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Editor's Choice

Resource use associated with type 2 diabetes in Asia, Latin America, the Middle East and Africa: results from the International Diabetes Management Practices Study (IDMPS)

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SUMMARY

Aims: To estimate diabetes-related resource use and investigate its predictors among individuals with type 2 diabetes in 24 countries in Asia, Latin America, the Middle East and Africa. **Methods:** Cross-sectional observational data on diabetes-related resource use were collected from 15,016 individuals with type 2 diabetes within the second wave of International Diabetes Management Practices Study. Mean (SD) annual quantities were determined and predictors of diabetes-related hospitalisations, inpatient days, emergency room visits and absenteeism were investigated using negative binomial regression. **Results:** Patients in Asia (n = 4678), Latin America (n = 6090) and the Middle East and Africa (n = 4248) made a mean (SD) of 3.4 (6.9), 5.4 (6.7) and 2.5 (4.4) General Practitioner visits per year. The mean (SD) number of inpatient days amounted to 3.8 (18.1), 2.2 (13.9) and 2.6 (13.5) per year. Results of the regression analysis showed the major influence of diabetes-related complications and inadequate glycaemic control on resource use. The expected annual rate of hospitalisation of patients with macrovascular complications compared with those without was 4.7 times greater in Asia [incidence rate ratio (IRR) = 4.7, 95% CI: 2.8–7.8, n = 2551], 5.4 times greater in Latin America (IRR = 5.4, 95% CI: 3.0–9.8, n = 3228) and 4.4 times greater in the Middle East and Africa (IRR = 4.4, 95% CI: 2.8–6.9, n = 2630). **Conclusions:** Micro- and macrovascular complications and inadequate glycaemic control are significant predictors of resource use in people with type 2 diabetes of developing countries. This knowledge confirms the health economic importance of early diagnosis of diabetes, education of patients and glycaemic control.

What's known

A dramatic increase in type 2 diabetes prevalence is projected for the developing countries over the coming decades. Data on the economic impact of type 2 diabetes and its complications are scarce for countries outside Europe and North America.

What's new

This study reports estimates of resource use related to type 2 diabetes in 24 countries in Asia, Latin America and the Middle East and Africa. Given the rising prevalence, these types of health economic data will be increasingly important to appreciate the economic burden imposed by type 2 diabetes and to inform healthcare policy decisions.

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Disclosures
A. Ringborg, C. Cropet and P. Lindgren are employed by contract research organisations performing consultancy for the study sponsor (sanofi-aventis). B. Jönsson has no conflict of interest to declare. J. J. Gagliardino and A. Ramachandran are members of the IDMPS Steering Committee and have received honoraria and traveling sponsorships in relation to the IDMPS.

Introduction

The number of people with diabetes is projected to increase dramatically worldwide over the coming decades, reaching a total of 366 million by 2030 (1). The greatest increase in prevalence in absolute as well as relative terms will occur in developing countries as a result of population growth and increased rates of obesity and physical inactivity (2–4).

Besides causing significant morbidity, decreased quality of life and premature mortality, type 2 diabetes and its complications impose a major economic burden (5). In developing countries, many diabetic patients are diagnosed late, at onset of diabetes-related infections or complications such as retinopathy, nephropathy, foot ulceration, myocardial infarction and stroke, at which point clinical outcomes are poor and costs substantial (6). Thus, the unfolding epidemic of type 2 diabetes will represent a dramatic challenge to public social security, private insurance schemes, healthcare providers and patients in these countries. Moreover, given that economically productive age groups within society will be particularly affected (1,7), the effects of rising diabetes prevalence on lost production are likely to be considerable.

Several cost-of-illness studies quantifying the economic impact of type 2 diabetes and its complications have been conducted in European countries and the USA (8–13), but comprehensive data for the developing countries are scarce and typically highly aggregated (14,15). In light of the rapidly rising prevalence of the disease, assessments of the resource use and costs associated with type 2 diabetes and its

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complications will be vital for decision-makers and healthcare planners in the developing countries to select prevention and care strategies that optimise quality of care and resource use (16).

The aim of this study was to estimate resource use related to type 2 diabetes in 24 countries in Asia, Latin America and the Middle East and Africa and to investigate predictors of diabetes-related hospitalisations, inpatient days, emergency room (ER) visits and absenteeism based on cross-sectional data collected within the second wave of the International Diabetes Management Practices Study (IDMPS), one of the largest population-based studies of diabetic patients in developing countries.

Methods

Study design

The IDMPS is an ongoing multicentre observational study conducted in five waves (one wave per year) with the primary aim of documenting the management of people with type 2 diabetes in clinical practice. Secondary aims are to evaluate initiation, characteristics and management of insulin therapy and to assess the health economic impact of type 2 diabetes. The study focuses on diabetes practices and compliance with guidelines in the non-Western world, including countries in Asia, Eastern Europe, Latin America and the Middle East and Africa (17). Results of the IDMPS with regard to factors predictive of glycaemic control were recently published by Chan et al. (18).

For each IDMPS study wave, a random sample of physicians experienced in insulin therapy (initiation and titration) is selected in each participating country and asked to enrol the first 10 patients with type 2 diabetes and the first five with type 1 diabetes seen during a 2-week period. Patient exclusion criteria are < 18 years of age, concomitant participation in another clinical study, participation in a previous wave of the IDMPS and current temporary insulin treatment because of conditions such as gestational diabetes, pancreas cancer or surgery.

