Research

Management of diabetes and associated cardiovascular risk factors in seven countries: a comparison of data from national health examination surveys

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Objective To examine the effectiveness of the health system response to the challenge of diabetes across different settings and explore the inequalities in diabetes care that are attributable to socioeconomic factors.

Methods We used nationally representative health examination surveys from Colombia, England, the Islamic Republic of Iran, Mexico, Scotland, Thailand and the United States of America to obtain data on diagnosis, treatment and control of hyperglycaemia, arterial hypertension and hypercholesterolaemia among individuals with diabetes. Using logistic regression, we explored the socioeconomic determinants of diagnosis and effective case management.

Findings A substantial proportion of individuals with diabetes remain undiagnosed and untreated, both in developed and developing countries. The figures range from 24% of the women in Scotland and the USA to 62% of the men in Thailand. The proportion of individuals with diabetes reaching treatment targets for blood glucose, arterial blood pressure and serum cholesterol was very low, ranging from 1% of male patients in Mexico to about 12% in the United States. Income and education were not found to be significantly related to the rates of diagnosis and treatment anywhere except in Thailand, but in the three countries with available data insurance status was a strong predictor of diagnosis and effective management, especially in the United States.

Conclusion There are many missed opportunities to reduce the burden of diabetes through improved control of blood glucose levels and improved diagnosis and treatment of arterial hypertension and hypercholesterolaemia. While no large socioeconomic inequalities were noted in the management of individuals with diabetes, financial access to care was a strong predictor of diagnosis and management.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Introduction

The estimated global prevalence of diabetes is around 6.4% and more than 280 million people in the world have diabetes. Of those affected, the majority live in the developing world.[1] Projections for 2010 were that diabetes would account for almost 4 million deaths worldwide.[2] The burden of diabetes will only continue to grow, since the number of adults with diabetes in developing countries is projected to rise by more than two-thirds between 2010 and 2030.[1] Previous studies have documented significant deficits in the management of individuals with diabetes.[3–8]

Five strategies can help reduce the burden of diabetes at the population level: (i) case prevention through reductions in modifiable risk factors such as obesity; (ii) screening coupled with pharmacological or lifestyle interventions targeting individuals with pre-diabetes;[9,10] (iii) improved diagnosis and control of blood glucose among individuals with diabetes;[11–13] (iv) improved management of microvascular complications, including renal disease, retinopathy, diabetic foot and other neuropathies;[14,15] and (v) improved management of associated cardiovascular risks.[13,16] It is essential to understand how well health systems are performing in terms of these five strategies and the role of health system and individual attributes such as physical access, financial access, provider quality and patient education and motivation.

While diabetes care under specific providers is extensively examined in the literature,[17–19] there is only one previous comparative analysis of how health systems overall are responding to diabetes.[7] In this paper we expand the range of comparisons by analysing in a consistent way surveys conducted in three developed and four developing settings. We focus the analysis on the two strategies for which data are available: (i) diagnosis and control of blood glucose, and (ii) the management of arterial blood pressure and serum cholesterol in individuals with diabetes. We explore the relationship between socioeconomic status, financial access to diabetes care and place of residence with effective management of diabetes.

Methods

Our selection of countries was opportunistic. We searched extensively for nationally representative health examination surveys that included measurements of fasting plasma glucose or glycosylated haemoglobin or haemoglobin A1c (HbA1c) as well as arterial blood pressure and serum cholesterol. We downloaded publicly available data sets from England, Scotland and the United States of America. For other countries we requested data and collaboration on this project from the institution that conducted the survey and were able to include surveys from Colombia, the Islamic Republic of Iran, Mexico and Thailand.

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Table 1. **Sample information for nationally representative surveys used to study the management of diabetes and associated cardiovascular risk factors in seven countries**

Sample characteristic	Colombia[20]	England[21]	Islamic Republic of Iran[22]	Mexico[23]	Scotland[24]	Thailand[3]	United States[25]
Survey year(s)	2007	2003	2004	2006	2003	2004	2003–06
Overall sample size	41 833	18 553	89 400	45 446	8148	39 290	20 470
Ages (in years) included in analysis	35–64	35+	35–64	35+	35+	35+	35+
Method used to diagnose diabetes	FPG	HbA1c	FPG	FPG	HbA1c	FPG	HbA1c
No. in sample within age group of analysis	7284	10 890	49 695	30 602	4438	33 058	7142
No. in sample with some physical measurement	7035	6434	37 784	3856	3397	31 203	6460
No. of individuals with diabetes	349	363	4068	720	186	4145	1018
Diabetic individuals with measured arterial blood pressure	322	305	4050	699	158	4131	911
Diabetic individuals with measured serum cholesterol	345	242	4011	648	125	4123	785
Diabetic individuals with measured blood glucose, blood pressure and serum cholesterol	319	208	3993	630	103	4109	716

FPG, fasting plasma glucose; HbA1c, glycosylated haemoglobin.

Table 1 presents the characteristics of each survey. For all surveys except the one conducted in the Islamic Republic of Iran, sampling weights were available and were taken into account in the analysis.

Table 2 summarizes the definitions, diagnostic parameters and treatment targets for all the conditions under study. We followed the International Diabetes Federation (IDF) guidelines[26] for diagnosis and treatment values in all cases except for serum cholesterol, for which we used the guidelines of the National Institute for Health and Clinical Excellence (NICE).[27] Individuals with diabetes were categorized into four mutually exclusive groups: (i) undiagnosed, (ii) diagnosed but untreated, (iii) treated but not controlled (not meeting treatment targets), and (iv) treated and controlled (meeting treatment targets) for blood glucose, blood pressure and serum cholesterol. Our analysis was limited to medical treatment as lifestyle interventions, such as dietary changes, are not measured consistently in the household surveys.

Analysis of determinants

We used logistic regression to explore the determinants of being diagnosed, treated and controlled among individuals with diabetes, separately for each survey. We examined the determinants of having been previously diagnosed by a physician and, among those previously diagnosed, we explored the determinants of having been effectively treated for all identified conditions. We also performed a regression to identify the

determinants of meeting treatment targets for blood glucose (Appendix A, available at: http://www.healthmetricsandevaluation.org/files/2010/diabetes_comparative_analysis/Webappendix_1.pdf). We controlled for the following determinants: age and sex of the respondent, urban or rural residence, income or wealth quintile, insurance status, and educational level. For Colombia and Mexico we created a household wealth index and divided households into quintiles. For Thailand and the United States, the surveys included information on self-reported income and we divided individuals into income quintiles. In the Islamic Republic of Iran, the survey questionnaire did not include information on income or assets.

In the United States, the survey enquired whether the respondent had or did not have insurance. For Mexico we used three insurance status categories: (i) uninsured, (ii) insured through the informal sector (*Seguro Popular*), and (iii) insured through the formal or private sector. For Colombia we used three categories: (i) uninsured, (ii) insured through the informal sector (*régimen subsidiado*), and (iii) insured through the formal sector (*régimen contributivo*) or through a special social security fund for the military, the police, teachers and public oil company employees (*régimen especial*). Insurance status was not available in the Islamic Republic of Iran or Thailand.

All analyses were run using STATA version 11 (StataCorp. LP, College Station, USA).

Results

Fig. 1 shows the age-standardized prevalence and rates of diagnosis of diabetes and the rates of treatment and effective control of blood glucose. Mexico stands out for its high prevalence of the disease, with 24% of males and 21% of females over the age of 35 years having diabetes.[23] England and Scotland appear to have the lowest prevalence rates. Prevalence is higher among males in Colombia, England, Mexico and the United States, and among women in the Islamic Republic of Iran and Thailand (Appendix B, available at: http://www.healthmetricsandevaluation.org/files/2010/diabetes_comparative_analysis/Webappendix_1.pdf).

