"Damm Sokkor"*
Factors associated with the quality of care of patients with diabetes: A study in primary care in Tunisia

(**Damm* = blood pressure, *Sokkor* = diabetes, in Arabic)

Received for publication 15 March 2007 and accepted in revised form 7 May 2007.

Additional information for this article can be viewed in an online appendix at http://care.diabetesjournals.org.

Running Title:
Diabetes in primary care in Tunisia

Hugh Alberti, MRCGP (Member of the Royal College of General Practitioners)
Nessiba Boudriga, MMSP (Médecin Major de la Santé Publique)
Mounira Nabli, MISP ((Médecin Inspecteur de la Santé Publique)

DSSB (Direction des Soins de Santé de Base)
[Primary Health Care Department, Ministry of Public Health]
31 Rue Khartoum
Tunis
Tunisia

Correspondence:
Dr Hugh Alberti
BP 66
2073 Borj Louzir
Ariana
Tunisia
Hugh.alberti@newcastle.ac.uk

Abstract

Objective

To identify the organisational, physician and patient factors associated with the quality of care of patients with diabetes in a low/middle income country.

Research Design and Methods

Data from 2160 randomly selected patients with diabetes were extracted from the manual medical records of a nationwide sample of 48 randomly selected health centres. Physician and organisational characteristics were collected from national reports, questionnaires, interviews and observation at the centres. Univariate and multivariate regression analyses were undertaken to identify associations with four quality of care scores, based on processes and intermediate outcomes of care, and 53 potential explanatory factors.

Results

The mean age of the study population was 62.4years, mean duration of diabetes was 8.4years, 62% were female and 94% had type 2 diabetes. In the final multivariate models, factors independently and significantly associated with higher process of care scores were regional affluence, doctor motivation and the use of chronic disease clinics ($p<0.05$). Health centres with younger patients and increased availability of medication were independently and significantly associated with improved outcome of care scores ($p<0.05$). The final models of the 4 quality of care scores explained 55-71% of the variations in scores.

Conclusions

Use of chronic disease clinics, availability of medication and possibly doctor motivation, appear to be the most strongly related modifiable factors influencing diabetes care. These findings will be used to develop and implement culturally appropriate, quality improvement interventions to improve the quality of diabetes care. We recommend our findings be taken into account in other low/middle income countries.

Worldwide, the quality of care of patients with diabetes has been shown to be variable and sub-optimal [1-6], despite the evidence that good control of blood pressure and glucose significantly reduces the risk of cardiovascular and microvascular complications [7,8]. The management of diabetes is acknowledged to be complex: The quality of diabetes care can be influenced by patient, health professional and organisational factors [9-11]. Commonly reported patient factors are adherence, attendance and education together with individual characteristics such as age, sex and presence of comorbidity [11-14]. Health physician factors include the number, training and sex of the treating physician and practice team, the role of clinical inertia and the clinician/patient relationship [10,12,15-18]. Many organisational factors have been shown to influence care such as the use of structured diabetes clinics, recall systems, practice guidelines and educational programmes [14,19].

Very few studies on the factors influencing the care of patients with diabetes have been reported from low/middle income countries, despite the fact that 80% of all chronic disease deaths worldwide now occur in such countries [20]. None, to our knowledge, have used a nationwide sample from primary care where most patients with diabetes are managed. It is crucial that quality improvement efforts are underpinned by more specific knowledge of modifiable factors amenable to change in order to efficiently target improvement strategies, particularly in resource-limited settings.

Tunisia, a low/middle income country, is experiencing a major increase in non-communicable diseases such as diabetes [21]. In response, the Tunisian Ministry of Health have initiated a national programme of diabetes management within primary care with the aim of improving the quality of care [22]; the program was initiated in 1993 and extended to the whole country in 1998. The programme incorporates teaching of primary health care doctors and the use of national, standardised protocols, disease registers and disease-specific medical records. There has also been an emphasis on patient education, prioritising the availability of medications for chronic diseases and introducing weekly chronic disease clinics.

We sought to identify the patient, physician and organisational factors that are associated with the quality of care of patients with diabetes using Tunisia as an illustrative example of a low/middle income country.

Research Design and Methods

Setting

Tunisia is a country of 10 million inhabitants, situated on the North African coast. There are approximately two thousand public sector, primary care health centres situated throughout the 24 regions of the country. The majority of these centres are small, nurse-ran health posts that do not manage patients with chronic diseases; we therefore chose to include only health centres that hold medical consultations 4 or more times a week (n=567). Two health centres were randomly selected from each region using data obtained from the Ministry of Public Health.