The number of physicians recruited is based on the patient sample size requirement, which is determined as the number needed to estimate the proportion of type 2 diabetic patients receiving insulin treatment with an absolute precision of 20%.

A cross-sectional survey of management practices is conducted for all patients during the 2-week recruitment period of each wave using standardised paper case report forms completed by the recruiting physician. In addition, people with type 2 diabetes enrolled within the wave are followed longitudinally for 9 months to document management patterns and clinical progress. Data on physician characteristics are also collected through a physician profile form administered at the initiation of the study.

The IDMPS has been approved by appropriate regulatory and ethics committees in all participating countries and centres. All patients provide written informed consent prior to enrolment. Study design and reporting format are in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (19).

Resource data

This study of diabetes-related resource use is based on cross-sectional data collected within the second wave of the IDMPS, which took place during 2006–2007. Within the ensuing longitudinal part of this wave, the drop-out rate was 20.9%.

The frequency of diabetes-related general practitioner (GP) visits, specialist visits, hospitalisations, inpatient days, ER visits, diabetes educator visits, days of sick leave (absenteeism) and pharmacological treatment was assessed among the enrolled type 2 diabetic patients to determine utilisation rates of the economically most important items within the healthcare system and, in the case of absenteeism, the economic impact of type 2 diabetes on employers and national economies. Patients were asked to state the number of diabetes-related GP visits, specialist visits and other items made during the previous 3 months, and in the case of diabetes educator visits, the number made during the previous year. In the case of drugs usage, current treatment status with respect to oral antidiabetic drugs (OAD), insulin, antihypertensive and lipid-lowering drugs was assessed.

We adopted a prevalence-based approach to estimate diabetes-related resource use in each of the 24 participating countries divided in three regions: Asia (ASIA), Latin America (LATAM) and the Middle East and Africa (ME-A). This implies that examining resource use and/or costs incurred during a 1-year period for a prevalence cohort of people suffering a given disease, in this case type 2 diabetes. Consistent with standard methodology, reported 3-month quantities of the investigated resource items (e.g. the number of GP visits made during the 3-month period of recall) were extrapolated to annual estimates under the assumption that average quantities of resource use do not differ between different 3-month periods of a given year. Resource variables related to drug treatment were reported as proportions receiving treatment, as quantities consumed could not be determined from the collected data.

Statistical analysis

Mean (SD) per-patient quantities of diabetes-related GP visits, specialist visits, hospitalisations, inpatient days, ER visits, diabetes educator visits and absenteeism were computed by country and region to determine the average annual resource utilisation of type 2 diabetic patients at the local as well as the regional level. The evaluations were carried out using the complete set of non-missing values of each resource variable, zero values included (i.e. available case analysis). Data were considered as missing if the answer option 'unknown' was ticked in the case report form or if no answer option was selected (i.e. empty case). Median quantities of each resource were considered for users i.e. for patients with non-zero, non-missing values.

Predictors of hospitalisations, inpatient days, ER visits and absenteeism were analysed using negative binomial regression, a modelling technique which has proved suitable for discrete outcomes data (20). These four key resource items were selected because of their high unit costs. Negative binomial regression is a generalisation of the Poisson regression model that accounts for overdispersion. As the model uses a log link function, the exponents of the regression coefficients, can be interpreted as incidence rate ratios (IRR).

Regression models for hospitalisations, inpatient days, ER visits and absenteeism were developed by region, rendering a total of 12 models. In each case, the relationship between the dependent resource variable and the following potential explanatory variables was tested in univariate analyses: age (continuous variable), gender, body mass index (BMI) (≤ 18.5/18.5–25/25–30/30–35/> 35), locality (urban/rural), education level (illiterate/primary–secondary/university), type of health insurance (no/public/private/public + private), time since diabetes diagnosis, presence of microvascular complications (defined as retinopathy, proteinuria, dialysis, neuropathy, foot ulcer and/or amputation), presence of macrovascular complications (defined as angina, myocardial infarction/acute coronary syndrome, heart failure, stroke and/or peripheral vascular disease), blood pressure at goal (defined as systolic < 130 mmHg and diastolic < 80 mmHg), low-density lipoprotein cholesterol at goal (defined as < 100 mg/dl), high-density lipoprotein cholesterol at goal (defined as > 40 mg/dl), HbA1c at goal (defined as < 7%), fasting blood glucose (FBG) at goal (defined as ≤ 100 mg/dl), type of practice of the recruiting physician (mostly public/mostly private/public + private) and speciality of the recruiting physician (diabetologist or endocrinologist/GP or other specialist).

Variables significant at the 20% level in univariate analysis were selected to enter the regression model. A backward selection method was applied, with the final model restricted to variables significant at the 5% level as well as a set of forced dummy variables for country.

Complete case analysis, which involves the discarding of cases where the dependent variable or any of the identified predictors are missing, was applied as the base-case. However, as data were characterised by patterns of multivariate missingness, which potentially leads to the deletion of large numbers of observations, negative binomial regression models were also developed using imputed values of the dependent variables. Imputation of missing values was carried out at the regional level using random effects regression models.

As a result of model convergence difficulties brought about by small patient numbers, the models for hospitalisations and inpatient days in Latin America excluded patients from Panama and the models for ER visits and absenteeism excluded patients from Panama and Guatemala.