Fig. 1 also shows the proportion of individuals who had diabetes but remained undiagnosed at the time of the survey. Diagnosis rates were higher for women than men, with the largest sex differential seen in Colombia. Appendix C (available at: http://www.healthmetricsandevaluation.org/files/2010/diabetes_comparative_analysis/Webappendix_1.pdf) shows the same results expressed in terms of the proportion of individuals with diabetes. Coverage of treatment with medication for control of blood glucose is higher in developed countries, but low overall, especially in younger people (Fig. 1). The highest treatment rates were found in the United States. In Colombia, the Islamic Republic of Iran and Thailand the majority of individuals with diabetes were not using medication for blood glucose control.

Table 2. **Definitions of categories used in the analysis in seven-country study of the management of diabetes and associated cardiovascular risk factors**

Condition	Status	Definition
Diabetes (self-reported diagnosis or HbA1c ≥ 6.5% or FPG ≥ 126 mg/dl)	Undiagnosed	No self-reported diagnosis of diabetes and HbA1c ≥ 6.5% (FPG ≥ 126 mg/dl)
	Diagnosed and untreated	Self-reported diagnosis of diabetes and no self-reported current use of medication for diabetes and HbA1c ≥ 6.5% (FPG ≥ 126 mg/dl)
	Diagnosed, treated, uncontrolled	Self-reported diagnosis of diabetes and self-reported current use of medication for diabetes and HbA1c ≥ 6.5% (FPG ≥ 126 mg/dl)
	Diagnosed, treated, controlled	Self-reported diagnosis of diabetes and self-reported current use of medication for diabetes and HbA1c < 6.5% (FPG < 126 mg/dl)
Hypertension (Self-reported diagnosis or SBP ≥ 130 mmHg)	Undiagnosed	No self-reported diagnosis of hypertension and systolic blood pressure ≥ 130 mmHg
	Diagnosed and untreated	Self-reported diagnosis of hypertension and no self-reported current use of medication for hypertension and systolic blood pressure ≥ 130 mmHg
	Diagnosed, treated, uncontrolled	Self-reported diagnosis of hypertension and self-reported current use of medication for hypertension and systolic blood pressure ≥ 130 mmHg
	Diagnosed, treated, controlled	Self-reported diagnosis of hypertension and self-reported current use of medication for hypertension and systolic blood pressure < 130 mmHg
Serum cholesterol (self-reported diagnosis or total cholesterol ≥ 5.0 mmol/l)	Undiagnosed	No self-reported diagnosis of hypercholesterolaemia and total serum cholesterol ≥ 5.0 mmol/l
	Diagnosed and untreated	Self-reported diagnosis of hypercholesterolaemia and no self-reported current use of medication for hypercholesterolaemia and total serum cholesterol ≥ 5.0 mmol/l
	Diagnosed, treated, uncontrolled	Self-reported diagnosis of hypercholesterolaemia and self-reported current use of medication for hypercholesterolaemia and total serum cholesterol ≥ 5.0 mmol/l
	Diagnosed, treated, controlled	Self-reported diagnosis of hypercholesterolaemia and self-reported current use of medication for hypercholesterolaemia and total serum cholesterol < 5.0 mmol/l
	Diagnosed, uncontrolled[a]	Self-reported diagnosis of hypercholesterolaemia and total serum cholesterol ≥ 5.0 mmol/l; medication use unknown
	Diagnosed, controlled[a]	Self-reported diagnosis of hypercholesterolaemia and total serum cholesterol < 5.0 mmol/l; medication use unknown
	Management status unknown[b]	Total serum cholesterol ≥ 5.0 mmol/l; diagnosis status and medication use unknown
Comprehensive management	Undiagnosed or untreated for one or more conditions	Individual has diabetes and is either "undiagnosed" or "diagnosed and untreated" for diabetes, hypercholesterolaemia, or hypertension
	Ineffective management of one or more conditions	Individual has diabetes and is currently taking all necessary medication, but "diagnosed, treated, and uncontrolled" for one or more condition
	Effective management of all conditions	Individual has diabetes and is "diagnosed, treated and controlled" for all existing conditions

FPG, fasting plasma glucose; HbA1c, glycosylated haemoglobin; mg/dl, milligrams per decilitre; mmHg, millilitres of mercury; mmol/l, millimoles per litre; SBP, systolic blood pressure.
[a] Colombia only.
[b] Islamic Republic of Iran only.

The highest proportion of diagnosed but untreated individuals was found among Colombian women, at 12%.

In all surveys only a small fraction of individuals with diabetes met treatment targets. The United States was the best performer, with about 26% of individuals with diabetes meeting treatment targets. In Colombia, 27% of men and 24% of women were meeting the targets, while England and Scotland were among the worst performers. While the proportion of diabetic individuals who were on treatment was low in Colombia, that country appeared to be more effective than others at reaching treatment targets.

Fig. 2 shows the prevalence of arterial hypertension and the rates of diagnosis, treatment and control among individuals with diabetes. The prevalence of arterial hypertension was high in all surveys but was highest among Scottish women and lowest among Mexican women. The rate of diagnosis was distinctly higher in England, Scotland and the United States than in Colombia, the Islamic Republic of Iran, Thailand or Mexico, countries where more than half of men with diabetes and arterial hypertension had never been diagnosed.

Treatment rates for arterial hypertension followed a similar pattern and were higher in the more developed countries. The highest proportion of individuals with diabetes and hypertension who were meeting treatment targets for hypertension was seen in the United States (38% for men and 25% for women), while in all other surveys fewer than 15% of individuals with diabetes were meeting treatment targets for blood pressure.

