

Research: Health Economics

Financial costs for families of children with Type 1 diabetes in lower-income countries

G. D. Ogle^{1,2}, H. Kim³, A. C. Middlehurst^{1,2}, M. Silink^{1,4} and A. J. Jenkins^{1,3,5}

¹International Diabetes Federation Life for a Child Program, Glebe, Sydney, ²Diabetes NSW, Glebe, Sydney, ³NHMRC Clinical Trials Centre, University of Sydney, Sydney, ⁴Children's Hospital at Westmead, Sydney and ⁵Insulin for Life Australia and Global, Caulfield, Melbourne, Australia

Accepted 15 October 2015

Abstract

Aims To assess the direct costs of necessary consumables for minimal care of a child with Type 1 diabetes in countries where the public health system does not regularly provide such care.

Methods Supply costs were collected between January 2013 and February 2015 from questionnaires submitted by centres requesting International Diabetes Federation Life for a Child Program support. All 20 centres in 15 countries agreed to the use of their responses. Annual costs for minimal care were estimated for: 18 × 10 ml 100 IU/ml insulin, 1/3 cost of a blood glucose meter, two blood glucose test strips/day, two syringes/week, and four HbA_{1c} tests/year. Costs were expressed in US dollars, and as % of gross national income (purchasing power parity) per capita.

Results The ranges (median) for the minimum supply costs through the private system were: insulin 10 ml 100 IU/ml equivalent vial: \$5.10–\$25 (\$8.00); blood glucose meter: \$15–\$121 (\$33.33); test strip: \$0.15–\$1.20 (\$0.50); syringe: \$0.10–\$0.56 (\$0.20); and HbA_{1c}: \$4.90–\$20 (\$9.75). Annual costs ranged from \$255 (Pakistan) to \$1,185 (Burkina Faso), with a median of \$553. Annual % gross national income costs were 12–370% (median 56%). For the lowest 20% income earners the annual cost ranged 20–1535% (median 153%). St Lucia and Mongolia were the only countries whose governments consistently provided insulin. No government provided meters and strips, which were the most expensive supplies (62% of total cost).

Conclusions In less-resourced countries, even minimal care is beyond many families' means. In addition, families face additional costs such as consultations, travel and indirect costs. Action to prevent diabetes-related death and morbidity is needed.

Diabet. Med. 33, 820–826 (2016)

Introduction

Type 1 diabetes mellitus, the most common childhood endocrine disorder, is fatal without exogenous insulin therapy and careful treatment. There are ~ 491,000 children < 15 years of age with diabetes [1], of whom 34% live in low- and lower-middle income countries, as defined by the World Bank [2].

Higher-income countries generally have universal healthcare, regularly reviewed treatment guidelines, and active diabetes associations and professional bodies advocating for diabetes care. Governments in these countries usually provide diabetes supplies free or at a more affordable subsidized price; however, this is not the case in many lower-income countries with under-resourced medical systems. In such countries, management of Type 1 diabetes

poses a major financial burden on the healthcare system and on the individual and/or their family, which can lead to fragmentary and compromised healthcare and treatment adherence, extremes of glycaemia, the early development of chronic complications, and premature death [3–10].

The lowest acceptable level of care in very limited resource healthcare settings, 'minimal care', is defined as access to adequate insulin, diabetes education, monitoring and medical care [11]. Diabetes aid organizations, such as the International Diabetes Federation (IDF) Life for a Child programme (LFAC), exist to at least partially support a subset of the world's poorest children and young people with Type 1 diabetes [12].

Previous papers have reported the estimated direct care costs of Type 2 diabetes in various lower-income countries [13,14]. There are also a few studies in individual countries on actual expenditures by families with a child or adult with Type 1 diabetes [3,4,15,16].

Correspondence to: Graham Ogle. E-mail: grahamo@diabetesnsw.com.au

What's new?

- There is little published information on the comparative costs of care for a child with Type 1 diabetes in less-resourced countries, or the proportion of family income spent on such care.
- The study highlights the high proportional cost of self-monitoring of blood glucose.
- The study suggests insulin and meter/strip prices are decreasing in some countries, but remain prohibitively high for many families.
- Awareness of costs of care may promote review of national and international diabetes care policies and support programmes, and dialogue with and action by other key stakeholders, such as industry.