Model coefficients were reported in terms of IRR with 95% CI. All statistical analyses were performed by Mapi-Naxis in Lyon, France using SAS version 8.02 (SAS Institute Inc., Cary, NC, USA).

Results

Patients

A total of 15,016 patients with type 2 diabetes were recruited to the second wave of the IDMPS. Table 1 reports demographical, clinical and socioeconomic characteristics of the patient population by country and region as well as gross domestic product (GDP) per capita. Sample sizes were generally large with the mentioned exception of Panama and Guatemala ($n = 31$ and $n = 85$ respectively).

The mean (SD) age of recruited patients was 57 (12), 60 (12) and 57 (11) and the mean (SD) number of years since diabetes diagnosis was 7.7 (7.0), 9.7 (8.9) and 8.4 (7.2) in ASIA, LATAM and ME-A respectively. Proportions of patients treated with OADs, insulin, antihypertensive and lipid-lowering drugs were generally high (Table 2).

Annual quantities of resource use

Mean (SD) quantities of resource use for each of the investigated items are reported in Table 3 by country and region. Study patients made a mean (SD) of 3.4 (6.9), 5.4 (6.7) and 2.5 (4.4) GP visits, and 8.2 (7.8), 6.3 (5.6) and 5.0 (5.5) specialist visits per year in ASIA, LATAM and ME-A respectively.

The proportion of patients who made at least one GP visit during the 3-month recall period was 32%, 62% and 36% in ASIA, LATAM and ME-A

Table 1 Demographics and clinical characteristics of type 2 diabetic patients enrolled in the IDMPS second wave by country and region

Country/region	GDP/capita (USD)*	*N* patients enrolled	Mean (SD), age (years)	% Female	Mean (SD) diabetes duration (years)	% Screened for microvascular complications	% With microvascular complications	% Screened for macrovascular complications	% With macrovascular complications	% With HbA1c < 7%	% Employed (full- or part-time)
Asia	–	4678	57.2 (11.6)	49	7.7 (7.0)	51	47	50	20	37	42
China	2483	540	59.7 (11.8)	44	6.6 (6.4)	57	53	55	29	44	34
Hong Kong	29,753	511	60.5 (12.9)	49	9.2 (7.6)	54	45	55	22	37	40
India	942	854	53.1 (11.1)	42	7.3 (6.5)	42	36	41	16	34	47
Indonesia	1925	674	55.2 (10.2)	55	6.1 (6.4)	56	53	49	20	31	44
South Korea	20,015	807	57.9 (10.9)	47	8.2 (7.1)	46	43	46	13	41	45
Malaysia	6956	472	55.4 (11.2)	48	9.3 (7.9)	54	50	53	22	31	48
Taiwan	16,697	398	60.7 (11.7)	51	7.6 (7.4)	53	41	53	28	37	35
Thailand	3732	422	59.5 (11.1)	62	8.5 (7.0)	51	48	55	13	40	41
Latin America	–	6090	59.9 (12.4)	56	9.7 (8.9)	45	40	45	22	37	42
Argentina	6609	658	63.5 (10.0)	47	10.5 (9.2)	42	33	46	17	46	47
Chile	9884	771	62.0 (11.7)	55	8.9 (8.4)	39	34	39	17	46	41
Colombia	4264	1094	62.0 (12.7)	56	8.7 (8.8)	42	35	40	23	35	30
Dominican Republic	4671	279	59.9 (12.3)	55	8.5 (8.1)	32	34	34	20	40	40
Guatemala	2532	85	58.2 (12.6)	48	7.9 (7.8)	35	31	37	14	41	57
Mexico	9717	2620	57.4 (12.4)	60	10.3 (8.9)	47	44	47	20	31	46
Panama	5905	31	62.4 (16.2)	55	8.9 (8.9)	42	32	42	23	58	36
Venezuela	8282	552	60.1 (12.0)	56	9.3 (9.2)	55	50	57	38	27	37
Middle East and Africa	–	4248	56.9 (11.3)	48	8.4 (7.2)	46	40	45	23	31	45
South Africa	5916	688	57.4 (11.4)	44	8.4 (7.1)	50	34	48	26	33	56
Algeria	3903	456	58.0 (9.8)	53	8.7 (7.3)	48	43	43	18	38	23
Saudi Arabia	15,724	353	51.6 (10.8)	28	8.3 (6.5)	50	47	48	20	27	65
Egypt	1739	289	54.3 (10.7)	55	9.3 (7.8)	59	50	59	38	16	50
Gulf countries	35,923	268	51.3 (10.4)	32	7.2 (6.1)	37	33	33	13	37	68
Lebanon	6569	1285	59.9 (11.5)	51	8.7 (7.5)	50	42	50	30	30	42
Morocco	2422	509	55.5 (10.2)	60	7.4 (7.0)	34	31	32	10	31	31
Tunisia	3424	400	57.0 (11.5)	48	8.6 (7.3)	43	40	44	14	23	41

*International Monetary Fund (IMF) estimates for 2007. GDP, gross domestic product.