The prevalence of hypercholesterolaemia among individuals with diabetes was similarly high; it was above 55% in all surveys except in Mexico, where it was only about 35% (Fig. 3). Rates of diagnosis are very low in all surveys except the one in the United States. Diagnostic rates in Thailand were below one-fourth the rate observed in the United States, even though both countries had a similar prevalence of diabetes. Countries had a lower proportion of diabetic individuals on treatment for the control of serum cholesterol than for blood pressure or blood glucose control, but of those receiving treatment for hypercholesterolaemia, higher proportions were
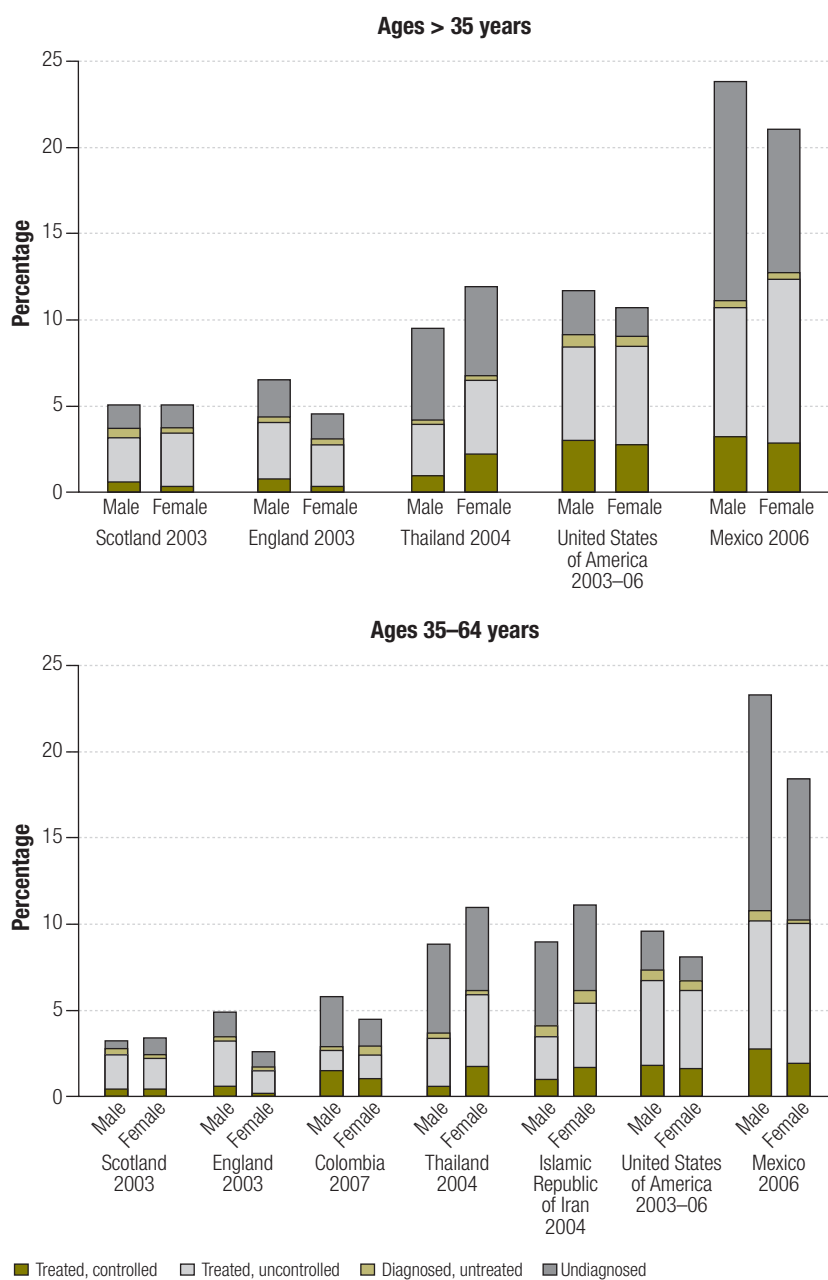
meeting treatment targets when compared to those on treatment for hyperglycaemia or hypertension.

Fig. 4 depicts how well countries perform overall in managing individuals with diabetes. Effective management was defined in terms of the proportion of individuals with diabetes who were receiving the treatment they required and who were meeting treatment targets for blood glucose, blood pressure and serum cholesterol. Across all surveys, only a small proportion of individuals with diabetes had achieved treatment targets for all three conditions. Within this set of surveys, the United States had the highest rates of effective management, at 13% for men and 6% for women. Ineffective management was assessed in terms of the proportion of individuals who were receiving required treatment for all the conditions they had but who were not meeting treatment targets. A striking finding, shown in Fig. 4, was the enormous proportion of individuals with diabetes who were undiagnosed or who had been diagnosed but were not being treated for hyperglycaemia, arterial hypertension or hypercholesterolaemia, individually or in combination. It was highest in Thailand, where 88% of men and 85% of women were lacking management, largely on account of the low rates of diagnosis of hypercholesterolaemia. The United States had the lowest proportion of individuals who were not being managed, but even there more than 40% of men and women with diabetes were undiagnosed or had been diagnosed but were not being treated for one or more conditions. There is substantial room for improvement in the management of diabetes and its associated cardiovascular risks.

Surprisingly, wealth was not significantly associated with the probability of being diagnosed with diabetes (Table 3) anywhere except in Thailand, where the poorest quintile had significantly lower odds of being diagnosed than the richest quintile. In Thailand, individuals with a higher educational level also had significantly higher odds of being diagnosed. In the Islamic Republic of Iran and Thailand, living in an urban location was associated with significantly higher odds of being diagnosed than living in a rural location, but it was not a significant determinant in other surveys. In Colombia, Mexico and the United States, where data were available, insurance status was a strong and significant predictor of diagnosis.

Finally, Table 3 explores the determinants of being on treatment and meeting

Fig. 1. **Prevalence, diagnosis and treatment rates for diabetes[a] among adults in seven-country study of the management of diabetes and associated cardiovascular risk factors**

Ages > 35 years

Ages 35–64 years

Legend: Treated, controlled; Treated, uncontrolled; Diagnosed, untreated; Undiagnosed

[a] Individuals with diabetes are assigned to one of four groups: (i) undiagnosed, (ii) diagnosed but not on treatment, (iii) diagnosed, on treatment but not meeting treatment targets, and (iv) diagnosed, on treatment and meeting treatment targets. The overall height of the bars represents the diabetes prevalence in that population.

treatment targets for all existing cardiovascular risks. Once diagnosed, males were less likely to be effectively managed than females in the Islamic Republic of Iran and Mexico, but in Thailand they were more likely to be. In Thailand, the two lowest income quintiles were less likely to be effectively managed, but surprisingly, in other surveys income was not a significant determinant of effective management. Similarly, a higher educational level was associated with a higher probability of

meeting treatment targets in Colombia but not in other countries. Finally, insured individuals in the United States were almost twice ($P < 0.05$) as likely to be effectively managed as those without insurance, but insurance status was not associated with effective management in Colombia or Mexico. It is also important to note that in England and Scotland none of the socio-economic determinants were significantly associated with higher rates of diagnosis or effective treatment.
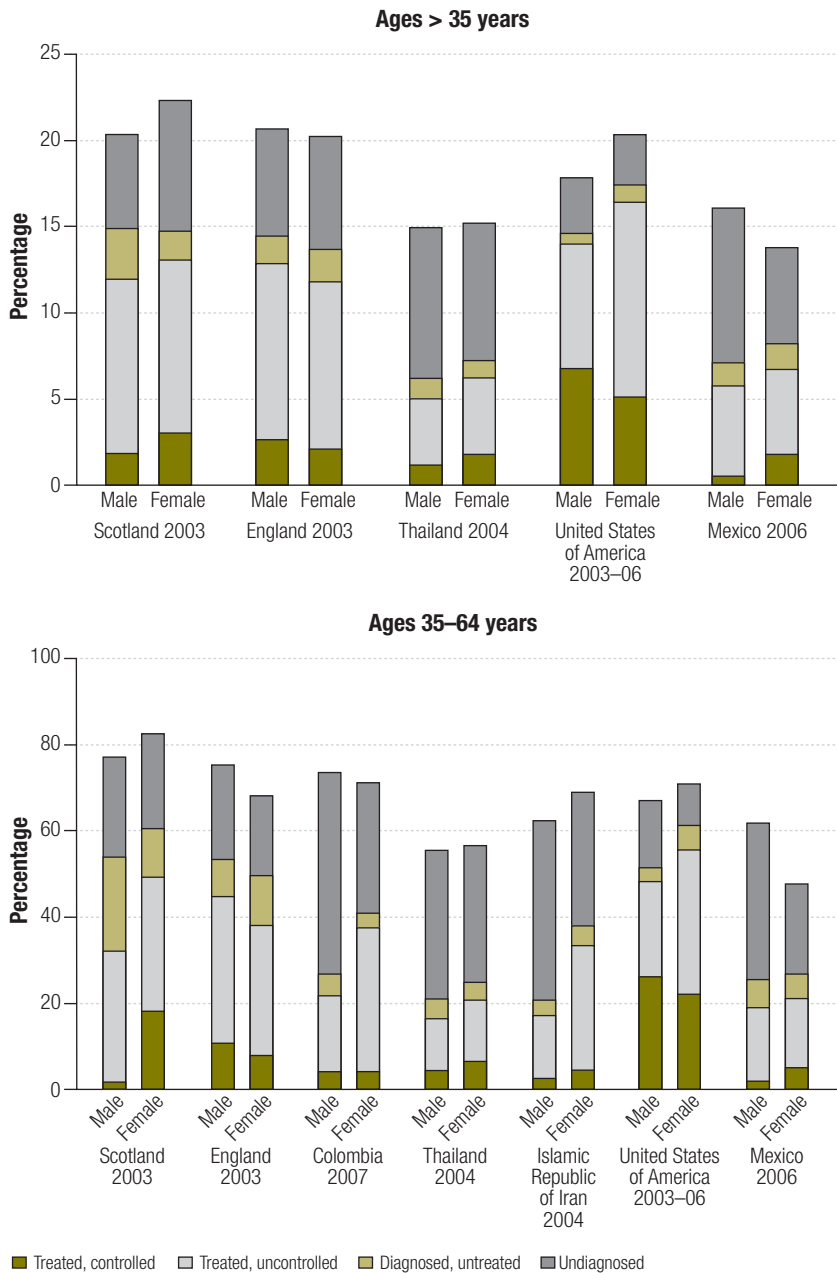
Discussion