Design and patients

Patient data were extracted from manual medical records. A maximum of 50 patients with diabetes were randomly selected per health centre. Patient details included demographic data, clinical background, processes of care (i.e. whether a measurement had been recorded in a 12 month period), outcomes of care (i.e. the result of the measurement) and prescriptions of blood

glucose-lowering, antihypertensive and lipid-lowering medication.

Physician and organisational characteristics were collected from national and health centre reports, a structured questionnaire administered at each centre and interviews with the staff at the health centres.
Explanatory factors were selected on the basis of research findings elsewhere and exploratory qualitative work in Tunisia [23] (table 1).

Quality of care measures
The quality of care indicators were based on two process of care scores and two outcome of care scores.
The process of care scores were calculated based on recommendations from the Tunisian national program [21], namely: Assessments of fasting glucose, blood pressure, weight, total cholesterol, creatinine, foot examination, cardiovascular examination, electrocardiogram (ECG), eye examination and HbA1c. The latter four tests usually require referral to a local hospital, as they cannot be performed on-site at the health centre. Following a model proposed by Gulliford *et al* in Trinidad and Tobago [24], we combined the process of care results to create two quality of care scores.

1. Non-weighted process of care score (NWPOC): Obtained by assigning to each patient a score of 1 for each measurement undertaken in the previous 12 month-period (maximum score: 10).
2. Weighted process of care score (WPOC): To take into account the importance of glycaemic and blood pressure control, a score was calculated in which glucose and blood pressure measurement were given a weighted score of 4 rather than 1; the other measurements remained with a score of 1 (maximum score: 16).

The outcome of care scores were based on levels of fasting glucose, blood pressure, total cholesterol and body mass index. The assessment was based on an average of all the results collected per patient.

3. Four-variable outcome of care score (4vOOC): An outcome of care score was calculated based on how many of the following targets a patient achieved: Blood pressure of =<140/80, fasting glucose <=7.8mmol/l, total cholesterol <=5mmol/l, BMI <=25kg/m^2 [25]. Missing data were excluded. A score was assigned to each patient based on the proportion of targets achieved.
4. Two-variable outcome of care score (2vOOC): A second outcome of care score was calculated using fasting glucose and blood pressure levels only. The scoring system used a range from good control (using definitions above), borderline control and poor control (defined as blood pressure >=160/95mmHg and fasting glucose >=11.1mmol/l). Each patient was assigned a score of 2 for good control, 1 for borderline and 0 for poor control for both fasting glucose and blood pressure using a denominator of 2 (if only 1 variable recorded) or 4 (if both variables recorded).

A mean of each of the four scores was calculated for each health centre. The scores were assessed for normality, and the value of Cronbach's alpha was calculated to measure the internal consistency of each score.

Statistical analysis
The health centre was used as the unit of randomisation in order to cluster patients into practices, as recommended in primary care studies [26].

All explanatory variables were first tested against each of the outcome variables (quality of care scores) using ANOVA (categorical variables) or linear regression (continuous variables). Logarithmic transformations were

made for variables not normally distributed; if the variable remained not normally distributed, the variable was converted into a categorical variable. Analyses were weighted for number of patients per centre and date of data collection. Potentially significant variables ($p<0.15$) were entered into three separate multilinear regression models grouping variables into patient, health professional or organisational with each of the outcome variables as the dependent variable. Potentially significant variables ($p<0.15$) from each of the three separate models were then entered into a final regression model against each outcome variable.

The data were analysed using SPSS software package (version 12.0.1).

Approval for the study was granted by the Tunisian Ministry of Public Health.

Results

A total of 2160 patients with diabetes were selected for medical record review from 48 health centres; the mean age of patients in the study was 62.4years, mean duration of diabetes was 8.4years, 62% were female and 94% had type 2 diabetes.

A mean of 45 patients were selected per health centre. The ratio of urban:rural health centres was 2:1. Health centres had a mean of 2.1 primary care doctors and 5.6 nurses and 20% had a nutritionist available for patients with diabetes. On average, each health centre served a population of 15,986, managed 162 patients with diabetes and 26 patients attended per clinic per doctor. Among the 48 health centres, 85% had the new disease-specific medical records available, 70% had a chronic disease register, 63% used patient-held records, 79% had a weekly chronic disease clinic, 39% had an ECG machine on site, 93% had a glucometer on site and 57% ran regular patient education sessions.