In the present study we assess the direct costs to the family of consumables needed for the minimal care of a child with Type 1 diabetes in 15 countries where the public health system does not provide such care, and relates these costs to a typical local income.

Methods

Local supply costs were collected from questionnaires submitted during January 2013 to February 2015 by medical centres requesting LFAC support. The LFAC programme has a standardized questionnaire (in English, French and Spanish), that is sent to all new centres requesting support, and includes questions about the current cost of diabetes supplies if they cannot be obtained from the government healthcare system.

The questionnaire also asked the percentage of families with a person aged < 23 years with Type 1 diabetes who needed assistance beyond their family resources to cover the cost of each minimal care supply.

Cost questions included: a 10-ml vial of insulin (100 IU/ml equivalent), a blood glucose meter, a blood glucose test strip, an insulin syringe, and a HbA_{1c} test. Data were converted to US dollar equivalent at the time. When prices were expressed as a range in a particular country, the lowest price was used for analysis. For the six centres in India, results are expressed as a median (range), with the median used in the country analysis.

The total annual supply cost for a person with Type 1 diabetes was estimated as provision of 18 vials of insulin (assuming daily usage of 40–45 IU with a little wastage, based on LFAC clinical experience), one blood glucose meter every 3 years, two blood glucose test strips per day, two insulin syringes per week (i.e. implying some reuse), and four HbA_{1c} tests per year.

The following economic data were obtained from the World Bank database [2]: gross national income (purchasing

power parity) per capita, health expenditure per capita, and the mean income per year of the population with the lowest 20% share of income.

Data were managed in Excel and descriptive statistics were obtained.

Results

Twenty completed questionnaires were received from 15 countries: Benin, Burkina Faso, Cambodia, Central African Republic, Ecuador, India (six centres), Ivory Coast, Malawi, Mauritania, Mongolia, Nepal, North Korea, Pakistan, St Lucia, and Somalia. Responders were: nine Diabetes Associations, three Ministry of Health/government hospitals (Nepal, North Korea, St Lucia), six private clinics/foundations (Bangalore, Indore, Belgaum, Kota, Pune, Visakhapatnam), one mission hospital (Pakistan), and one private university hospital (Somalia).

Across all countries, the median % of families needing supply support were: 88% for insulin, 90% for blood glucose test strips, 84% for syringes and 90% for HbA_{1c}.

Correspondence by the LFAC programme staff with the participating clinics determined that the government consistently provided insulin either free or at a minimal cost in only St Lucia and Mongolia. In all other countries, families must buy insulin at market rates some or all the time, except if supplies are available through charitable organizations.

Aside from free government provision of HbA_{1c} tests in Mongolia and syringes in St Lucia, non-insulin diabetes supplies in all countries (meters, strips, syringes and HbA_{1c} tests) must be purchased most or all of the time, except if provided by charitable organizations.

The estimated costs to a family for diabetes consumables for a child or adolescent with Type 1 diabetes in the 15 countries studied, including the mean of the six centres in India, are summarized in Table 1. For countries that consistently provided supplies at no cost, e.g. insulin in St Lucia and Mongolia, the cost to the family was listed as \$0. If HbA_{1c} testing was not available (North Korea and Somalia) this cost was also recorded as \$0. The costs at each of the six independent clinics in India varied little between centres (Table 2).

As shown in Table 1, across the 15 countries, diabetes consumable costs varied widely: fivefold for insulin, eightfold for a blood glucose meter; eightfold for a blood glucose test strip; sixfold for an insulin syringe; and fourfold for an HbA_{1c} test.

The estimated total annual cost of minimal care diabetes supplies to the family of a child with Type 1 diabetes, assuming no government or charity provision, varied fourfold (Table 1).