In this paper we present a unique comparative picture of diabetes mellitus management based on an analysis of nationally representative surveys from seven countries, three of them developed and four in development. The overall finding was that a substantial proportion of individuals with diabetes remain undiagnosed and untreated and, perhaps more worryingly, that the percentage of individuals reaching International Diabetes Federation treatment goals for blood glucose, blood pressure and serum cholesterol is very low, ranging from 1% to 12%. These low rates of diagnosis, treatment and control reflect many lost opportunities for reducing the growing global burden of diabetes.

Once individuals are diagnosed, they are highly likely to be treated with medication, both in developed and in developing countries. Information on the management of hyperglycaemia with lifestyle interventions such as diet is not available. Nevertheless, in all countries more than 70% of individuals with diabetes were not reaching the blood glucose treatment targets set by the International Diabetes Federation and there was considerable variation across the seven surveys. While diagnostic criteria were largely consistent across national guidelines, there was less agreement on the treatment targets for blood glucose (Table 4), which may partly explain the wide variation in control rates. More recent evidence on the most appropriate treatment targets for blood glucose control[34] further complicates the process of arriving at national and international treatment guidelines that are consistent, acceptable and implemented by national health-care providers and individuals with diabetes. Successful blood glucose management is clearly the result of a complex interplay between physician behaviour and patient adherence to treatment.

One of the keys to the effective management of individuals with diabetes is the treatment of associated cardiovascular risks.[13,16] Our analysis showed that 28–78% of individuals with diabetes who were also hypertensive were being treated or had attained therapeutic control targets. Much greater variation was seen in the treatment of hypercholesterolaemia, with especially low rates of diagnosis and treatment in Thailand. Control rates for blood pressure and serum cholesterol were much higher than for blood glucose, perhaps because of the high efficacy and minimal side-effects of the drugs used to lower blood pressure and serum cholesterol. Some of the varia-

Fig. 2. **Prevalence, diagnosis and treatment rates for arterial hypertension[a] among adults in seven-country study of the management of diabetes and associated cardiovascular risk factors**

Ages > 35 years

Ages 35–64 years

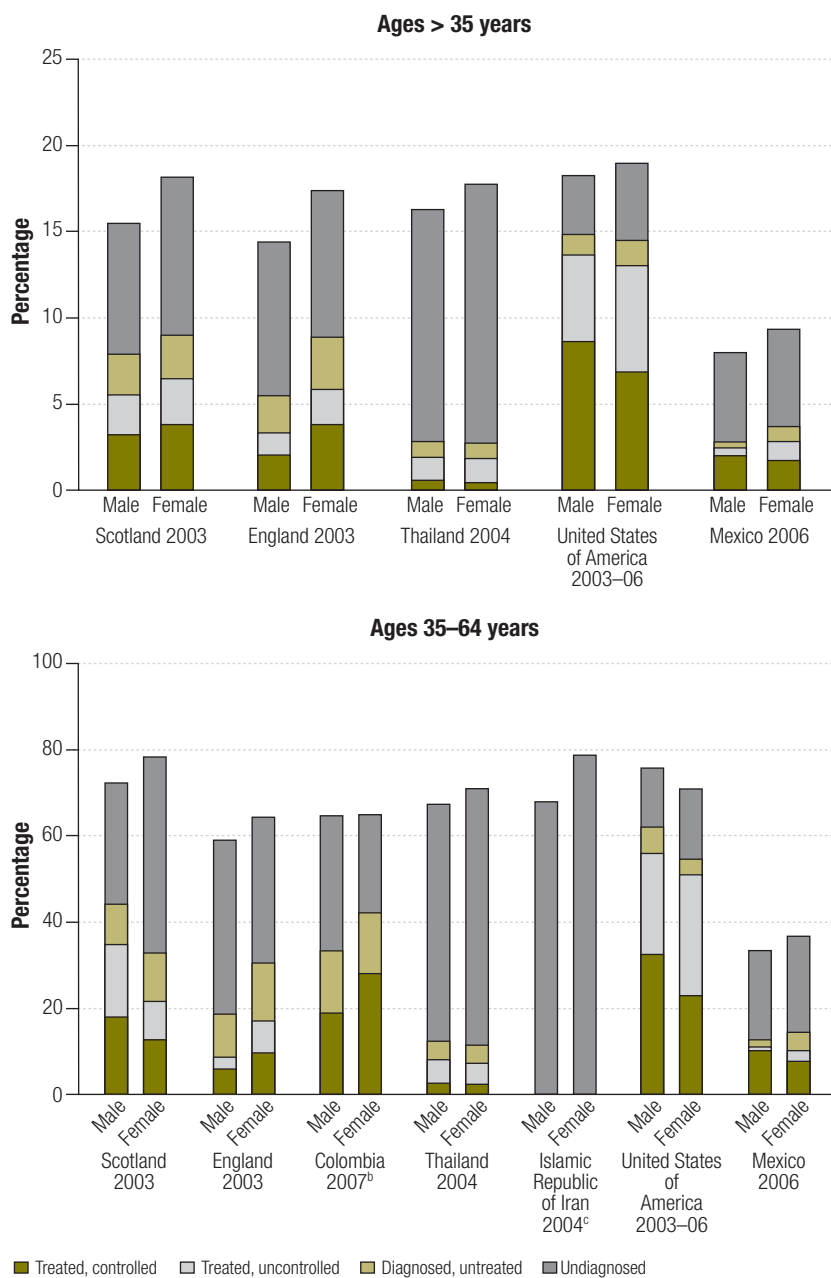■ Treated, controlled   ▫ Treated, uncontrolled   ▫ Diagnosed, untreated   ▪ Undiagnosed

[a] Individuals with arterial hypertension are assigned to one of four groups: (i) undiagnosed, (ii) diagnosed but not on treatment, (iii) diagnosed, on treatment but not meeting treatment targets, and (iv) diagnosed, on treatment and meeting treatment targets. The total height of the bars represents the prevalence of arterial hypertension in individuals with diabetes.

tion seen across countries may be related to differential treatment guidelines. For both arterial hypertension and hypercholesterolaemia, low treatment rates coupled with high control rates among treated individuals suggest that there is a huge potential for reducing the burden of diabetes, particularly in developing countries.

