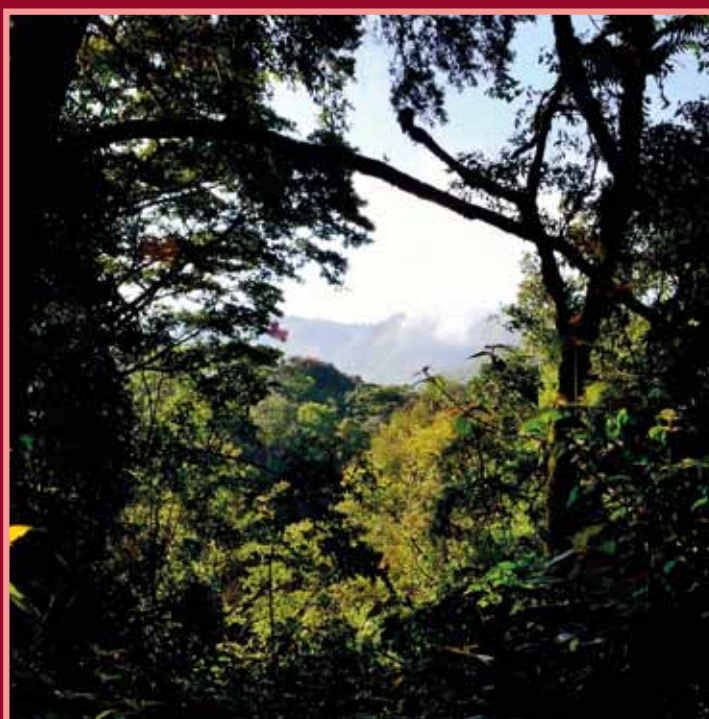


Volume 24 Number 1

May 2016



Overview of childhood diabetes mellitus

Prevalence of diabetes and its associated risk factors in south-western Uganda

Physical disability and functional impairment resulting from type 2 diabetes in sub-Saharan Africa: a systematic review

Community support for T2DM

Assah, FK, Atanga EN, Enoru S, Sobngwi E, Mbanya JC. Community-based peer support significantly improves metabolic control in people with type 2 diabetes in Yaoundi, Cameroon. *Diabetic Medicine* 2015; 32: 886–889

Researchers from Cameroon have examined the effect of community-based peer support on glycaemic control in a group of 96 patients with established T2DM. All had 'poor control' (defined as an HbA1c >7.0%), and they were each assigned to a peer supporter who also had T2DM, but had better glycaemic control. These supporters operated by group and individual meetings, as well as phone calls. The study patients, as well as a matched control group (who had no peer support), had normal routine diabetes clinical care. After six months, and compared with the control group, there were significant reductions in HbA1c, body mass index (BMI), serum cholesterol, and diastolic blood pressure (BP) — all $p < 0.001$. This is an interesting study, showing major benefits from a simple and inexpensive support system. However, the follow-up period was short (six months), and whether the effects would be maintained longer-term is uncertain. The study also took place in a city environment, and may be difficult to replicate in rural areas.

Epidemiology of type 1 diabetes in Rwanda
Marshall, SL, Edidin D, Arena VC et al. Prevalence and incidence of clinically recognised cases of type 1 diabetes in children and adolescents in Rwanda, Africa. *Diabetic Medicine* 2015; 32: 1186–1192

There is a lack of epidemiological information on type 1 diabetes (T1DM) in Africa. The disease is generally thought to be less common than in areas such as Europe or North America, but the high early mortality of the condition in Africa makes enumeration difficult. Researchers from the USA and Rwanda have recently reported a detailed survey of T1DM incidence in Rwanda. They studied seven districts, and collected data by visits to district hospitals, as well as using the 'Life for a Child' (LFAC) registry. LFAC is a system run by the International Diabetes Federation (IDF) and other partners, and provides insulin for individual children in resource-poor areas. The prevalence of T1DM was found to be 16.4/100 000 in those <26 years, and 4.8/100 000 in those <15 years. Incidence figures were 2.7/100 000/year for <26 years, and 1.2/100 000/year for <15 years. These figures are much lower than in western areas of the world, but the authors accept that (as with other similar surveys) there is likely to be under-ascertainment, and deaths before presentation to hospital.