Table 2 Medical treatment received by recruited type 2 diabetic patients by country/region

Country/ region	*N*	% On OAD treatment*	% On insulin treatment*	% With hypertension	% On antihypertensive treatment*,†	% With dyslipidaemia	% On lipid-lowering treatment‡,§
Asia	4678	90	28	63	97	60	83
China	540	80	45	58	94	55	73
Hong Kong	511	87	34	78	97	74	76
India	854	93	28	59	98	47	92
Indonesia	674	89	19	48	93	54	82
South Korea	807	90	30	59	97	46	86
Malaysia	472	92	31	74	99	85	86
Taiwan	398	94	12	70	97	61	80
Thailand	422	92	20	72	96	82	87
Latin America	6090	83	28	62	98	64	80
Argentina	658	82	34	73	98	73	76
Chile	771	82	25	67	98	65	75
Colombia	1094	83	24	64	98	67	87
Dominican Republic	279	84	30	68	99	56	82
Guatemala	85	92	18	46	100	62	75
Mexico	2620	85	29	55	97	58	78
Panama	31	87	32	65	100	81	100
Venezuela	552	82	31	73	98	76	85
Middle East and Africa	4248	87	30	61	97	57	87
South Africa	688	86	46	78	97	62	87
Algeria	456	86	31	60	99	45	91
Saudi Arabia	353	92	35	53	98	63	97
Egypt	289	83	32	62	97	61	84
Gulf countries	268	98	22	64	97	78	91
Lebanon	1285	89	23	65	97	65	88
Morocco	509	81	25	44	94	33	75
Tunisia	400	80	28	51	97	43	75

*Among patients with hypertension. †< 1% missing data. ‡Among patients with dyslipidaemia. §1–10% missing data. OAD, oral antidiabetic drug.

respectively. For specialist visits, the corresponding proportions were 86%, 80% and 70%.

The mean (SD) number of inpatient days per year amounted to 3.8 (18.1) in Asia, 2.2 (13.9) in Latin America and 2.6 (13.5) in the Middle East and Africa, with the high SD explained by the fact that most patients were not hospitalised (i.e. having zero values) and a few patients had extremely high values as a result of long hospital stays, a variability typical of resource variables relating to inpatient care.

Proportions hospitalised were 8.5% in ASIA, 6.5% in LATAM and 8.8% in ME-A. As for ER visits, similarly low proportions of patients utilised the resource (3.0%, 7.4% and 5.5% in ASIA, LATAM and ME-A respectively), and the mean annual number of visits did not exceed one with the exception of Saudi Arabia (mean 3.0, SD 5.9).

The proportion of patients employed full- or part-time amounted to 42% in ASIA and LATAM and 45% in ME-A (Table 1), reflecting the fact that a substantial proportion of patients with type 2 diabetes in the studied regions is of working age. Mean days of sick-leave among employed patients did not differ much at the aggregated regional level [mean (SD) 5.0 (23.1), 6.4 (33.2) and 5.7 (24.3) in the respective regions], but varied considerably between individual countries [e.g. mean (SD) 0.5 (3.2) in Hong Kong compared with 11.7 (32.3) in Indonesia].

Predictors of resource use

Results of the negative binomial regression models applying complete case methods identified the presence of diabetes-related complications as the major predictor of resource use.