Figure 1 shows the total annual cost to the family of diabetes consumables expressed as a percentage of the country's average gross national income (purchasing power

Table 1 Costs in all countries

Country	Insulin cost (100 IU/ml 10 ml equivalent vial), \$	Blood glucose meter, \$	Blood glucose strip, \$	Syringe, \$	HbA _{1c} , \$	Annual cost of direct supplies, \$	Annual costs as a % HE pc, \$	Income spent on direct costs by lowest 20% income earners, %
Benin	8.00	37.50	0.50	0.27	9.50	588	1782	248
Burkina Faso	10.00	30	1.20	0.19	20.00	1,185	3118	505
Cambodia	10.00	40.00	0.30	0.50	10.00	504	988	117
Central African Republic	18.62	121.46	0.39	0.56	4.90	737	4094	1535
Ecuador	6.10	45.00	0.72	0.30	9.00	718	199	62
India (median)	5.75	19.40	0.23	0.12	6.60	314	536	46
Ivory Coast	5.10	43.20	0.48	0.26	17.40	553	628	153
Malawi	25.00	25.00	0.56	0.50	20.00	999	3996	1480
Korea, DPR	10	100.00	0.90	0.20	Not available	891	Not available	Not available
Mauritania	7.79	50.78	0.54	0.20	14.22	630	1212	198
Mongolia	–	52.00	0.60	0.18	–	474	204	36
Nepal	7.50	25.00	0.50	0.10	8.13	551	1531	189
Pakistan	4.98	30.08	0.15	0.15	7.52	255	654	38
St Lucia	–	15.00	0.36	–	20.00	348	63	20
Somalia	10.00	30.00	0.20	0.20	Not available	357	2099	Not available
Median	8.00	37.50	0.50	0.20	9.75	552	988	153

HE pc, Health Expenditure per capita.

Costs in US dollars. Insulin provided free in Mongolia and St Lucia, syringes provided free in St Lucia and HbA_{1c} tests in Mongolia. HbA_{1c} tests are not available in Somalia and North Korea. Some economic data were not available for North Korea and Somalia.

Table 2 Costs (in US dollars) reported by six independent centres in India

	Centre 1	Centre 2	Centre 3	Centre 4	Centre 5	Centre 6	Median
Insulin cost per 10 ml 100 IU/ml equivalent vial, \$	6.70	6.00	5.50	4.43	5.18	6.13	5.75
% needing insulin support	75	30	71	60	100	50	65
Blood glucose meter cost, \$	19.40	19.40	19.20	10.50	21.30	20.64	19.40
Blood glucose strip cost, \$	0.39	0.16	0.27	0.16	0.18	0.32	0.23
% needing strips support	75	90	71	60	100	50	73
Syringe cost, \$	0.11	0.12	0.15	0.16	0.10	0.11	0.12
% needing syringe support	75	90	71	60	100	90	90
HbA _{1c} cost, \$	6.50	9.70	6.70	2.80	3.85	9.60	6.60
% needing HbA _{1c} support	75	90	71	70	100	85	73

parity). The mean and median costs of diabetes consumables for one child or young person with Type 1 diabetes were 88% and 53% of the mean individual income, with a range of 12–370%. The costs related to mean health expenditure per capita are shown in Table 1.

As people requiring LFAC support more frequently come from the less affluent levels of society, the costs of diabetes supplies relative to the mean annual income of earners in the lowest 20% income group in each country are shown in Table 1. The mean and median costs of diabetes consumables equate to 356 and 153%, respectively, of the mean individual income for earners in the lowest 20% income group, with a range of 20–1535%.

The proportional costs of specific supplies are shown in Figure 2. Test strips were generally the most expensive diabetes consumable (mean proportional cost 61.9% overall), with the mean proportional cost of insulin being 25.9%, syringes 4.6% and HbA_{1c} 7.7%.

Discussion

In 15 less-resourced countries, the potential direct costs for the minimal care of a child with Type 1 diabetes varies fourfold, with a median cost of 56% of the mean annual income of an individual in that country, or 153% of the annual income of an individual in the lowest 20% income group. These high costs are beyond the means of many families in these and similar less-resourced countries, and probably contribute to the unacceptably high morbidity and premature mortality rates, and the low observed prevalence of Type 1 diabetes in such countries [10,15,17–19].

High diabetes supply costs in many less-resourced countries

The high diabetes care costs we have identified are in keeping with earlier studies, which mainly relate to Type 2 diabetes.