Table 2 depicts selected patient characteristics and table 3 the results of the process and intermediate outcomes of care of the study population.

All four quality of care scores were normally distributed. Internal consistency was high for the process of care scores (0.84 and 0.81) but lower for the outcome of care scores (0.58 and 0.29) due to the lower number of variables incorporated.

Multivariate linear regression analyses

Univariate analysis demonstrated a potential association between 16, 18, 13 and 11 of the 53 explanatory factors with the four quality of care indicators (NWPOC, WPOC, 4vOOC and 2vOOC respectively) [data shown in supplementary table]. All factors potentially related to each quality of care indicator were entered into the three separate multilinear regression models, grouping factors into patient, health professional or organisational. Factors that remained potentially significant were entered into a final regression model for each indicator and these are demonstrated in table 4.

The final models explained 71.3% (NWPOC), 62.7% (WPOC), 64.4% (4vOOC) and 55.9% (2vOOC) of the variations in scores.

Conclusions

We report the first, nationwide study from primary care of the factors that influence the care of patients with diabetes from a low/middle income country. Use of chronic disease clinics, availability of medication and doctor motivation appear to be the most strongly related modifiable factors influencing diabetes care in our context. The other factors that were independently and significantly associated with improved processes or outcomes of care were regional affluence and younger age.

Standards of care

The process of care results show that the majority of patients are having their blood pressure and fasting glucose recorded annually. These results compare favourably with studies from similar countries [4,5,6,27,28]. Around half of the patients have most of the other measures performed annually. Fewer patients are recorded as having an ECG, eye examination and HbA1c measurement: The latter is almost certainly due to the fact that this test is not generally available within primary care. The low recording of eye and ECG examinations may be due to the fact that these tests are usually performed in secondary care; primary care physicians report difficulties in persuading patients to attend and in receiving the results from secondary care. Since the time of the study, training of primary care doctors in the use of ophthalmoscopes has been introduced and it is hoped that this will improve the uptake of eye examinations. Particularly striking is the variation in results between health centres as has been demonstrated in other countries [3,4]. The percentage of patients achieving targets of blood pressure, fasting glucose and cholesterol is variable and suboptimal, but again compares favourably with results from other countries [4,5,27].

Factors associated with improved quality of care

Assessing the relative influence of specific factors that influence diabetes care is essential for the development of targeted interventions to improve the quality of care. Our study showed five factors to be clearly associated with improved processes or outcomes of care; regional affluence, doctor motivation and use of chronic disease clinics (processes) and younger age and increased availability of medication (outcomes).

An association between affluence and quality of care has been demonstrated previously in studies from the developed world [11,29] and it appears that this influence is equally important in less affluent countries. Financial aspects strongly influence the care of patients, especially those with chronic diseases, from developing nations [30].

The significant influence of doctor motivation is perhaps unexpected. Historically, more emphasis has been placed on the training and education of clinicians rather than their attitudes and beliefs, but motivation of the health professionals is increasingly being recognised as having as central role in diabetes care [12]. However, this finding must be approached with caution given the subjective nature of the term 'motivation', even within the context of a theoretical model (31), and the subjective method of data collection (interviews and observations). Further investigation is required using more formal methods, such as validated questionnaires or surveys, to confirm this potential discovery. The introduction of weekly chronic disease clinics at most of the health centres studied seems to have been a major success in improving the quality of diabetes care in Tunisia. Structured care in the primary care setting has been shown in systematic reviews from developed nations to be associated with improved quality [19] and our findings suggest that these results can be generalised to less affluent nations.

The association of younger age with improved outcomes of care seems to be related to the inclusion of body mass index and cholesterol in the 4-variable outcome of care score. A national nutrition survey in Tunisia 10 years ago demonstrated the association of age with body mass index and cholesterol in Tunisia, as in other countries [32].

Finally, the association of improved outcomes of care at health centres with increased

availability of medication suggests a direct link between intermediate patient outcomes and medication availability. In the Tunisian public sector, medications are free on the payment of a small consultation fee. If the medications are unavailable, patients are required to buy them privately from pharmacists and many cannot afford to do so. Other authors from developing nations have stressed the essential role of the provision of medication [30,33]. One of the aims of the Tunisian national program has been to prioritise the supply of medicines for chronic diseases and our evidence supports this initiative.