The rates of effective management of cardiovascular risk factors in individuals with diabetes vary considerably. In all countries except Thailand, a large fraction of individuals with diabetes – about 35% in England and Scotland and close to 50% in the United States – take medication to lower blood glucose, blood pressure and serum cholesterol, but without meeting treatment targets. This suggests that the burden of diabetes in high-income countries could be reduced through improved patient management. It should be noted that the rates of effective management of

Fig. 3. **Prevalence, diagnosis and treatment rates for hypercholesterolaemia[a] among adults in seven-country study of the management of diabetes and associated cardiovascular risk factors**

Ages > 35 years

Ages 35–64 years

■ Treated, controlled   ▢ Treated, uncontrolled   ▨ Diagnosed, untreated   ▩ Undiagnosed

[a] Individuals with hypercholesterolaemia are assigned to one of four groups: (i) undiagnosed, (ii) diagnosed but not on treatment, (iii) diagnosed and on treatment but not meeting treatment targets, and (iv) diagnosed, on treatment and meeting treatment targets. The total height of the bars represents the prevalence of hypercholesterolaemia in individuals with diabetes.

[b] No information on current use of cholesterol-lowering medication was available for Colombia. The bars reflect whether individuals are diagnosed and whether they are meeting treatment targets.

[c] No information on previous diagnosis or current use of cholesterol-lowering medication was available for the Islamic Republic of Iran. The height of the bar represents the prevalence of hypercholesterolaemia among individuals with diabetes.

cardiovascular risk factors for England and Scotland may have changed since 2004 as a result of the National Health Service's experiment for improving the quality of care, but more recent data are not available.[7,35]

At least three strategies can be employed to improve the management of

diabetes in the short term. First, efforts to standardize and track the care of patients with diabetes do not appear to have had a major impact to date. Hence, greater effort in this area and clear targets for physicians and patients are needed. Second, offering incentives to providers and patients is a

new but promising approach, although it calls for further experimentation and evaluation. These incentives should ideally be related to blood glucose outcomes rather than process measures. The experience of the United Kingdom of Great Britain and Northern Ireland with providing incentives to physicians to improve the quality of care and disease management will be a source of useful lessons for other countries. Third, there appears to be an urgent need for technological innovation in the care of diabetes. The poor performance noted, for example, in meeting blood glucose control targets may be strongly related to the narrow window between ideal and excessively low blood glucose levels. Innovations in blood glucose monitoring and drug delivery could increase the proportion of diabetic individuals who remain within an optimal blood glucose range. Clearly, diabetes management has not been successful at the population level and both policy and research need to be strengthened in the future.

In most countries, income, wealth and education were not significantly associated with diagnosis, treatment and control rates. This is an encouraging finding, especially given the large socioeconomic inequalities seen in many health outcomes. In Thailand, however, low income and low educational level were significantly associated with lower rates of diabetes diagnosis and effective management, and with the diagnosis and treatment of arterial hypertension and hypercholesterolaemia.[36] These findings suggest a clear need for better strategies targeting the poor in Thailand.

More intriguing still is the finding that health insurance status is an important predictor of diagnosis and treatment. This underscores the fact that for those who require diagnosis and chronic management, financial access to care is a critical concern. This is particularly evident in the United States. The fact that Mexico has succeeded in expanding financial access to services through a public insurance scheme highlights the interplay between financial access and disease management. Even though *Seguro Popular* had only existed for two years when the Mexican survey was conducted, individuals with diabetes who were covered by *Seguro Popular* had been diagnosed at significantly higher rates than those who were uninsured, and at rates comparable to those observed among individuals who were insured through the formal sector. This is very different from what we found in Colombia, where in 2007 individuals insured through the informal sector (subsidized scheme) had the same

Fig. 4. **Comprehensive management[a] of blood glucose, arterial hypertension and hypercholesterolaemia among adults with diabetes in seven-country study of the management of diabetes and associated cardiovascular risk factors**

Ages > 35 years

Ages 35–64 years

Effective management ▪ Ineffective management ▪ Lacking management
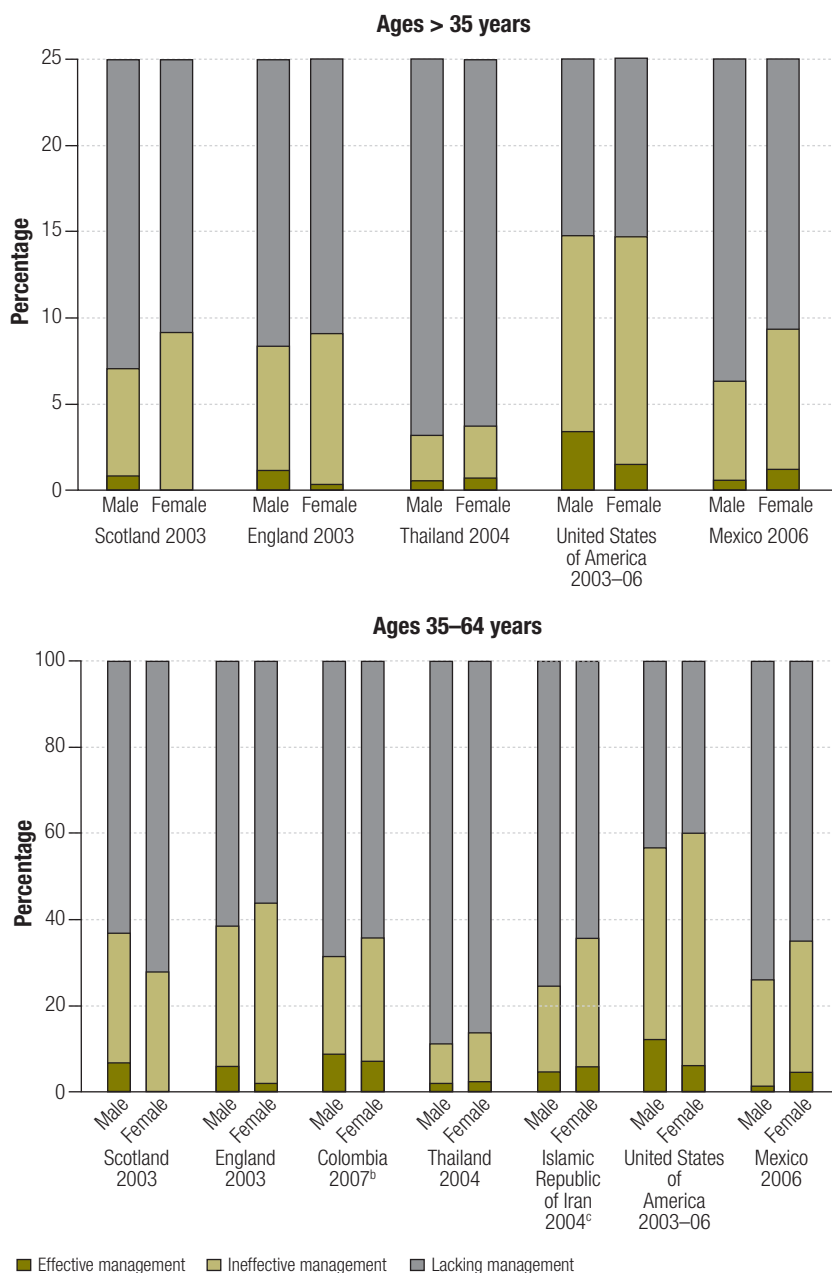
[a] Effective management refers to individuals with diabetes who are diagnosed, treated and controlled for all existing conditions. Ineffective management of one or more conditions refers to individuals with diabetes who are currently taking all necessary medication but are not meeting treatment targets for one or more condition. Lacking management refers to individuals with diabetes who are either undiagnosed or diagnosed but untreated for diabetes, arterial hypertension or hypercholesterolaemia.