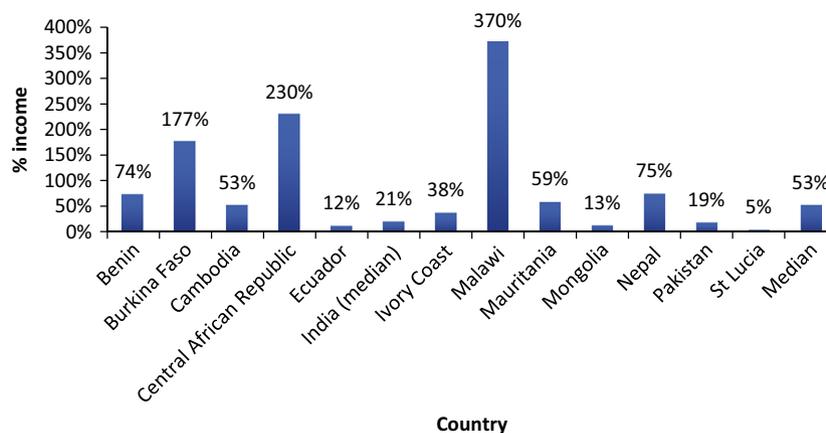


FIGURE 1 Annual consumables costs for Type 1 diabetes as a percentage of per capita gross national income. Data not available for North Korea and Somalia.

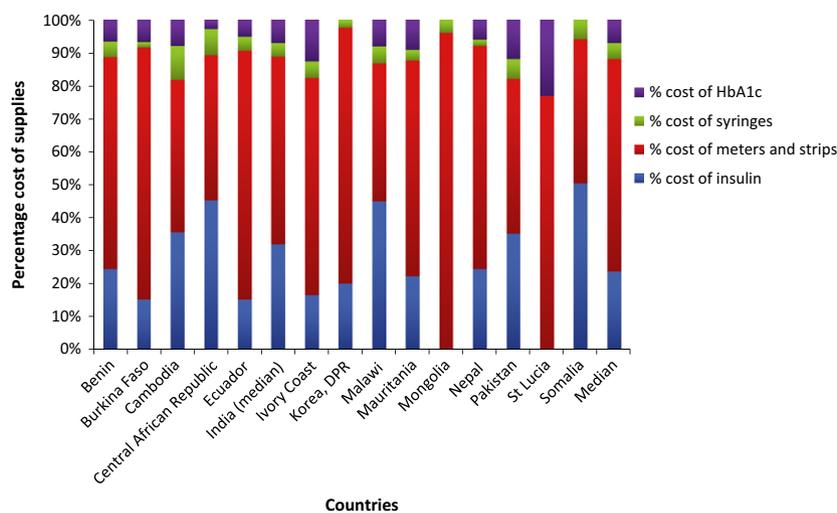


FIGURE 2 Proportional cost of each supply, by country. Note: there was free provision of some supplies in some countries: insulin (Mongolia and St Lucia), syringes (St Lucia), and HbA_{1c} tests (Mongolia). HbA_{1c} testing was not available in North Korea and Somalia.

The IDF and also the International Insulin Foundation have assessed the annual costs of care for an insulin-requiring adult with Type 2 diabetes. The 2006 IDF Survey [13] assumed one vial insulin (33 IU of 100 IU/ml per day), six syringes, and one blood glucose test strip per month. In Pakistan the annual cost was 14% of per capita gross domestic product, and in 13 other low-income and low- to middle-income countries (none included in the present study), the mean was 28% [2006]. The International Insulin Foundation’s assessments [14] assumed one (10 ml, 100 IU/ml) insulin vial per month, one syringe, one blood glucose test, one consultation and one travel cost. Total cost was \$74 in Nicaragua (where the government provided free insulin), and ranged from \$199 to \$427 in Mali, Mozambique, Zambia and Vietnam. In these latter countries this represented 21–75% of per capita income. Mendis *et al.* [20] found that 1 month’s supply of (40 IU) insulin represented

19.6 days of the lowest-paid government worker in Malawi, 7.3 days in Nepal, and 4.7 days in Pakistan.