Table 3 Annual quantities of diabetes-related resource use by country/region

Country/ region	*N*	No. of GP visits	No. of specialist visits	No. of diabetes educator visits	No. of hospita lisations	No. of inpatient days	No. of ER visits	No. (%) unemployed because of diabetes	No. of days of sick-leave*
Asia	4678†	3.4 (6.9)	8.2 (7.8)	1.6 (4.3)	0.5 (2.2)	3.8 (18.1)	0.2 (1.0)	77 (1.6)	5.0 (23.1)
China	540†	6.6 (12.1)	12.3 (14.2)	3.1 (8.9)	0.9 (2.4)	11.7 (33.6)	0.2 (1.0)	15 (2.8)	8.5 (23.2)
Hong Kong	511‡	0.9 (4.2)	5.7 (6.2)	1.3 (2.1)	0.5 (3.2)	1.1 (12.6)	0.1 (1.1)	6 (1.2)	0.5 (3.2)
India	854§	5.1 (7.0)	7.5 (5.6)	1.3 (2.0)	0.5 (1.4)	3.2 (18.2)	0.2 (1.2)	8 (0.9)	8.6 (31.9)
Indonesia	674§	6.2 (7.8)	10.2 (7.5)	1.4 (2.8)	0.7 (1.8)	7.0 (20.9)	0.3 (1.4)	16 (2.4)	11.7 (32.3)
South Korea	807†	8.1 (8.7)	9.8 (6.1)	1.7 (4.2)	0.4 (1.6)	3.6 (16.2)	0.0 (0.4)	15 (1.9)	2.5 (9.6)
Malaysia	472‡	2.5 (4.2)	3.7 (4.1)	0.6 (1.5)	0.2 (1.4)	0.8 (4.8)	0.2 (1.2)	3 (0.6)	4.5 (32.6)
Taiwan	398‡	0.5 (2.0)	9.1 (6.2)	1.7 (5.0)	0.2 (1.4)	1.3 (8.6)	0.2 (1.0)	7 (1.8)	0.9 (4.8)
Thailand	422‡	3.4 (4.8)	6.4 (4.4)	2.2 (3.4)	0.5 (3.2)	1.0 (6.8)	0.1 (0.7)	7 (1.7)	2.3 (11.6)
Latin America	6090†	5.4 (6.7)	6.3 (5.6)	1.1 (3.2)	0.4 (1.6)	2.2 (13.9)	0.4 (2.2)	172 (2.8)	6.4 (33.2)
Argentina	658‡	2.6 (4.0)	8.2 (5.3)	0.6 (1.5)	0.1 (0.7)	0.5 (3.9)	0.1 (0.6)	3 (0.5)	1.3 (15.3)
Chile	771‡	4.0 (6.0)	5.5 (5.1)	0.7 (1.8)	0.2 (1.0)	1.9 (12.1)	0.4 (1.8)	27 (3.5)	7.7 (41.6)
Colombia	1094‡	6.2 (5.1)	4.2 (4.7)	1.6 (2.8)	0.3 (1.7)	1.5 (8.1)	0.4 (2.1)	19 (1.7)	2.3 (10.9)
Dominican Republic	279†	0.2 (1.2)	7.4 (5.8)	0.3 (1.3)	0.2 (0.9)	1.3 (5.9)	0.3 (1.0)	7 (2.5)	1.7 (6.7)
Guatemala	85†	2.0 (3.0)	7.7 (6.6)	0.6 (1.2)	0.2 (0.8)	0.3 (2.4)	0.0 (0.0)	1 (1.2)	0.3 (2.0)
Mexico	2620†	6.7 (8.2)	6.6 (5.8)	1.2 (4.2)	0.5 (2.0)	2.8 (17.3)	0.5 (2.3)	85 (3.2)	8.2 (36.6)
Panama	31‡	0.8 (1.7)	7.3 (3.5)	0.0 (0.2)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Venezuela	552†	2.1 (4.8)	6.5 (5.5)	0.9 (2.1)	0.5 (1.8)	4.4 (18.7)	0.9 (4.5)	30 (5.4)	18.7 (58.3)
Middle East and Africa	4248†	2.5 (4.4)	5.0 (5.5)	0.8 (1.7)	0.5 (1.8)	2.6 (13.5)	0.4 (2.0)	35 (0.8)	5.7 (24.3)
South Africa	688‡	3.6 (4.8)	2.3 (3.2)	1.2 (1.6)	0.3 (1.2)	1.8 (7.3)	0.1 (0.5)	8 (1.2)	3.5 (15.1)
Algeria	456‡	1.5 (3.1)	3.6 (3.6)	0.8 (1.5)	0.1 (0.7)	1.5 (10.3)	0.1 (0.7)	2 (0.4)	3.3 (15.4)
Saudi Arabia	353§	5.7 (6.9)	9.5 (6.2)	1.5 (3.4)	1.3 (3.1)	6.3 (18.6)	3.0 (5.9)	1 (0.3)	9.5 (20.5)
Egypt	289†	2.0 (4.8)	8.5 (8.4)	0.3 (1.5)	0.9 (3.8)	6.7 (30.8)	0.6 (2.2)	1 (0.3)	16.5 (39.3)
Gulf countries	268†	4.2 (5.1)	8.5 (6.0)	0.5 (1.1)	0.2 (1.1)	1.3 (8.4)	0.2 (0.9)	0 (0.0)	5.9 (28.8)
Lebanon	1285†	2.1 (4.1)	5.0 (5.3)	0.4 (1.2)	0.6 (1.7)	2.6 (9.1)	0.3 (1.7)	9 (0.7)	5.2 (22.2)
Morocco	509‡	0.9 (2.9)	4.8 (4.9)	1.4 (1.9)	0.3 (1.0)	2.4 (18.0)	0.1 (0.8)	7 (1.4)	6.4 (36.2)
Tunisia	400‡	2.9 (3.3)	3.8 (3.8)	0.6 (1.1)	0.3 (1.6)	1.9 (10.7)	0.1 (1.1)	7 (1.8)	4.3 (28.5)

Data are reported as mean (SD) annual consumption of each resource item within country/region unless otherwise indicated. *Among employed patients. †Approximately 20% missing values. ‡Approximately 10% missing values. §Approximately 10% missing values. GP, general practitioner; ER, emergency room; Diabetes education = training in behaviour modification and self-management of the disease including glucose monitoring.

In Asia, the expected annual rate of hospitalisation was 4.7 times greater (IRR = 4.7, 95% CI: 2.8–7.8, $n = 2551$), the expected rate of inpatient days 5.5 times greater (IRR = 5.5, 95% CI: 2.8–10.9, $n = 3243$), the expected rate of ER visits 3.7 times greater (IRR = 3.7, 95% CI: 1.8–7.6, $n = 3146$) and the expected rate of absenteeism 4.1 times greater (IRR = 4.1, 95% CI: 1.6–10.3, $n = 1334$) for patients with macrovascular complications compared with those without macrovascular complications (Figures 1–4).

Similarly, in the Middle East and Africa, the expected rate of hospitalisation was 4.4 times greater (IRR = 4.4, 95% CI: 2.8–6.9, $n = 2630$), the expected rate of inpatient days 7.9 times greater (IRR = 7.9, 95% CI: 3.9–15.8, $n = 2622$), the expected rate of ER visits 3.8 times greater (IRR = 3.8, 95% CI: 2.3–6.3, $n = 2970$) and the expected rate of absenteeism 9.9 times greater (IRR = 9.9, 95% CI: 3.7–26.9, $n = 1039$) for patients with macrovascular complications compared with patients free from macrovascular complications.

In Latin America, patients with macrovascular complications had an expected annual rate of hospitalisation 5.4 times that of patients without macrovascular complications (IRR = 5.4, 95% CI: 3.0–9.8, $n = 3228$). The corresponding rate ratios related to presence of macrovascular complications were 16.1 for inpatient days (IRR = 16.1, 95% CI: 6.8–37.8, $n = 3501$), 4.0 for ER visits (IRR = 4.0, 95% CI: 2.1–7.4, $n = 2900$) and 6.1 for absenteeism (IRR = 6.1, 95% CI: 2.2–16.5, $n = 1594$).