[b] No information on current use of cholesterol-lowering medication was available for Colombia. Comprehensive management has been estimated for blood glucose and blood pressure only.

[c] No information on previous diagnosis or current use of cholesterol-lowering medication was available for the Islamic Republic of Iran. Comprehensive management has been estimated for blood glucose and blood pressure only.

rates of treatment as the uninsured and significantly lower rates of treatment than those insured through the formal sector (contributory scheme). This may be attributable to the fact that at the time of the survey the two insurance schemes were offering substantially different benefits packages. Provisions for diabetes treatment under both packages were made identical in 2008, and since the survey was conducted insurance coverage has expanded almost the entire population. Therefore,

the role of insurance in the diagnosis and management of individuals with diabetes in Colombia may become less important in the future.

Our study has several limitations. First, while the data we used are the latest available, they are not very recent. Changes in diagnosis and treatment guidelines have subsequently occurred in several countries. The most recent survey from England and Scotland was conducted in 2003, before the 2004 NICE experiment for improving quality. More recent studies have shown that prescription rates for oral hypoglycaemic agents have increased in the United Kingdom since 2000,[37] so our results have probably underestimated the performance of the National Health Service in effectively controlling cardiovascular risks in individuals with diabetes. Second, there is debate as to whether there are differences when diabetes is diagnosed based on fasting plasma glucose versus HbA1c, and as to whether the method used to measure HbA1c is the same across surveys or not. In four of the surveys used in this analysis, fasting plasma glucose was measured, while HbA1c was measured in the other three. Recent literature, however, provides strong evidence that an HbA1c level of 6.5% is equivalent to a fasting plasma glucose level of 126 milligrams (mg) per decilitre (dl).[38] Third, individuals in the sample for whom all three physical examination measures were available were fewer than those for which blood glucose levels were available, and the difference between the two groups varied across countries. Thus, our estimates may have been subject to selection bias. Fourth, much of this analysis relied on self-reported diagnosis and treatment obtained from population surveys, and the limitations of self-reported data are known. It is also impossible to ascertain the reasons for not being on medication or for not reaching treatment targets, and it is possible that poor patience adherence is playing a part. Fifth, the number of individuals with diabetes in the surveys conducted in Colombia, England and Scotland is very small, as a result of which greater uncertainty surrounds the estimates from these countries. Finally, our analysis of treatment is limited to pharmacological treatment only. Lifestyle intervention programmes, especially those that rely on dietary changes and increased physical activity, play an important role in diabetes management. However, household health surveys are inconsistent in enquiring about diet and physical activity, and this limited our ability to monitor the uptake of these interventions at the population level.

Table 3. **Probability of (i) being diagnosed with diabetes if diabetic, and of (ii) being treated and meeting treatment targets for blood glucose, blood pressure and serum cholesterol if previously diagnosed as diabetic in seven-country study of the management of diabetes and associated cardiovascular risk factors**

Determinant	Colombia		England		Islamic Republic of Iran		Mexico		Scotland		Thailand		United States	
	OR	P	OR	P	OR	P	OR	P	OR	P	OR	P	OR	P
Probability of being diagnosed														
Age group (years)														
35–44	0.29	0.000	0.80	0.627	0.55	0.000	0.36	0.000	3.00	0.344	0.35	0.000	0.73	0.328
45–54	0.86	0.631	0.99	0.981	0.82	0.007	0.75	0.178	1.04	0.954	0.63	0.000	0.78	0.344
55–64	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–
65+	–	–	0.70	0.331	–	–	0.96	0.867	0.98	0.957	1.09	0.268	0.95	0.820
Sex														
Male	0.76	0.296	0.62	0.092	0.70	0.000	0.82	0.220	0.80	0.588	0.63	0.000	0.82	0.268
Female	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–
Residence														
Urban	1.30	0.430	1.31	0.356	1.60	0.000	0.88	0.551	0.68	0.366	1.30	0.000	–	–
Rural	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	–	–
Wealth quintile														
Poorest	1.19	0.746	1.10	0.858	–	–	0.86	0.613	1.74	0.546	0.61	0.008	1.38	0.289
Quintile 2	1.62	0.298	1.54	0.412	–	–	1.57	0.115	1.51	0.629	0.80	0.075	1.45	0.243
Quintile 3	1.00	0.992	1.45	0.475	–	–	1.20	0.489	3.38	0.199	1.08	0.527	1.21	0.537
Quintile 4	1.79	0.195	1.19	0.730	–	–	1.53	0.094	0.68	0.664	0.96	0.733	1.35	0.340
Richest	1.00	–	1.00	–	–	–	1.00	–	1.00	–	1.00	–	1.00	–
Insurance status[a]														
Insured A	3.31	0.005	–	–	–	–	1.47	0.029	–	–	–	–	2.23	0.002
Insured B	1.62	0.232	–	–	–	–	1.74	0.027	–	–	–	–	–	–
Uninsured	1.00	–	–	–	–	–	1.00	–	–	–	–	–	1.00	–
Education[b]														
No education	1.00	–	–	–	1.00	–	1.00	–	–	–	1.00	–	–	–
Complete primary	1.06	0.858	1.00	–	1.09	0.292	0.71	0.123	1.00	–	1.23	0.075	1.00	–
Complete secondary	0.99	0.987	1.37	0.428	0.94	0.597	0.52	0.018	0.66	0.390	1.39	0.039	0.82	0.391
University	–	–	1.41	0.546	0.75	0.012	–	–	4.18	0.119	1.51	0.028	0.76	0.204
Sample size	297		283		4063		717		156		3706		988	
Probability of being effectively managed														
Age group (years)														
35–44	0.68	0.471	0.62	0.429	0.86	0.311	2.09	0.073	0.40	0.364	0.80	0.345	1.66	0.212
45–54	0.96	0.914	0.61	0.428	0.85	0.112	0.99	0.986	0.06	0.043	0.72	0.049	1.13	0.691
55–64	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–
65+	–	–	0.65	0.383	–	–	1.19	0.565	0.44	0.226	1.11	0.321	0.89	0.608
Sex														
Male	0.76	0.465	0.83	0.636	0.63	0.000	0.59	0.035	1.84	0.312	1.27	0.020	1.25	0.230
Female	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–
Residence type														
Urban	0.73	0.509	1.27	0.579	0.93	0.487	1.42	0.263	1.08	0.899	1.03	0.775	–	–
Rural	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	–	–
Wealth quintile														
Poorest	1.28	0.741	0.53	0.381	–	–	1.42	0.448	4.27	0.339	0.56	0.047	1.79	0.066
Quintile 2	0.61	0.460	1.13	0.855	–	–	0.93	0.860	0.63	0.743	0.65	0.011	1.11	0.745
Quintile 3	0.81	0.728	0.72	0.632	–	–	0.85	0.696	0.98	0.991	0.72	0.055	1.52	0.186
Quintile 4	0.75	0.603	1.12	0.868	–	–	1.32	0.497	0.10	0.175	0.86	0.371	1.09	0.793
Richest	1.00	–	1.00	–	–	–	1.00	–	1.00	–	1.00	–	1.00	–
Insurance status[a]														
Insured A	0.81	0.750	–	–	–	–	0.87	0.612	–	–	–	–	1.98	0.039