Tuberculosis and diabetes

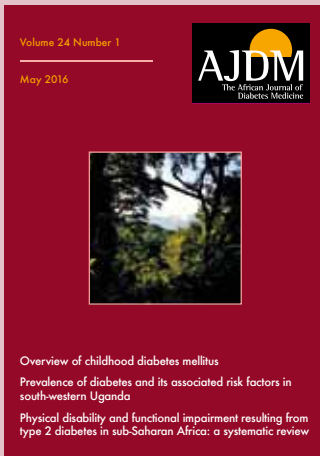
Harries AD, Mukar AMV, Satyanarayana S et al. Addressing diabetes mellitus as part of the strategy for ending TB. *Trans Royal Soc Trop Med Hyg* 2016; 110: 173–179

A group of respected international experts have recently reviewed the problematic link between tuberculosis (TB) and diabetes. It is now well accepted that diabetes (either T1DM or T2DM) increases the risk of TB three-fold. Diabetes also increases the risk of adverse TB outcomes — including treatment failure, relapse and mortality. The recent 'Sustainable Development Goals' (SDGs) of the United Nations (UN) include a commitment to end the current TB epidemic by 2030. The authors of the current paper point out that if this is to be achieved, the problem of diabetes as a major TB risk factor must be addressed. Further research on how best to achieve this is needed, but potential strategies do exist. 'Bidirectional Screening' should be encouraged (screening TB patients for diabetes, and diabetic patients for TB), and early diagnosis and treatment is of course important. At least in some areas, there may be a case for integrating diabetes and TB treatment and follow-up services. This is an interesting model, bringing together both communicable and non-communicable disease care.

More on GLP-1 analogues

Curtis L, Holt H, Richardson T, Knott J, Partridge H. GLP-1 analogue use in patients with sub-optimally controlled type 1 diabetes and obesity improves weight and HbA1c. *Practical Diabetes* 2016; 33: 13–17

The incretin hormones are gut peptides whose action is mediated via GLP-1. They have multiple actions which favour blood glucose lowering, but in particular stimulate pancreatic insulin release and suppress glucagon. The main GLP-1 analogues (exenatide and liraglutide) have been in use for a number of years now as adjunctive therapy in T2DM. They can lower both body weight and HbA1c without significant hypoglycaemia. A small UK study has now reported benefits also in type 1 diabetes (T1DM). In 33 patients treated with GLP-1 analogues as well as their usual insulin, HbA1c fell from a mean 9.4% at baseline, to 8.6% at six months, 8.6% at 12 months and 8.9% at 30 months. Mean weight at the same time points was 104.9 Kg, 98.5 Kg, 94.7 Kg and 92.0 Kg. The results (particularly for weight) were statistically significant. Though the numbers are small, this is a long follow-up study with very beneficial results (particularly with regard to weight). GLP-1 analogues remain expensive and are therefore not in common use in Africa. However, their wider introduction in the future seems likely.



Editor

Professor Geoff Gill
Liverpool School of Tropical
Medicine and
Aintree University Hospital,
Liverpool, UK

Consulting Editor

Professor Sir George Alberti
Senior Research Fellow,
Imperial College London
Past President,
International Diabetes Federation

Editorial Board

Prof Ibrahim Sherif – Libya
Prof Ken Huddle – South Africa
Dr Kaushik Ramaiya – Tanzania
Prof Nigel Unwin – UK
Prof J C Mbanya – Cameroon

Publisher

Bryan Pearson

Managing Editor and Production

Michelle Tooke

Business Development Manager

Nigel Blake

Business Manager

Grant Docking

ISSN 2042-8545 (Print)
ISSN 2053-4787 (Online)

All contents are © 2016

FSG Communications Ltd



Correspondence to:
African Journal of Diabetes Medicine,
FSG Communications Ltd
Vine House • Fair Green • Reach
Cambridge CB25 0JD • UK
Tel: +44 (0)1638 743633
Fax: +44 (0)1638 743998
E-mail: editor@fsg.co.uk

2 From the Journals

4 In the News

5 Review Article

Overview of childhood diabetes mellitus

U I Umar

10 Original Article

Physical disability and functional impairment resulting from type 2 diabetes in sub-Saharan Africa: a systematic review