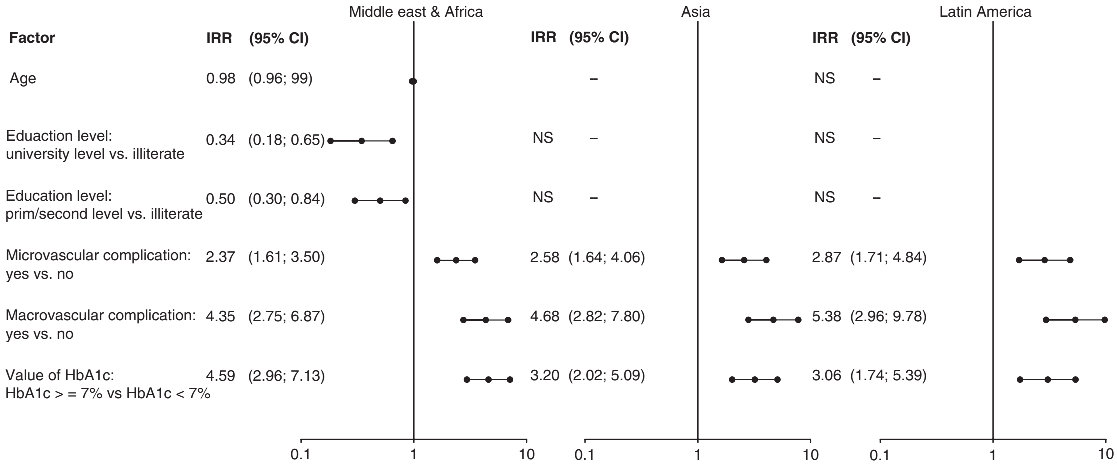

Figure 1 Factors predictive of hospitalisations among patients with type 2 diabetes by region

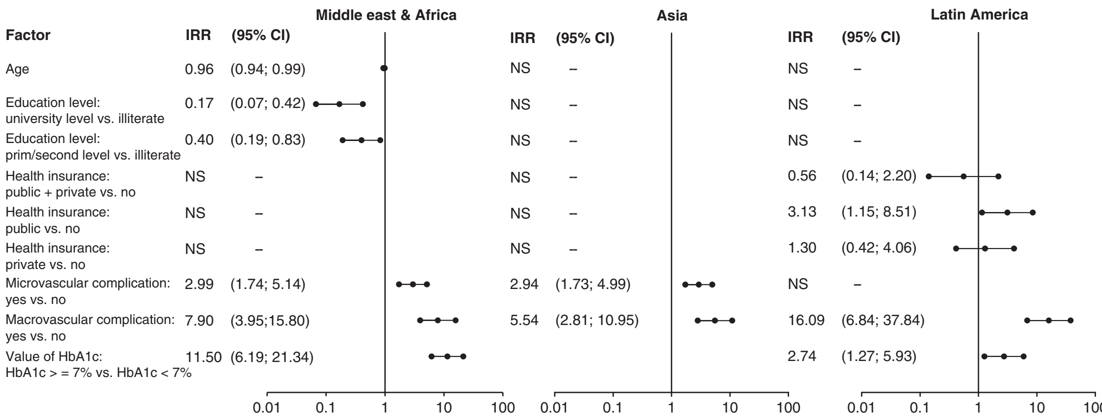

Figure 2 Factors predictive of inpatient days among patients with type 2 diabetes by region

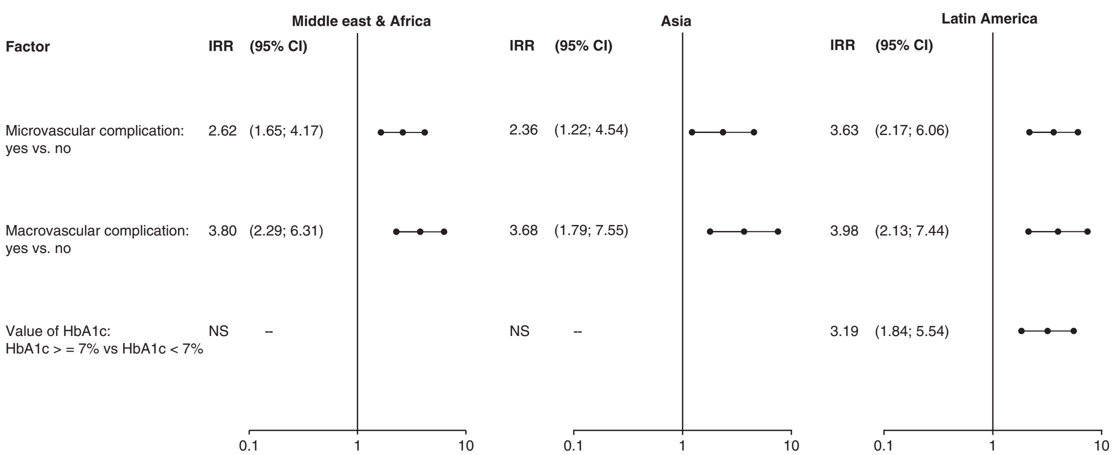

Figure 3 Factors predictive of ER visits among patients with type 2 diabetes by region