Determinant	Colombia		England		Islamic Republic of Iran		Mexico		Scotland		Thailand		United States	
	OR	P	OR	P	OR	P	OR	P	OR	P	OR	P	OR	P
Insured B	0.90	0.868	–	–	–	–	0.70	0.311	–	–	–	–	–	–
Uninsured	1.00	–	–	–	–	–	1.00	–	–	–	–	–	1.00	–
Education[b]														
No education	1.00	–	–	–	1.00	–	1.00	–	–	–	1.00	–	–	–
Complete primary	0.80	0.628	1.00	–	1.05	0.625	0.86	0.624	1.00	–	1.24	0.210	1.00	–
Complete secondary	4.48	0.011	0.60	0.322	0.92	0.647	1.46	0.386	0.69	0.601	1.06	0.810	1.10	0.700
University	–	–	1.05	0.945	1.08	0.663	–	–	0.14	0.135	1.24	0.413	1.07	0.764
Sample size	156		131		2107		318		73		2097		603	

OR, odds ratio.

[a] Insured A includes those insured in the United States and insured through the formal sector in Colombia and Mexico. Insured B includes those insured through the informal sector in Colombia and Mexico.

[b] For Colombia and Mexico, complete secondary includes individuals with a university education.

Table 4. **Comparison of diagnostic thresholds for diabetes and treatment targets for blood glucose, systolic blood pressure (BP) and serum cholesterol across national guidelines in seven-country study of the management of diabetes and associated cardiovascular risk factors**

National guideline (country, issuing body, year of publication)	Diagnostic threshold, FPG (mg/dl)	Treatment target		
		Blood glucose (HbA1c or FPG)	Systolic BP (mmHg)	Serum lipids (mmol/l)
Colombia, Ministry of Social Protection,[28] 2007	≥126	<7.0% HbA1c	<140	LDL <2.6
England and Scotland, National Institute for Clinical Excellence,[29] 2008	NA	<6.5–7.5% HbA1c	<140	LDL <3.0 TC <5.0
Islamic Republic of Iran, Ministry of Health,[30] 2004	≥126	<140 mg/dl FPG	<130	TG <2.3 LDL <3.4 TC <6.2
Mexico, Ministry of Health,[31] 1994	≥126	<140 mg/dl FPG	<130	TG <2.3 TC <6.2 TG <2.3
Thailand, National Health Security Office,[32] 2008	≥126	<6.5% HbA1c; 70–110 mg/dl FPG	<130	HDL >0.9 LDL <2.6 TC 3.4–4.4 TG <1.7
United States, American Diabetes Association,[33] 2009	≥126	<7.0% HbA1c	<130	HDL ≥1.0 LDL <2.6 TG <1.7
World, International Diabetes Federation,[26] 2005	≥126	<6.5% HbA1c; <110 mg/dl FPG	<130	HDL >1.0 LDL <2.5 TG <2.3 HDL >1.0

FPG, fasting plasma glucose; HbA1c, glycosylated haemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein; mg/dl, milligrams per decilitre; mmHg, millimetres of mercury; mmol/l, millimoles per litre; NA, not available; TC, total cholesterol; TG, triglycerides.

Based on this comparison of how well seven countries are performing in terms of population-level management of diabetes, hypertension and hypercholesterolaemia we make several recommendations. First, since the prevalence of diabetes is increasing worldwide and particularly in developing countries, it is critical to track diabetes care at the population level and to focus on actual outcomes, rather than on the process of care. It is also critical to study other countries with larger numbers of individuals with diabetes, such as China and India, for which nationally representative studies are not readily available. Second, it is important to prioritize the development and implementation of national guidelines and the use of new incentive programmes for the management of hypertension and hypercholesterolaemia among individuals with diabetes in developing countries. Our findings suggest that such progress may be more feasible and more likely to have a larger population health impact than blood glucose control. Third, there are opportunities for innovation in providing incentives, in the technology of diabetes management and in improving financial access to care. Real progress at the population level in the management of diabetes will likely require all three: monitoring performance in meeting treatment targets, expanding management of hypertension

ملخص

التدبير العلاجي للسكري وعوامل الاختطار القلبية الوعائية المرتبطة به في سبعة بلدان: مقارنة المعطيات من مسوحات وطنية لفحص الصحة الوطنية

الغرض: فحص فعالية تصدي النظام الصحي لتحدي السكري في مواقع مختلفة واستكشاف عدم المساواة في رعاية السكري التي تُعزَى إلى عوامل اجتماعية واقتصادية.

الطريقة: استخدم الباحثون مسوحات وطنية لفحص الصحة من كل من كمبوديا، وانكلترا، وجمهورية إيران الإسلامية، والمكسيك، وسكوتلاندا، وتايلاند، والولايات المتحدة الأمريكية لجمع معطيات تشخيص، ومعالجة، وتضبيط فرط سكر الدم، وفرط الضغط الشرياني، وفرط كوليستيرول الدم بين المصابين بالسكري. واستكشف الباحثون، باستخدام التحوّف اللوجستي، المحددات الاجتماعية-الاقتصادية للتشخيص والتدبير العلاجي الفعّال للحالات.

النتائج: لم تُشخَّص ولم تعالج نسبة كبيرة من المصابين بالسكري، في كل من البلدان المتقدمة والنامية. وتراوحت هذه النسبة من24% بين النساء في سكوتلاندا والولايات المتحدة الأمريكية إلى% 62 بين الرجال في تايلاند.

وكانت نسبة المصابين بالسكري الذين بلغوا مرامي معالجة غلوكوز الدم، وضغط الدم الشرياني، والكوليستيرول المصلي نسبة منخفضة للغاية، تراوحت بين% 1 من الذكور في المكسيك إلى % 12 في الولايات المتحدة. لم يُلاحَظ للدخل والتعليم علاقة يعتد بها إحصائياً مع معدلات التشخيص والمعالجة في أي مكان ماعدا تايلاند، وكانت حالة التأمين، في ثلاثة بلدان توفرت فيها المعطيات، منبئاً قوياً على التشخيص وفعالية التدبير العلاجي، ولاسيما في الولايات المتحدة.

الاستنتاج: كثير من الفرص المفقودة يمكن الاستفادة منها للحد من عبء السكري عن طريق تحسين تضبيط مستويات غلوكوز الدم، وتحسين تشخيص ومعالجة فرط الضغط الشرياني وفرط كوليستيرول الدم. ومع أنه لم يُلاحَظ في التدبير العلاجي للمصابين بالسكري قدر كبير من عدم المساواة الاقتصادية والاجتماعية، إلا أن القدرة المالية على الوصول إلى خدمات الرعاية كانت منبئاً قوياً على التشخيص والتدبير العلاجي.