D Ganu, N Fletcher, and
N K Caleb

15 Original Article

Prevalence of diabetes and its associated risk factors in south-western Uganda

K Dickson

18 Original Article

A qualitative study of healthcare professionals' perceived trust in and willingness to recommend alternative medicines for the management of diabetes mellitus

M F Mahomoodally, C D Ruhee,
and T F M Holmes

22 Original Article

Prevalence of hyperglycaemia in children seen at a paediatric emergency unit

U I Umar

23 Guidance to Authors

Editorial

Glycaemic targets in diabetes

A major issue of controversy in diabetes management globally — but especially in Africa — is glycaemic targets. What levels of blood glucose should we be planning to achieve in our diabetic patients? There are two issues here — the research evidence, and what is practically achievable.

The evidence for type 1 diabetes (T1DM) suggests that the nearer to normoglycaemia the better — equivalent to an HbA1c <6.5%. The problem of this degree of 'tight' control is of course the risk of hypoglycaemia. In type 2 diabetes (T2DM) the situation is less clear, as there is evidence that over-tight control may be associated with excess mortality, particularly in those with cardiovascular risk factors.

All the studies which examine the benefits or otherwise of glycaemic control have been in European or North American populations. Their results are probably broadly applicable to Africa. However, the real problem is that in many African environments patients with diabetes may have no facilities for home glucose monitoring, regular HbA1c testing, diabetes team support etc. In situations like this, targets may have to be relaxed and individualised; and even become qualitative rather than quantitative. For example, some African intervention programmes have used symptom control and lack of hypoglycaemia as their primary aims. In T2DM, lack of nocturia¹, or a random clinic blood glucose of <14.0 mmol/l² may equate to reasonable HbA1c levels.

Simple protocols which are not based on HbA1c levels can be effective in leading to glycaemic improvements in T2DM.³ Once again, this demonstrates that diabetes practice in Africa can be effective despite a lack of laboratory and other technical support.

Professor Geoff Gill

Editor, African Journal of Diabetes

Medicine, Liverpool School of Tropical
Medicine, Liverpool, UK

References

1. Udezue EO. Nocturnal urinary frequency as an indicator of hyperglycaemia in Nigerian patients. *Pract Diab Digest* 1990; 1: 39–40.
2. Rotchford AP, Rotchford KM, Machattie T, Gill GV. Assessing diabetic control — reliability of methods available in resource-poor settings. *Diabetic Medicine* 2002; 19: 195–200.
3. Gill GV, Price C, Shandu D, et al. An effective system of nurse-led diabetes care in rural Africa. *Diabetic Medicine* 2008; 25: 606–611.

Front cover: Bwindi impenetrable forest, Uganda.

The World Health Organization pledge to prevent and control diabetes

The World Health Organization (WHO) has pledged its continued commitment to providing technical support for the development and implementation of policies and strategies for the prevention and control of diabetes.

WHO made the pledge during celebrations marking World Health Day held under the theme: 'Prevention and Control of Diabetes'.

Speaking at Liberia's Ministry of Information press briefing, Liberia's WHO Representative, Alex Gasasira said that diabetes has risen from four million to 25 million within the African region.

He attributed the sharp rise to rapid uncontrolled urbanisation, globalisation, and major changes in lifestyle with a resultant increase in the prevalence of the lifestyle risk factors.

According to Gasasira, unhealthy diets, lack of physical exercise, tobacco use, alcohol consumption, obesity, and overweight are some of the factors that could contribute to the two types of diabetes, which he named as Diabetes One and Diabetes Two.

He explained that Diabetes One is characterised by insufficient insulin production in the body, which requires daily injection of insulin, while Diabetes Two results from ineffective use of insulin in the body.

'I urge all governments to implement the globally agreed actions to prevent and control diabetes, most especially with the global increase from 108 to 422 million in 2014,' he warned.

World Health Day is a global health awareness day celebrated every year on 7 April, under the sponsorship of WHO.

In 1948, the WHO held the First World Health Assembly. The Assembly decided to celebrate 7 April of each year, with effect from 1950, as World Health Day.

Gasasira explained that the disease can be prevented by maintaining normal body weight, engaging in regular physical activity, eating healthy diets that include sufficient consumption of fruits and vegetables and avoiding alcohol consumption and use of tobacco.