Most studies of costs for families with a child or adult with Type 1 diabetes have been in situations where there was with little or no self-monitoring of blood glucose (SMBG). In India, one of the countries included in the present study, Shobhana *et al.* [3] found that an annual figure of \$310.47 was spent in 2002 on insulin and syringes in their study of mainly adults.

Three studies in other less-resourced countries have also been published. In Tanzania (1992) the mean annual direct cost was \$287 (in a clinic of adults and some children), with the insulin component of \$156 approaching the average annual family income level [15]. There are two publications from exclusively paediatric populations: in Sudan (1995), the mean annual direct cost was \$283 (23% median income) with insulin accounting for 36% of this [4] and in Mexico

(2008), the mean annual direct cost was \$1,670, far greater than the minimum official wage of \$4 per day [16]. This was the only study that found there was substantial SMBG (see below).

Inconsistent supply and high costs of insulin

Supplies, even of life-saving insulin, are not constant in the public health system of the countries included in the present study. Prices are often substantially increased by customs duties, taxes, VAT, and mark-ups in both the private and public systems [5–8,10,14,15,20]. Our questionnaire results and experience via the LFAC programme indicate that insulin provision, even for children with Type 1 diabetes, is unstable in all the responding countries, with the exceptions of St Lucia and Mongolia where the public health service provides insulin free of charge.

Observed insulin prices in the present study were similar or a little lower than those found in 2000–2010 by the IDF [6,13] and Health Action International [7]. Prices were generally highest in African countries and lowest in India and Pakistan. This probably represents larger market size, with greater competition and availability of generics.

Insulin syringe costs

Insulin must be injected in very accurate doses, particularly in children, and syringes are the least expensive means of drug delivery. Our observed wide variation in syringe costs is consistent with previous studies [10,13,14]. Availability in the public sector is often very low, meaning that families must buy them at private outlets. Syringes are sold as single-use, but by necessity are reused [14,15], and this is generally safe [21,22]. LFAC's standard provision is only two syringes/week, but the results of the present study show that even this frequency imposes a significant cost if the family needs to purchase them. Insulin pen administration is preferable for convenience and comfort (especially important in the care of children), but both pen needles and the accompanying cartridge insulin preparations are more expensive than syringes and larger insulin vials [6,7]. As with insulin, taxes on insulin syringes and pen needles are common [10,14].

Expensive blood glucose monitoring

Whilst the price of blood glucose meters has generally fallen over the last decade [6,13], probably related to marketing strategies, the high costs of blood glucose test strips remain. If insulin dosage changes are to be made safely and intensive insulin regimens are to be used, SMBG is essential; without SMBG excellent blood glucose control in Type 1 diabetes cannot be achieved. In affluent countries SMBG at least four times a day is usually recommended for people with Type 1 diabetes. The range and pattern of costs of glucose test strips in the present study were similar to those reported in

previous studies [6,13], with costs highest in Africa and lowest in South Asia; however, the cost of even once-daily monitoring is beyond the means of most families in lower-income countries [3–6,9,10]. In Sudan in 2005 [4], 26% of the study group ($n = 147$) had not had a blood glucose test in the preceding 6 months. In the Cost of Diabetes in India study [23], few people with Type 1 diabetes (18.4% of 282 subjects) were undergoing HbA_{1c} tests, and the mean number of blood glucose tests per year for those with Type 1 diabetes was 32. In Ghana SMBG and HbA_{1c} testing were uncommonly performed because of cost [5]. In Mexico, the mean cost for families for SMBG (carried out an average twice per day) was \$895 (53% of the total direct cost) [16]. Even in Brazil, an upper- to middle-income country where care costs are covered by the government, the expense of blood glucose monitoring (mean of 3.4 tests per day) consumed 52.8% (\$697) of the total annual cost per patient with Type 1 diabetes of \$1,216 [24]. Insulin represented 26.1% of expenses. Further analysis of the Cobas study also showed that more frequent SMBG (up to four tests per day) was associated with improved HbA_{1c} levels [25].