摘要

七个国家糖尿病和相关心血管危险因素的管理:全国健康检查调查数据比较

目的 旨在考察不同环境下的医疗体系应对糖尿病挑战的有效性,并探讨因社会经济因素引起的糖尿病护理中的不平等现象。

方法 我们运用哥伦比亚、英格兰、伊朗、墨西哥、苏格兰、泰国和美国的全国代表性体检调查结果,从中获得糖尿病患者在诊断、治疗和高血糖、动脉高血压和高胆固醇血症的控制方面的数据。使用逻辑回归分析探讨了诊断和病例有效管理的社会经济因素。

结果 无论是在发达国家还是在发展中国家,有相当比例的糖尿病患者仍然未经诊断和治疗。这方面数字在24%(苏格兰和美国女性)到62%(泰国男性)之间变化。实现血糖、动

脉血压和胆固醇治疗目标的糖尿病患者的比例非常低,仅占1%(墨西哥男性)到约12%(美国)。除泰国外,未发现收入和教育程度与诊断和治疗比例显著相关。然而,在有可用数据的三个国家,特别是在美国,保险状况是实现糖尿病诊断和有效管理的一个强大的预警器。

结论 人们错过了很多通过更好地控制血糖水平、更早地诊断和治疗动脉高血压和高胆固醇血症来减轻糖尿病负担的机会。尽管在糖尿病患者的管理中并未发现重大经济社会不公现象,但是,具备享受医疗服务的经济能力仍是实现糖尿病诊断和有效管理的一个强大预警器。

Résumé

Traitement du diabète et des facteurs de risque cardiovasculaire associés dans sept pays: comparaison des données d'enquêtes nationales de santé par examen

Objectif Étudier l'efficacité de la réponse du système de santé au problème du diabète sur différents paramètres et explorer les inégalités dans la prise en charge du diabète, attribuables à des facteurs socioéconomiques.

Méthodes Nous avons utilisé des enquêtes de santé par examen représentatives au plan national pour la Colombie, l'Angleterre, la République islamique d'Iran, le Mexique, l'Écosse, la Thaïlande et les États-Unis d'Amérique. Les données exploitées portent sur le diagnostic,

le traitement et le contrôle de l'hyperglycémie, de l'hypertension artérielle et de l'hypercholestérolémie chez les diabétiques. Nous avons utilisé la régression logistique pour explorer les déterminants socioéconomiques du diagnostic et de la bonne gestion thérapeutique.

Résultats Une proportion substantielle des diabétiques n'a pas fait l'objet d'un diagnostic et ne reçoit par conséquent aucun traitement et ce, à la fois dans les pays développés et dans les pays en voie de développement. Les chiffres vont de 24% des femmes en Écosse et aux

États-Unis d'Amérique à 62% des hommes en Thaïlande. La proportion de diabétiques atteignant les cibles de traitement pour la glycémie, la tension artérielle et le cholestérol sérique était très faible: de 1% des patients masculins au Mexique jusqu'à environ 12% aux États-Unis. Il n'a pas été constaté que le revenu et l'éducation aient un lien significatif avec les taux de diagnostic et de traitement sauf en Thaïlande. Toutefois, pour les trois pays pour lesquels nous disposons de données, la couverture sociale était un puissant indicateur de diagnostic et de traitement efficace, particulièrement aux États-Unis.

Conclusion Il existe de nombreuses occasions manquées de réduction du fardeau du diabète au moyen d'un contrôle renforcé des taux de glycémie et d'un diagnostic et d'un traitement meilleurs de l'hypertension artérielle et de l'hypercholestérolémie. Alors qu'aucune inégalité socioéconomique importante n'a été relevée dans le traitement des diabétiques, le coût de l'accès aux soins s'est révélé être un puissant indicateur de diagnostic et de traitement.

Резюме

Ведение диабета и управление связанными с ним факторами риска сердечно-сосудистых заболеваний в семи странах: сравнительный анализ данных национальных опросов по изучению состояния здоровья

Цель Рассмотреть эффективность реакции системы здравоохранения на проблему диабета в различных условиях и исследовать неравенство в области медико-санитарной помощи при диабете, обусловленное социально-экономическими факторами.

Методы Для получения данных о диагностике, лечении и контроле гипергликемии, артериальной гипертензии и повышенного уровня холестерина среди больных диабетом мы использовали данные национально-репрезентативных опросов по изучению состояния здоровья, проводившихся в Англии, Исламской Республике Иран, Колумбии, Мексике, Соединенных Штатах Америки, Таиланде и Шотландии. Используя логистическую регрессию, мы исследовали социально-экономические детерминанты диагностики и эффективного лечения больных.

Результаты Как в развитых, так и в развивающихся странах у значительной доли больных диабет не диагностируется, и они не получают лечения. Цифры варьируют от 24% женщин в Шотландии до 62% мужчин в Таиланде. Доля больных диабетом, достигающих целей лечения в отношении

содержания глюкозы в крови, артериального кровяного давления и сывороточного холестерина, была очень низкой и ранжировала от 1% пациентов-мужчин в Мексике до примерно 12% в США. Нигде, за исключением Таиланда, не было выявлено существенной корреляции между доходом, образованием и показателями диагностирования и лечения. Однако в трех странах, данные по которым были доступны, особенно в США, сильным предиктором диагностирования и эффективного ведения диабета являлся страховой статус.

Вывод Существует много неиспользованных возможностей для снижения бремени заболеваемости диабетом путем улучшения контроля над уровнем содержания глюкозы в крови, а также совершенствования диагностики и лечения артериальной гипертензии и повышенного уровня холестерина. Хотя значительного социально-экономического неравенства в ведении больных диабетом отмечено не было, финансовая доступность медико-санитарной помощи являлась сильным предиктором диагностики и эффективного лечения болезни.

Resumen

Tratamiento de la diabetes y factores de riesgo cardiovascular asociados en siete países: comparación de datos de las encuestas nacionales de exámenes médicos

Objetivo Examinar la efectividad de la respuesta del sistema sanitario ante el reto de la diabetes en diversos entornos y observar las desigualdades atribuibles a factores socioeconómicos en el tratamiento de la diabetes.

Métodos Hemos empleado las encuestas representativas a nivel nacional de los exámenes médicos de Colombia, Escocia, Estados Unidos, Inglaterra, México, la República Islámica de Irán y Tailandia para obtener datos sobre el diagnóstico, el tratamiento y el control de la hiperglucemia, la hipertensión arterial y la hipercolesterolemia en pacientes con diabetes. Empleando una regresión logística, hemos analizado los determinantes socioeconómicos del diagnóstico y de un tratamiento efectivo de cada caso.

Resultados Un proporción considerable de pacientes con diabetes permanecen sin diagnosticar y sin tratar, tanto en los países desarrollados como en aquellos en vías de desarrollo. Las cifras oscilan desde un 24% de las mujeres en Escocia y Estados Unidos hasta un 62% de los hombres en Tailandia. Solo una proporción muy reducida de personas con diabetes

(oscilando entre el 1% de los pacientes hombres en México y alrededor del 12% en Estados Unidos) alcanzó los objetivos de su tratamiento para sus problemas de glucosa en sangre, presión arterial y nivel sérico de colesterol. En ninguna de las regiones (excepto Tailandia) se observó que los porcentajes de diagnóstico y tratamiento estuvieran relacionados con los ingresos y la educación, si bien en tres países con datos disponibles contar con un seguro representó un factor importante de previsibilidad para el diagnóstico y tratamiento efectivo de la diabetes, especialmente en el caso de Estados Unidos.

Conclusión Se han dejado pasar muchas oportunidades para reducir la carga de la diabetes a través de un mejor control de los niveles de glucosa en sangre y de un mejor diagnóstico y tratamiento de la hipertensión arterial y de la hipercolesterolemia. Si bien no se observaron grandes desigualdades socioeconómicas en el tratamiento de los pacientes con diabetes, el acceso económico al tratamiento fue un factor importante de previsibilidad para el diagnóstico y el tratamiento de esta enfermedad.

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