Quality of care indicators

Quality of health care is a multidimensional concept that has been identified as including a combination of access (assessed in our study by processes of care) and effectiveness (assessed by outcomes of care) [344]. Much debate has centred on the use of processes or outcomes to assess quality of care [35]: We chose to use a combination of process and outcome measures, in an attempt to give a more accurate overall picture of the factors influencing both the recording of care and the achievement of clinical outcomes. We recognize that our outcome variables are intermediate and not long term; it is not possible at present to identify long-term outcomes, such as complication and mortality rates, in our setting.

Strengths and weaknesses of the study

Our study is the first, nationwide study from primary care on the factors that influence diabetes care from a low/middle income country to be reported. In addition, it is one of the first to incorporate an extensive number and range of potential variables, including patient, health professional and organisational factors. Selection of the variables was based on exploratory, qualitative work from Tunisia [23] in addition to reported findings from elsewhere. Our inclusion of over 50 potential factors, though larger than previous studies, is not exhaustive and other unexplored factors may be playing a role. However, it is reassuring to note that our final models did explain most of the variations in quality scores observed. Certain explanatory variables could be subject to bias; for example, availability of medication was based on reports from staff rather than an objective measure.

Based on a 2-stage randomised procedure, our study is nationally representative of the public sector, primary care management of patients with diabetes, covering over 150,000 patients throughout the country. It is possible that some of the factors discovered may be contextual and not transferable to other settings. Nonetheless, being one of the first and largest studies to be reported from a low/middle income country, we would suggest that our findings are more likely to be relevant to other similar countries than previous work from developed nations.

In summary, we found the use of chronic disease clinics, the availability of medication and possibly, doctor motivation, to be the most strongly related modifiable factors influencing the quality of diabetes care in the Tunisian primary care setting. We suggest that our findings be evaluated in other settings. However, it is unlikely that such a large, encompassing study can be undertaken in every context, particularly in less affluent nations. We would therefore recommend that clinicians, managers and health policy makers take our results into consideration in order to develop and implement culturally appropriate, quality improvement interventions in other low/middle income countries.

Acknowledgements

We would like to thank all the staff at the primary care health centres for their

hospitality and assistance. We are also grateful for helpful advice from Rudy Bilous, Nigel Oswald, Janine Gray, Tom Chadwick, George Alberti, Robbie Foy and colleagues at the DSSB.

A summary of this article was presented at the International Diabetes Federation Conference, South Africa, 2006.