Diabetes patch technology aiming to eliminate finger prick test

Most diabetic patients need a finger prick test several times a day to determine whether their blood sugar level is under control.

But the developers of a transparent patch with its electric circuits and tiny gold plates claim that they may be freed from this painful routine.

The device allegedly allows people with diabetes to easily monitor their blood sugar levels and the medication to be injected when and wherever necessary.

Dae-Hyeong Kim, Professor of Chemical and Biological Engineering, Seoul National University says: 'Diabetic patients are very reluctant to measure blood sugar, or get an insulin shot in public. This creates a problem with the management of that disease. Things that a person with diabetes should take care of on a daily basis are often only done once a fortnight. This technology makes the diabetes management painless. It's also not visible to others and less stressful.'

The sensors of the patch send the data collected from the patient's sweat to a smartphone app, which makes calculations



based on the sweat-based data. If the app judges that the patient needs medication, then the micro-needles embedded in the patch deliver the drug.

Developers who claim the thin micro-needles cause hardly any pain to the patient are now looking ahead.

'I think that the diabetes patch can enter the market within a short time after the technical development stabilises and a process for mass production is established. Nevertheless, in order to commercialise the patch, new plants should be built, production lines should be established, and we still need to get certified. The patch needs to go through animal testing and clinical demonstration because drug from the patch is injected into the body, and I think it will take more than five years to complete this process,' he continued.

According to World Health Organization, diabetes affects around 422 million adults worldwide, killing 1.5 million people each year.

Zimbabwe Diabetic Association seeking free access to medications

The Zimbabwe Diabetic Association estimates that 10 out of 100 people in the country have diabetes but may be unaware, as many people remain undiagnosed due to lack of knowledge about the disease.

Dr. John Mangwiro, president of the association, said they are lobbying government to provide free access to diabetic medications as the cost of managing the disease continues to escalate.

'We hope that diabetes management medications become more accessible and can be provided for free like other chronic disease management regimes and we are currently lobbying government to make this a reality,' said Dr. Mangwiro.

Dr. Mangwiro said lack of current statistics on the disease and its prevalence is hampering progress in coming up with a comprehensive programme of managing the disease.

He said: 'We are aware that figures are going up but we need current statistics to forward to government so that we can come up with a comprehensive national management program to help fight the disease.'

Current statistics from the association indicate that 1.4 million Zimbabweans have diabetes, which is characterised by dry mouth and extreme thirst, a constant need to urinate especially at night, and unexplained and unintentional weight loss.

Overview of childhood diabetes mellitus

U I Umar

Introduction

Diabetes mellitus is the common end-point of a variety of disorders of insulin production and/or insulin action resulting in hyperglycaemia with associated abnormalities of carbohydrate, fat, and protein metabolism.^{1,2} The aetiology of diabetes is heterogeneous, but most cases of diabetes can be classified into two broad aetiopathogenetic categories: type 1 and type 2. However, the American Diabetes Association (ADA) classifies diabetes into: type 1 diabetes, type 2 diabetes, gestational, and acquired disorders.² In children, the most common form of diabetes is type 1, due to destruction of the β cells of the pancreas, with eventual complete lack of insulin secretion.³ The second most common form of diabetes in children is type 2 diabetes, which has been increasing worldwide in children in association with the increase in childhood obesity.⁴ It results from peripheral and hepatic resistance to insulin coupled with inability of the pancreatic β cells to compensate.^{3,4} Recently a new classification of diabetes has been proposed, the β cell-centric classification.⁵ This model pre-supposes that all diabetes originates from a final common denominator, the abnormal pancreatic β cell. It recognises that interactions between genetically predisposed β cells with a number of factors, including insulin resistance (IR), susceptibility to environmental influences, and immune dysregulation/inflammation, lead to the range of hyperglycaemic phenotypes within the spectrum of diabetes.