Impact of costs

Diabetes care costs can be devastating for families. For the poorest of families, the cost of diabetes consumables for minimum care would take all of their family income, leaving nothing for food, shelter and clothing. Some have to sell assets or borrow [26]. Many have to make chilling choices under the principle of opportunity cost; such as, do they cover the cost of diabetes care for the affected child, or provide education for their other children? [6,26]. To offset high costs and increase the time until more insulin needs to be purchased, insulin doses are often missed or reduced [5,8,18,26].

The present study only evaluated the costs of diabetes consumables and HbA_{1c} testing. Families face other direct costs: lancets for blood glucose testing; medical consultations; other laboratory tests, including diabetes complication screening; and travel expenses to and from clinics. Travel costs can be high, even prohibitive [8,9,14,17,26], and overnight lodging may also be needed [26]. In Ethiopia [17], 13% of patients with Type 1 travelled > 180 km to attend a clinic. In a study of five countries, travel was the most expensive component in two [14].

There are also indirect costs of diabetes care, such as lost parental income when caring for the child or travelling to clinic, and intangible costs such as opportunity cost, anxiety and depression [4,27,28].

In the absence of provision of supplies by the public health system or benevolent sources, costs to families will only rise with time; as body weight increases and puberty occurs, more insulin is needed. With time, complications screening and, accelerated by poor glucose control, the development of complications themselves can be costly. Chronic complica-

tions occur earlier and more frequently in less-resourced countries, appearing in adolescents and young adults [18,19].

Potential solutions

Human insulin is less costly than insulin analogues and insulin vials cost less than cartridge/pen preparations. Syringes cost less than insulin pens, and also take less time to educate users in their use. It is critical that these supplies remain available in the global market [6]. It is also essential that less-resourced governments, struggling to provide insulin and other key diabetes supplies for their population, purchase human insulin rather than acceding to the requests of patient groups and the influence of marketing by pharmaceutical companies or distributors to purchase analogues [29]. Differential pricing of diabetes consumables (so that a lower price is offered to less-resourced countries) should be encouraged, with passing on of cost-savings through the supply chain to the user [7,28]. Taxes on all diabetes supplies must be removed.

More manufacturers usually leads to greater competition and lower prices. Lower-cost blood glucose testing meters and strips are urgently needed, perhaps via novel measuring techniques or a product released globally.

It is to be hoped that universal healthcare coverage will eventually provide coverage to all, but this may be years away in some very low-income countries. In the interim, focused advocacy, careful use of available funds and external support will be needed.

Study limitations

The present study has some limitations. The estimated costs of diabetes consumables were determined by report from an individual in each centre, although these individuals were all experienced observers who were coordinating care in their respective verified centres. The centres were, in most cases, the main youth diabetes centre in the respective country, and in the remaining countries were generally typical situations. Prices were not confirmed with a wider pharmacy survey or other observers (with the exception of India where six clinics were involved, with consistent results). However, the costs observed were consistent with or slightly less than previously published data in less-resourced countries [6,7,13]. We acknowledge there would be variation within many countries because of differential pricing between and within public and private sectors, and for different brands of supplies. The study design precluded assessment of actual costs; we recognize that some families would episodically receive supplies from the public health service or charitable support.

Conclusions

Our results show great variation in the estimated costs of diabetes consumables for the families with children with

Type 1 diabetes in less-resourced countries, but show that the cost of care for a child with Type 1 diabetes is financially overburdening and probably unaffordable for many families in lower-income countries.

Insulin is essential for people with Type 1 diabetes, but it is still not readily accessible, even for children, on an uninterrupted basis in low-resourced countries almost 100 years since its discovery. In a world where an artificial pancreas is on the horizon, no child should be dying from diabetes.