The presence of microvascular complications was also identified as a significant predictor, although the effect on resource use was of a lesser magnitude compared with macrovascular complications. Expected annual rates of hospitalisations were 2.6, 2.9 and 2.4 times greater for patients with microvascular

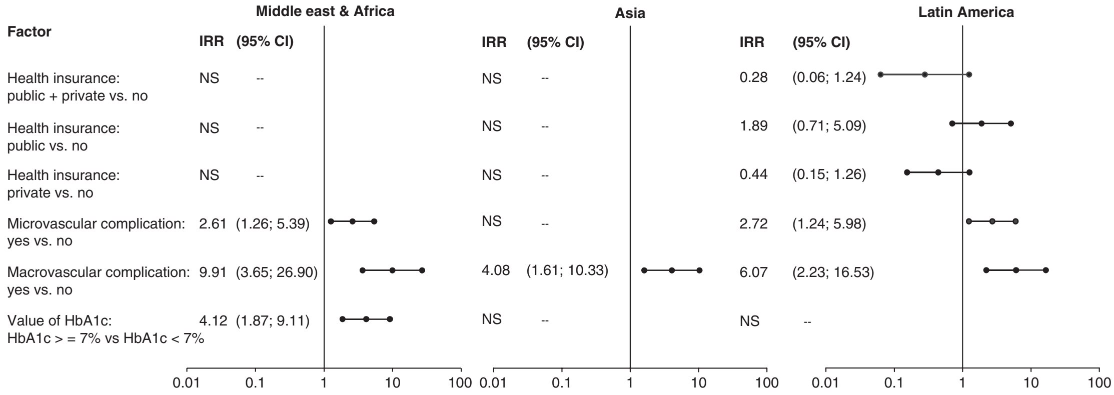

Figure 4 Factors predictive of absenteeism among patients with type 2 diabetes by region

complications in ASIA, LATAM and ME-A respectively, compared with patients without microvascular complications in these regions (IRR = 2.6, 95% CI: 1.6–4.1, n = 2551; IRR = 2.9, 95% CI: 1.7–4.8, n = 3228; IRR = 2.4, 95% CI: 1.5–3.5, n = 2630; Figure 1).

There was a substantial impact of inadequate glycaemic control, defined as HbA1c ≥ 7%, which emerged as a strong predictor of resource use in all three regions. The expected annual rate of hospitalisations increased by a factor of 3.2, 3.1 and 4.6 for inadequately controlled patients in ASIA, LATAM and ME-A respectively, compared with those controlled (IRR = 3.2, 95% CI: 2.0–5.1, n = 2551; IRR = 3.1, 95% CI: 1.7–5.4, n = 3228; IRR = 4.6, 95% CI: 3.0–7.1, n = 2630). In Latin America, inadequate glycaemic control was furthermore associated with increased rates of inpatient days and ER visits (IRR = 2.7, 95% CI: 1.3–5.9, n = 3501; IRR = 3.2, 95% CI: 1.8–5.5, n = 2900) and in the Middle East and Africa with increased rates of inpatient days and absenteeism (IRR = 11.5, 95% CI: 6.2–21.3, n = 2622; IRR = 4.1, 95% CI: 1.9–9.1, n = 1039).

Finally, the level of education was also identified as a significant predictor of hospitalisation and inpatient days in the Middle East and Africa, with rates of resource use found to be substantially lower for educated patients compared with illiterate patients (Figures 1 and 2). The rate of hospitalisation was 66% lower for patients with university level education and 50% lower for patients with primary/secondary education compared with illiterate patients (IRR = 0.34, 95% CI: 0.2–0.7; IRR = 0.50, 95% CI: 0.3–0.8; n = 2630). Type of healthcare insurance emerged as a predictor of inpatient days and absenteeism in Latin America (Figures 2 and 4), but the results were difficult to interpret as public healthcare insurance was associated with increased rates of resource use, whereas public and private healthcare insurance was associated with lower rates of resource use (compared with no coverage).

In the regression models with missing values of the dependent variable imputed, several additional predictors of resource use emerged as statistically significant because of higher patient numbers increasing the statistical power. Notably, in the models relying on imputed data, BMI predicted inpatient days, ER visits and absenteeism in Asia and microvascular complications predicted inpatient days in Latin America.

Discussion

This study confirmed the intensive resource utilisation linked to type 2 diabetes in 15,016 patients recruited in Asia, Latin America, the Middle East and Africa and highlighted the major influence of diabetes-related complications, in particular macrovascular complications, on resource use. Moreover, the analysis identified inadequate glycaemic control as an important predictor of resource use in patients with type 2 diabetes. Beyond the use of medical resources, our findings also called attention to the indirect costs and ensuing threat to national economies of type 2 diabetes via absenteeism.

Our results quantify the magnitude of savings that could be generated by the implementation of strategies of prevention or delay of macro- and microvascular complications and adequate control of hyperglycaemia. An integrated public health approach is crucial to raise awareness of the wide-reaching economic consequences of diabetes-related complications, to educate patients and healthcare workers and to allocate appropriate resources for disease management to avert the elevated costs following from complications. Rates of the particularly costly macrovascular complications of diabetes including myocardial infarction and stroke have previously been considered rare in developing countries but are gaining in importance (21–23).