References

1. Saaddine JB, Cadwell B, Gregg EW, Engelgau MM, Vinicor FF, Imperatore G, Narayan KM. Improvements in diabetes processes of care and intermediate outcomes: United States, 1988-2002. *Ann Intern Med* 144:465-477, 2006
2. Campbell SM, Roland MO, Middleton E, Reeves D. Improvements in quality of clinical care in English general practice 1998-2003: longitudinal observational study. *BMJ* 331:1121-5, 2005
3. Arday DR, Fleming BB, Keller DK, et al. Variation in diabetes care among states. *Diabetes Care* 25:2230-2237, 2002
4. Gulliford MC, Mahabir D, Ukoumunne OC. Evaluating variations in medical practice between government primary care health centres. *J Clin Epidemiol* 54: 511-517, 2001
5. Nagpal J, Bhartia A Quality of diabetes care in the middle- and high-income group populace. *Diabetes Care* 29: 2341-2348, 2006
6. Reed RL, Revel AD, Carter AO, Saadi HF, Dunn EV. A controlled before-after trial of structured diabetes care in primary health centres in a newly developed country. *Int J Qual Health Care* 17: 281-286, 2005
7. UK Prospective Diabetes Study Group. Intensive blood glucose control with sulphonylureas or insulin compared with conventional therapy and risk of complications in patients with type 2 diabetes: UKPDS 34. *Lancet* 352: 854-865, 1998
8. UK Prospective Diabetes Study Group. Tight blood pressure and risk of microvascular and macrovascular complications of type II diabetes: UKPDS 38. *BMJ* 317: 701-713, 1998
9. Brown BB, Harris SB, Webster-Bogaert S, Wetmore S, Faulds C, Stewart M. The role of patient, physician and systemic factors in the management of type 2 diabetes mellitus. *Fam Pract* 19:344-49, 2002
10. Khunti K. Use of multiple methods to determine factors affecting quality of care of patients with diabetes. *Fam Pract* 16:489-494, 1999
11. Pringle M, Stewart-Evans C, Coupland C, Williams I, Allison S, Sterland J. Influences on control in diabetes mellitus: patient, doctor, practice or delivery of care? *BMJ* 306:630-4, 1993
12. Simmons D, Lillis S, Swan J, Haar J. Discordance in perceptions of barriers to diabetes care between patients and primary care and secondary care. *Diabetes Care* 30:490-495, 2007
13. Clark M, Hampson SE. Comparison of patients' and health care professionals' beliefs about and attitudes towards Type 2 diabetes. *Diabetic Med* 20:152-154, 2003
14. Ward MM, Yankey JW, Vaughn TE, BootsMiller BJ, Flach SD, Welke KF, Penderghast JF, Perlin J, Doebbeling BN. Physician process and patient outcome measures for diabetes care: relationships to organisational characteristics. *Med Care* 42:840-850, 2004
15. Sutton M, McLean G. Determinants of primary medical care quality measured under the new UK contract: cross sectional study. *BMJ* 332:389-390, 2006
16. Pellegrini F, Belfiglio M, De Berardis G, *et al.* Role of organizational factors in poor blood pressure control in patients with Type 2 diabetes. *Arch Intern Med* 163:473-480, 2003
17. Larme AC, Pugh JA. Attitudes of primary care providers toward diabetes: Barriers to guideline implementation. *Diabetes Care* 21:1391-1396, 1998
18. Phillips LS, Branch WT, Cook CB, *et al.* Clinical Inertia. *Ann Intern Med* 135:825-834, 2001
19. Griffin S, Kinmouth AL. Systems for routine surveillance for people with diabetes mellitus. *Cochrane Database Syst Rev* 2002:4.
20. WHO. *Preventing chronic diseases, a vital investment, a WHO global report*. WHO, 2006.

21. Bouguerra R, Alberti H, Ben Salem L, et al. The Global Diabetes Pandemic: The Tunisian experience. *Eur J Clin Nutr* 61:160-165, 2007
22. Ministère de la Santé Publique. *Programme National de Prise en Charge des Diabétiques dans les Structures de 1ère Ligne.* Tunisie, 2001.
23. Alberti H. "Sokkor": Research into the contextual facilitators and barriers involved in the management of patients with type 2 diabetes mellitus must now intensify and extend into all cultures worldwide (Letter). *Fam Pract* 20:94, 2003
24. Gulliford MC, Mahabir D, Ukoumunne OC. Evaluating variations in medical practice between government primary care health centres. *J Clin Epidemiol* 54: 511-517, 2001
25. DiabetesUK. *Recommendations for the management of diabetes in primary care, second edition.* London, DiabetesUK, 2000.
26. Grimshaw JM, Campbell MK, Eccles MP, Steen IN. Experimental and quasi-experimental guideline implementation strategies. *Fam Pract* 17: S11-S18, 2000
27. Akel H, Hamadeh G. Quality of diabetes care in a university health center in Lebanon. *Int J Qual Health Care* 11:517-521, 1999
28. El-Shazly M, Abdel-Fattah M, Zaki A, *et al.* Health care for diabetic patients in developing countries: a case from Egypt. *Public Health* 114:276-281, 2000
29. Hippisley-Cox J, O'Hanlon S, Coupland C. Association of deprivation, ethnicity, and sex with quality indicators for diabetes: population based survey of 53 000 patients in primary care. *BMJ* 329:1267-1269, 2004
30. Whiting DR, Hayes L, Unwin NC. Diabetes in Africa. Challenges to health care for diabetes in Africa. *J Cardiovasc Risk* 10:103-110, 2003
31. Armitage CJ & Conner M. Efficacy of the Theory of Planned Behaviour: A meta-analytic review. *Br J Soc Psychol* 40:471-499, 2001
32. Bouguerra R, Ben Salem L, Alberti H, Ben Rayana C, El Khadhi A, El Alti J, Gaigi S, Ben Slana C, Zouari B. The prevalence of metabolic abnormalities in the Tunisian adult: A population based study. *Diabetes Metab* 32:215-221, 2006
33. De-Graft Aikins A. Healer shopping in Africa: new evidence from rural-urban qualitative study of Ghanaian diabetes experiences. *BMJ* 331:737-, 2005
34. Campbell SM, Roland MO, Buetow S. Defining quality of care. *Soc Sci Med* 51:1611-1625, 2000
35. Davies HTO, Crombie IK. Assessing the quality of care. *BMJ* 311:766, 1995