Acknowledgements

The authors thank the following health professionals from the centres for providing and allowing us to use their data: Jacqueline Diquemare, Unité Diabète du CHD, Benin; Prof. Drabo, Service de Médecine Interne, CHU Yalgado, Ouagadougou, Burkina Faso; Lorraine Fraser-King, Cambodian Diabetes Association Siem Reap, Cambodia; Dr Gaspard Kouriah, Association des Diabétiques en Centrafrique, Central African Republic; Prof. Abodo Jacko, Association Obésité et Diabète de Côte D'Ivoire; Ana Fernanda Sanchez Encalada, Fundación Los Fresnos, Casa de la Diabetes, Ecuador; Dr Srikanta, Jnana Sanjeevini Medical Centre, Bangalore, India; Dr S. Julka, Synergy Indore Endocrine Clinic, Indore, India; Dr M.V. Jali, Kore Hospital and MRC, Belgaum, Karnataka, India; Dr Ramchandani, Ramchandani Diabetic Clinic, Kota, India; Dr V.Khadilkar, Nityaasha Foundation, Pune, India; Prof. Mythili, Diabetic Child Society, Visakhapatnam, India; Rev. Timothy Ntambalika, Diabetes Association of Malawi, Blantyre, Malawi; Elghasoum Hadya Wane, Association Mauritanienne de lutte contre le Diabète, Noukachott, Mauritania; Dr Oyun Kookhor, Diabetes Council of Mongolia, Ulan Bator, Mongolia; Dr Santosh Pokhrel, Siddhartha Children and Women's Hospital (SCWH), AMDA, Butwal, Nepal; Choe Kyong Tae Endocrine Research Institute, DPR Korea; Dr Angela Condie, Bach Christian Hospital, Pakistan, Qualandabad; Dr Andrew Okello, SI University Hospital, Somali International University, Somalia, Africa; Dr Jacqueline Bird, Ministry Of Health-Wellness Centres, Castries, St Lucia.

The authors also thank healthcare economists Drs Philip Clarke and Derek Petrie from University of Melbourne Health Economics Research Centre for advice.

Funding sources

H.K. was funded by a Summer Student Research Grant from the University of Sydney and NHMRC Clinical Trials Centre. This research was part-funded by the Leona M. and Harry B. Helmsley Charitable Trust.

Competing interests

None declared.