Data on diabetes practices in the developing countries are scarce, and to our knowledge the IDMPS is the only prospective survey to date to have recorded resource use associated with type 2 diabetes in such a wide range of countries using a standardised protocol. Local cost studies in diabetes have previously been conducted in Hong Kong, Pakistan, India, Argentina and Mexico (24–29), but the results are difficult to compare with those of our study because of methodological disparities and the fact that we report resource use but not costs. Indeed, it is a drawback of general studies of resource use such as the present that quantities in different units (e.g. GP visits, specialist visits) cannot be aggregated. However, given that type 2 diabetes prevalence is known, participating countries will be able to conduct cost-of-illness studies by assigning country-level unit cost data to the mean resource quantities reported in this paper.

Facing countries with wide differences in healthcare funding, we applied a societal perspective to our study, i.e. considering diabetes-related resource use independent of payer. This is important to obtain a comprehensive national assessment of the economic burden imposed by type 2 diabetes. Establishing quantities of diabetes-related resource use does not permit us to say whether too much or too little is being devoted to diabetes care. However, inference of predictors of high cost events, such as hospitalisation and ER visits, can help health authorities and decision makers design strategies attempting to prevent such events, thus optimising usage of available resources. This is further supported by the fact that costs of patients with type 2 diabetes have been seen to increase significantly after an event requiring hospitalisation (30).

The economic consequences of the diabetes epidemic in the developing countries will be particularly dire if diagnosis of patients with type 2 diabetes continues to occur at advanced stages of disease progression. At present, neuropathic symptoms, foot ulcerations and stroke, conditioned by the presence of chronic complications, are frequent initial causes of medical consultation that lead to diagnosis (6). In Africa, approximately 20–25% of patients with type 2 diabetes have been found to have retinopathy at diagnosis (31) and in Latin America, 10–40% of patients have chronic complications when diagnosed (32). The substantial impact of complications on resource use clearly provides an economic rationale for concerted efforts for earlier diagnosis and implementation of appropriate treatment. In particular, the observed link between complications and absenteeism in countries involved in this study could entail huge societal costs because of the high proportion of people with type 2 diabetes of working-age (33).

The IDMPS included countries with wide disparities in GDP/capita and organisation of healthcare, but what is common to all is that they are currently undergoing a critical transition, from transmission diseases to chronic diseases. Countries were selected for participation according to the local representation of the sponsor, sanofi-aventis, with the grouping into regions based on geography. Some of the participating countries suffered times of social and political unrest during the study, which could have affected physician participation rates and the risk profile of patients presenting at clinics.

It should be noted that the external validity of the resource estimates reported in this study and consequently the extent to which results can be extrapolated to the national level depend on the representativity of the patients included in the IDMPS study sample in each country. Care was taken to ensure that participating physicians were representative of physicians managing people with type 2 diabetes in each country. However, the fact that only physicians with experience in insulin treatment/titration were selected may have introduced a selection bias.

We recognise that the population to which our study pertains is that within each country with access to physicians trained to initiate insulin therapy. If patients with type 2 diabetes visiting physicians with experience in insulin treatment generally are at a more advanced stage of disease progression, mean resource use would tend to be overestimated. Also, it is likely that individuals included in this study are covered by a health insurance or have economical means to pay for healthcare. More generally, the representativity of study patients with respect to age, rates of complications and type of healthcare coverage should be scrutinised before drawing country-wide conclusions from the estimates of resource use. The mean age of IDMPS study patients was generally quite high, given the life-expectancy in the developing world.

When collecting patient-level survey data on resource use, missing values are a common predicament and can potentially lead to biased estimates if data are not missing at random, i.e. if patients with non-missing values are a selective sub-sample of the entire sample of recruited patients (34). Within the IDMPS, mean resource use could only be computed for patients with non-missing values of each resource variable and for some variables, e.g. GP visits, percentages of patients with missing values were in the range of 30–50%. However, patients with and without missing values of the studied resource items were found to be very similar regarding age, gender, diabetes duration and proportion with complications, which indicates that non-random missing data may not be a major problem. To support this assumption, single imputation of missing data was carried out to determine the extent to which high percentages of missing data impacted on the results of the regression analyses. Mean and median values of the imputed variables were similar to those of complete cases, and only a few additional predictors were identified in the analysis with imputed values, compared with the complete case analysis. However, the effect sizes seen in the models using imputed data were generally smaller compared with the complete case models.

We defined microvascular complications as retinopathy, proteinuria, dialysis, neuropathy, foot ulcer and/or amputation. Micro-albuminuria is an early marker of these complications, and non-overt cases would clearly have been captured had we defined-vascular complications in terms of levels of albumin protein. Additionally, not all patients were screened for complications, e.g. by undergoing fundoscopic examination and there is thus a risk of missed cases.

In conclusion, type 2 diabetes was found to be associated with high levels of resource use among patients in Asia, Latin America, the Middle East and Africa recruited to the second wave of the IDMPS, with macro- and microvascular complications and inadequate glycaemic control, identified as the most important predictors. In view of the striking increase in type 2 diabetes prevalence projected for the developing countries, health economic data such as reported by this study will be increasingly important to appreciate the economic burden imposed by the disease and to guide healthcare policy decisions. In particular, there appears to be a clear economic rationale for early diagnosis and management strategies targeted at preventing or delaying micro- and macrovascular complications.

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Author contributions

A. Ringborg interpreted the data and drafted the article; C. Cropet conducted the statistical analyses; B. Jönsson, J. J. Gagliardino and A. Ramachandran critically revised the article; P. Lindgren devised the study concept and critically revised the article.

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