Table 1: Explanatory variables included in the analysis: Patient, health professional and organisational

Patient variables (n=21)	Health professional variables (n=9)	Organisational variables (n=23)
Age	Interest in diabetes of clinicians§	Urban/rural health centre
Gender	Training of clinicians‖	Size of health centre**
Type of diabetes	Gender of clinicians	Frequency of medical clinics
Family history of diabetes	Number of clinicians	Distance from capital city
Schooling level	Motivation of clinicians	Affluence of region††
Poverty*	Workload of clinicians#	Motivation of the regional director
Employment	Time commitment of clinicians	Distance from secondary care
Distance reside from centre	Nutritionist available	Number of patients (total and diabetic)
Marital status	Number of nurses	Proportion of patients with diabetes
Duration of diabetes		Presence and use of new DSMR
Insulin treatment		Use of disease register and patient-held records
Attendance issues (based on four indicators†)		Availability of medication‡‡
Compliance with treatment‡		Affluence of the patients attending the centre*
Smoking habit		Presence and use of chronic disease clinics
Alcohol consumption		Equipment (based on four indicators§§)
Associated illnesses (CVD, RD and Dyslipid.)		Patient education sessions

CVD: Cardiovascular disease, RD: Renal disease, Dyslipid: Dyslipidaemia, DSMR: Disease-specific medical records.
Data used for variables: *Poverty and affluence of patients – based on health insurance coverage; †Four indicators of attendance – non-attendees, frequency of attendance, frequency of appointments, late attendees; ‡Compliance with treatment – as indicated by clinician in medical records; §Interest in diabetes of clinician – presence of a regional coordinator of the national program; ‖Training of clinicians – attendance at post-graduate training in diabetes; ¶Motivation of clinicians and regional directors – assigned a score based on discussions and observations in line with the "theory of planned behaviour" in which motivation (intention) is influenced by 3 variables; the degree of control an individual feels they have over a behaviour, attitudes towards the behaviour and subjective norms (31); #Workload of clinicians – average number of patients per clinic; **Size of health centre – based on Ministry of Health classification; ††Affluence of region – based on United Nations regional poverty indicators; ‡‡Availability of medication – based on discussions with the health centre staff; §§Four equipment indicators – presence of an ECG machine, a glucometer, a means for measuring height and weight.

Table 2: Patient characteristics (n=2160)

	Mean ± SD	Percentage	95% CI	Data available
Age (years)	59.9 ± 14.1			2109
Duration of diabetes (years)	8.6 ± 6.3			1469
Mean fasting glucose (mmol/l)	10.2 ± 2.9			2071
Mean SBP (mmHg)	139 ± 18			2060
Mean DBP (mmHg)	80 ± 9			2059
Mean total cholesterol (mmol/l)	4.9 ± 1.0			1520
Mean creatinine (μmol/l)	85 ± 29			1027
Mean BMI (kg/m^2)	27.9 ± 5.1			819
Mean HbA1c (%)	8.9 ± 2.4			171
Women		61.8	58.1-65.4	2160
Married		77.0	73.7-80.3	1487
No formal education <14 years		64.1	57.0-71.2	1025
Type 2 diabetes		94.0	91.8-96.2	2160
Positive family history of DM		53.7	48.3-59.1	1311
Smoking		19.8	16.1-23.6	1223
Associated illnesses - CVD		7.7	3.9-11.5	1273
Associated illnesses - RD		5.8	3.7-7.8	1229
Associated illnesses - DYS		8.4	5.1-11.7	1195
Treatment*				
No glucose-lowering medication		4.4	3.2–5.6	2160
Blood-glucose lowering drugs		86.0	83.2–88.8	2160
Insulin (alone or with oral agents)		19.1	15.4-22.9	2160
Antihypertensive drugs		50.3	47.2–53.4	2160
Lipid-lowering drugs		15.6	12.8–18.4	2160

*Treatment is treatment prescribed on last documented visit.
SD: Standard deviation, CI: Confidence interval, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BMI: Body mass index, DM: Diabetes mellitus, CVD: Cardiovascular disease, RD: Renal disease, Dyslipid: Dyslipidaemia.

