic regimens. *Diabetes Care* 1985;**8**:610–6
40 Lee WC, Balu S, Cobden D, Joshi AV, Pashos CL. Prevalence and economic consequences of medication adherence in diabetes: a systematic literature review. *Manag Care Interface* 2006;**19**:31–41
41 Grams GD, Herbert C, Heffernan C, *et al.* . Perspectives on living with non-insulin-dependent diabetes. *CMAJ* 1996;**155**:1563–8
42 Chockalingam A, Bacher M, Camphell N, *et al.* Adherence to management of high blood pressure: recommendations of the Canadian Coalition for High Blood Pressure Prevention and Control. *Can J Public Health* 1998;**89**:15–111
43 Phillips LS, Branch WT, Cook CB, *et al.* Clinical inertia. *Ann Intern Med* 2001;**135**:825–34
44 Diabetes UK. *Diabetes and the Disadvantaged: Reducing Health Inequalities in the UK. World Diabetes Day 14 November 2006.* See http://www.diabetes.org.uk/Documents/Reports/Diabetes_disadvantaged_Nov2006.pdf (last accessed April 2012)
45 Wan Q, Harris MF, Jayasinghe UW, *et al.* Quality of diabetes care and coronary heart disease absolute risk in patients with type 2 diabetes mellitus in Australian general practice. *Qual Saf Health Care* 2006;**15**:131–5

Appendix A

Age:		*Sex: F/M*		*Duration of T2DM:*
Smoking: Y/N		*Physical activity: Y/N*		
Criterion number	Criterion	2008	2009	2010
1	**Blood glucose management**			
	1.1 Has blood glucose been measured within the last year?	Y/N	Y/N	Y/N
	1.2 If yes, how often was HbA1c levels measured?	• Once annually	• Once annually	• Once annually
		• Twice annually	• Twice annually	• Twice annually
		• More than twice annually	• More than twice annually	• More than twice annually
	1.3 What were the measurements for the HbA1c?	1- 2- 3-	1- 2- 3-	1- 2- 3-

(Continued)

Continued

Age:		*Sex: F/M*		*Duration of T2DM:*
Smoking: Y/N		*Physical activity: Y/N*		
	1.4 Has the person's blood glucose been controlled by lifestyle interventions?	Y/N	Y/N	Y/N
	1.5 Is the patient receiving oral blood lowering therapy?	Y/N	Y/N	Y/N
	1.6 Is the patient on insulin therapy?	Y/N	Y/N	Y/N
2	**Blood pressure management**			
	2.1 Has the person's blood pressure been measured within the last year?	Y/N	Y/N	Y/N
	2.2 If yes, how often was the blood pressure measured?	• Once annually	• Once annually	• Once annually
		• Twice annually	• Twice annually	• Twice annually
		• More than twice annually	• More than twice annually	• More than twice annually
	2.3 What were the measurements for the blood pressure?	1- 2- 3-	1- 2- 3-	1- 2- 3-
	2.4 Is the patient taking any medications to regulate the blood pressure?	Y/N	Y/N	Y/N
	2.5 If yes, was blood pressure control and medication use reviewed?	Y/N	Y/N	Y/N
3	**Blood lipid management**			
	3.1 Has the person's blood lipid been measured within the last year?	Y/N	Y/N	Y/N
	3.2 If yes, how often was the blood lipid measured?	• Once annually	• Once annually	• Once annually
		• Twice annually	• Twice annually	• Twice annually
		• More than twice annually	• More than twice annually	• More than twice annually
	3.3 What were the measurements for the blood lipids?	1- 2- 3-	1- 2- 3-	1- 2- 3-
	3.4 Is the patient taking any medications to regulate the blood lipids?	Y/N	Y/N	Y/N
4	**Antithrombotic therapy**			
	4.1 Is the patient taking any thrombotic drugs? Which anti-thrombotic drug the patient is been prescribed?	Y/N	Y/N	Y/N
	Aspirin	Y/N	Y/N	Y/N
	Plavix	Y/N	Y/N	Y/N
5	**Comorbidities**			
	5.1 Does the patient suffer from:			
	• Coronary heart disease	Y/N		
	• Hypertension	Y/N		
	• Hheart failure	Y/N		
	• Atrial fibrillation	Y/N		
	• Renal failure	Y/N		
	• Peripheral vascular disease	Y/N		

Appendix B

Frequency of process measures performed each year (%) in the study cohort: 2008–2010

Process of care indicators	*Frequency of measurements annually*	*Number of patients (%) 2008*	*Number of patients (%) 2009*	*Number of patients (%) 2010*
Glucose monitoring: HbA1c measurements	≥3	382 (100%)	382 (100%)	382 (100%)
Blood pressure monitoring: S/DBP measurements	≥3	382 (100%)	382 (100%)	382 (100%)
Blood lipids monitoring: LDL measurements	≥3	382 (100%)	382 (100%)	382 (100%)

HbA1c, glycated haemoglobin; LDL, low-density lipoprotein; SBP, systolic blood pressure; DBP, diastolic blood pressure

Appendix C

Four-variable outcome of care score (4vOOC): 2008–2010

4vOOC	*Mean*	*SD*	*95% CI*
2008	2.27	0.96	2.18–2.37
2009	2.26	0.97	2.16–2.35
2010	2.62	0.91	2.52–2.71

Appendix D

Proportions of women and men reaching the ADA targets: 2008–2010

	2008				*2009*				*2010*			
Intermediate outcomes	*Female n (%)*	*Male n (%)*	*Total n (%)*	*P value*	*Female n (%)*	*Male n (%)*	*Total n (%)*	*P value*	*Female n (%)*	*Male n (%)*	*Total n (%)*	*P value*
Targets achieved for HbA1c												
Yes	46 (22%)	31 (18%)	77 (20%)	$P = 0.3$	59 (28%)	44 (25%)	103 (27%)	$P = .5$	86 (41%)	72 (42%)	158 (41%)	$P = .9$
No	163 (78%)	142 (82%)	305 (79%)		150 (72%)	129 (75%)	27973%)		123 (59%)	101 (58%)	224 (59%)	
Targets achieved for LDL												
Yes	118 (56%)	95 (55%)	213 (56%)	$P = 0.8$	119 (57%)	103 (60%)	222 (58%)	$P = 0.7$	146 (70%)	128 (74%)	274 (72%)	$P = 0.4$
No	91 (44%)	78 (45%)	169 (44%)		90 (43%)	70 (40%)	160 (42%)		63 (30%)	45 (26%)	108 (28%)	
Targets achieved for SBP												
Yes	94 (45%)	68 (39%)	162 (42%)	$P = 0.3$	99 (47%)	58 (34%)	157 (41%)	$P = 0.006$	108 (52%)	71 (41%)	179 (47%)	$P = 0.04$
No	115 (55%)	105 (61%)	220 (58%)		110 (53%)	115 (66%)	225 (59%)		101 (48%)	102 (59%)	203 (53%)	
Targets achieved for DBP												
Yes	135 (65%)	117 (68%)	252 (66%)	$P = 0.5$	130 (62%)	90 (52%)	220 (58%)	$P = 0.05$	155 (74%)	125 (72%)	280 (73%)	$P = .7$
No	74 (35%)	56 (32%)	130 (34%)		79 (38%)	83 (48%)	162 (42%)		54 (26%)	48 (28%)	102 (27%)	

ADA, American Diabetes Association; HbA1c, glycated haemoglobin; LDL, low-density lipoprotein; SBP, systolic blood pressure; DBP, diastolic blood pressure