References

- 1 Patterson C, Guariguata L, Dahlquist G, Soltesz G, Ogle G, Silink M. Diabetes in the young – a global view and worldwide estimates of numbers of children with type 1 diabetes. *Diabetes Res Clin Pract* 2014; **103**: 161–175.
- 2 World Bank. Indicators. Available at <http://data.worldbank.org/indicator> Last accessed 17 February 2015.
- 3 Shobhana R, Rao PR, Lavanya A, Williams R, Padma C, Vijay V et al. Costs incurred by families having Type 1 diabetes in a developing country – a study from Southern India. *Diabetes Res Clin Pract* 2002; **55**: 45–48.
- 4 Elrayah H, Eltom M, Bedri A, Belal A, Rosling H, Ostenson C. Economic burden on families of childhood type 1 diabetes in urban Sudan. *Diabetes Res Clin Pract* 2005; **70**: 159–165.
- 5 Kratzer J. Structural barriers to coping with type 1 diabetes mellitus in Ghana: Experiences of diabetic youth and their families. *Ghana Med J* 2012; **46**: 39–45.
- 6 International Diabetes Federation. Access to Insulin and Diabetes Supplies. In: *Diabetes Atlas* 2nd edn, 2002; pp. 193–205.
- 7 Health Action International (HAI). A one day snapshot of the price of a medicine. Available at <http://www.haiweb.org/medicineprices> Last accessed 31 November 2014.
- 8 Higuchi M. Access to diabetes care and medicines in the Philippines. *Asia Pac J Public Health* 2010; **22**: 96–102.
- 9 Kesavadev J, Sadikot S, Saboo S, Shrestha D, Jawad F, Azad K et al. Challenges in Type 1 diabetes management in South East Asia: Descriptive situational assessment. *Indian J Endocrinol Metab* 2014; **18**: 600–607.
- 10 Beran D, Yudkin J, De Courten M. Access to care for patients with insulin-requiring diabetes in developing countries: Case studies of Mozambique and Zambia. *Diabetes Care* 2005; **28**: 2136–2140.
- 11 International Diabetes Federation. Diabetes in children: organization of care. *Pediatr Diabetes* 2007; **8**(Suppl. 1): 19–25.
- 12 Atkinson MA, Ogle GD. Improving diabetes care in resource-poor countries: challenges and opportunities. *Lancet Diabetes Endocrinol* 2013; **1**: 268–270.
- 13 IDF Task Force on Insulin, Test Strips and Diabetes Supplies. Report on the international diabetes supplies survey on cost and availability 2006. Brussels: International Diabetes Federation, 2007.
- 14 Beran D, Yudkin J. Looking beyond the issue of access to insulin: what is needed for proper diabetes care in resource-poor settings. *Diabetes Res Clin Pract* 2010; **88**: 217–221.
- 15 Chale S, Swai ABM, Mujinja PGM, McLarty DG. Must diabetes be a fatal disease in Africa? Study of costs of treatment *BMJ* 1992; **304**: 1215–1218.
- 16 Altamirano-Bustamante N, Islas-Ortega L, Robles-Valdés C, Garduño-Espinosa J, Morales-Cisneros G, Valderrama A et al. Economic family burden of metabolic control in children and adolescents with type 1 diabetes mellitus. *J Pediatr Endocrinol Metab* 2008; **21**: 1163–1168.
- 17 Alemu S, Watkins VJ, Dodds W, Turowska JB, Watkins PJ. Access to diabetes treatment in northern Ethiopia. *Diabet Med* 1998; **15**: 791–794.
- 18 Majaliwa ES, Munubhi E, Ramaiya K, Mpembeni R, Sanyiya A, Mohn A, Chiarelli F. Survey on acute and chronic complications in children and adolescents with type 1 diabetes at Muhimbili National Hospital in Dar es Salaam, Tanzania. *Diabetes Care* 2007; **30**: 2187–2192.
- 19 Marshall SL, Edidin D, Sharma V, Ogle G, Arena VC, Orchard T. Current clinical status, glucose control, and complication rates of children and youth with type 1 diabetes in Rwanda. *Pediatr Diabetes* 2013; **14**: 217–226.
- 20 Mendis S, Fukino K, Cameron A, Laing R, Filipe A Jr, Khatib O et al. The availability and affordability of selected essential medicines for chronic diseases in six low- and middle-income countries. *Bull World Health Organ* 2007; **85**: 279–289.
- 21 Schuler G, Pelz K, Kerp L. Is the reuse of needles for insulin injection systems associated with a higher risk of cutaneous complications? *Diabetes Res Clin Pract* 1992; **16**: 209–212.
- 22 Thomas DR, Fischer RG, Nicholas WC, Beghe C, Hatten KW, Thomas JN. Disposable insulin syringe reuse and aseptic practices in diabetic practices. *J Gen Intern Med* 1992; **4**: 97–100.
- 23 Bjork S, Kapur A, King H, Nair J, Ramachandran A. Global policy: aspects of diabetes in India. *Health Policy* 2003; **66**: 61–72.
- 24 Cobas RA, Ferraz MB, Matheus ASM, Tannus LRM, Negrato CA, de Araujo LA et al. The cost of type 1 diabetes: a nationwide multicentre study in Brazil. *Bull World Health Organ* 2013; **91**: 434–440.
- 25 Gomes MB, Tannus KRM, Cobas RA, Matheus ASM, Dualib P, Zucatti AT et al. Determinants of self-monitoring of blood glucose in patients with type 1 diabetes: a multi-centre study in Brazil. *Diabet Med* 2013; **30**: 1255–1262.
- 26 Metta M, Haisma H, Kessy F, Geubbels E, Hutter I, Bailey A. “It is the medicines that keep us alive”: lived experiences of diabetes medication use and continuity among adults in Southeastern Tanzania. *BMC Health Serv Res* 2015; **15**: 111.
- 27 Yesudian C, Grepstad M, Visintin E, Ferrario A. The economic burden of diabetes in India: a review of the literature. *Global Health* 2014; **10**: 80.
- 28 Volman B. Direct costs and availability of diabetes medicines in low-income and middle-income countries. Geneva: World Health Organization, 2008. Available at apps.who.int/medicinedocs/documents/s18387en/s18387en.pdf Last accessed 4 March 2015.
- 29 Beran D, Yudkin JS. The double scandal of insulin. *J R Coll Physicians Edinb* 2013; **43**: 194–196.