Table 3: Processes and intermediate outcomes of care

	Measurement	Percentage	n*	Range†(%)
Processes of care (n=2160)	Fasting glucose	88.8	1687	15.4 - 100
	Blood pressure	91.7	1741	46.2 - 100
	Weight	53.3	1013	0 - 100
	CVS examination	55.5	1053	0 - 100
	Foot examination	44.5	846	0 - 100
	Cholesterol	48.6	923	0 - 95.7
	Creatinine	32.9	625	0 - 97.8
	Electrocardiogram	16.9	321	0 - 82.6
	Fundoscopy	10.8	205	0 - 60.9
	HbA1c	4.5	86	0 - 71.8
Outcomes of care	Fasting glucose <= 7.8mmol/l	24.6	455/1785	4.9 - 47.2
	Blood pressure <= 140/80mmHg	66.9	1270/1898	34.4 - 91.4
	Total cholesterol <= 5mmol/l	56.2	668/1189	20 – 87.5
	Body mass index <= 25	28.7	189/659	9.1 – 62.5

* Number of patients (total is 2160 unless otherwise stated)

† Range is lowest and highest health centre percentage: For the outcomes of care, health centres with ≤10 patients with measurements undertaken excluded.

Processes of care are the percentage and number of patients having a measure undertaken in the preceding 12 months, of those who attended the health centre at least once.

Intermediate outcomes of care are the percentage and number of patients reaching targets based on an average measurement, including only patients with at least one measurement available.

Table 4: Final multivariate regression models of factors associated with process and outcome of care scores

Independent variable	Factor	ß coefficient (standardised)	95% CI	Significance
Non-weighted process of care score				
Motivation of clinicians	H P	0.55	-0.05 to 2.21	0.06
Regional affluence	Org	0.51	-0.54 to 0.07	0.11
Use of chronic disease clinics	Org	0.17	-0.04 to 0.06	0.59
Punctuality of attendance	Pat	0.10	0.08 to -0.06	0.73
Use of patient held records	Org	0.05	-1.45 to 1.78	0.82
Type 1 diabetes*	Pat	0.03	-7.50 to 6.58	0.92
Weighted process of care score				
Regional affluence	Org	0.51	0.12 to 0.53	0.003
Motivation of doctors	H P	0.37	0.22 to 1.68	0.013
Use of chronic disease clinics	Org	0.36	0.01 to 0.70	0.029
Family history of diabetes	Pat	0.22	-0.01 to 0.05	0.10
Presence of a nutritionist	H P	0.05	-1.16 to1.66	0.72
Punctuality of attendance	Pat	0.02	-0.05 to 0.06	0.91
4 variable outcome of care score				
Younger age	Pat	0.35	0.00 to 0.18	0.016
Availability of medication	Org	0.27	0.00 to 0.60	0.04
Lower number of patients*	Org	0.23	-45.1 to 660.1	0.09
Presence of new DSMR	Org	0.10	0.03 to 0.11	0.23
Gender (male)	Pat	0.18	0.00 to 0.01	0.25
2 variable outcome of care score				
Smaller health centres	Org	0.43	-0.09 to 0.04	0.37
Patient education sessions	Org	0.28	-0.11 to 0.21	0.48
Use of DSMR	Org	0.33	-0.05 to 0.03	0.51
No comorbidity of dyslipidaemia*	Pat	0.20	-0.65 to 0.98	0.65
Presence of DSMR	Org	0.16	-0.18 to 0.27	0.68
Lower number of doctors	H P	0.14	-0.06 to 0.08	0.74
Presence of a nutritionist	H P	-0.07	-0.28 to 0.25	0.89

*Logarithmic transformation used for these variables.
CI: Confidence interval, DSMR: Disease-specific medical records.
Type of variable: Pat; patient, H P: Health professional, Org: Organisational.
All models were weighted for the number of patients per centre (using the WLS option in SPSS), and included time of visit to the centre as a potential confounding factor.
Non-weighted process of care score is the proportion of 10 measures patients have had undertaken in the preceding 12 months. The weighted process of care score assigns a weight of 4 to blood pressure and fasting glucose measurements and 1 to the other 8 measures. 4 variables outcome of care score is based on achieving targets for fasting glucose, blood pressure, total cholesterol and body mass index. 2 variable outcome of care is based on achieving low and high targets for blood pressure and fasting glucose only.