Diabetes is a serious and costly disease and it is associated with acute and chronic complications that contribute to excess morbidity and mortality in individuals, especially in developing countries.⁶

Epidemiology

Worldwide, diabetes is one of the most common chronic diseases in children and type 1 diabetes accounts for over 90% of the cases.⁷ Annually about 80 000 children (age <15 years) are estimated to develop type 1 diabetes worldwide.⁸ The incidence of type 1 diabetes in children varies widely, and the incidence rates are correlated with the frequency of human leukocyte antigen (HLA) susceptibility genes in the general population.^{9,10} It is higher in Caucasian populations and in populations at a distance from the equator.³ Countries with the highest

annual incidence rates of type 1 diabetes in children are Finland, with 36.5 per 100 000, Sweden with 27.5 per 100 000, Canada (Prince Edward Island) with 24.5 per 100 000, and Norway (eight counties) with 21.2 per 100 000.⁸ In Asia, the incidence of type 1 diabetes is low compared with Caucasians.¹¹ Likewise in Africa, the reported incidence is also low, even though diabetes overall is not rare in Africa, but there is limited information from the region.¹² Generally a rise in type 1 diabetes incidence has been observed globally in recent decades.^{13–15} In some reports there has been a disproportionately greater increase in those under the age of five years,^{15,16} and in developing countries or those undergoing economic transition in recent decades.^{15,17}

Type 2 diabetes is becoming more common and accounts for a significant proportion of young-onset diabetes in certain at-risk populations.¹⁸ However, population-based epidemiological data are more limited compared with type 1 diabetes, even though investigators from various countries like USA,^{19,20} Canada, Japan, Austria, UK, and Germany, have reported increased rates of type 2 diabetes.^{21–25}

There are generally no significant gender differences in the incidence of diabetes, even though some differences are observed in some populations. However, a male gender bias is often observed in older adolescents and young adults.^{26–28}

Type 1 diabetes

Type 1 diabetes is a life-long medical condition and is the leading cause of diabetes in children of all ages.⁷ It is an autoimmune disease in which the immune system destroys the insulin-producing β cells of the pancreas that help regulate blood glucose levels.⁷ Type 1 diabetes usually begins in childhood or young adulthood, but can develop at any age. Combinations of genetic and environmental factors put people at increased risk for type 1 diabetes. The presence of any of the antibodies, GAD-65, ICA, IAA and IA-2 increase the risk of type 1 diabetes.²⁹ In general, 70% of people with new-onset type 1 diabetes will have a positive antibody if only one antibody is measured, whereas 90% will have at least one antibody when all four are measured.²⁹

Onset

Type 1 diabetes mostly has an acute onset, with children and adolescents usually able to pinpoint when symptoms began.³⁰ Some children and adolescents may present with ketoacidosis as the first indication.³¹ Others may have post-meal hyperglycaemia, or modest fasting hyperglycaemia that rapidly progresses to severe hyperglycaemia and/or ketoacidosis in the presence of infection or other stress.³⁰

Dr. Umar Isa Umar, Consultant Paediatrician, Paediatric Endocrinology Unit, Department of Paediatrics, Bayero University Kano/Aminu Kano Teaching Hospital, PMB 3452, Kano, Kano State, Nigeria. Correspondence to: Dr. U I Umar. Email: umarped@gmail.com

1. Classic symptoms of diabetes or hyperglycaemic crisis, with plasma glucose concentration ≥ 11.1 mmol/l (200 mg/dl) or
2. Fasting plasma glucose ≥ 7.0 mmol/l (≥ 126 mg/dl). Fasting is defined as no caloric intake for at least 8h* or
3. Two hour post-load glucose ≥ 11.1 mmol/l (≥ 200 mg/dl) during an oral glucose tolerance test (OGTT). (The test should be performed using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water or 1.75 g/kg of body weight to a maximum of 75g)
4. Haemoglobin A1c (HbA1c) $> 6.5\%$ †

Table 1. Criteria for the diagnosis of diabetes mellitus

Plasma blood glucose target range		HbA1c	Notes
Before meals	Bedtime/overnight		
5.0–7.2 mmol/l	5.0–8.3 mmol/l	$< 7.5\%$	A lower goal ($< 7.0\%$) is reasonable if it can be achieved without excessive hypoglycaemia
(90–130 mg/dl)	(90–150 mg/dl)		

Table 2. Blood glucose and HbA1c targets for type 1 diabetes across all paediatric age-groups³⁵

Symptoms

The immunologic process that leads to type 1 diabetes can begin years before symptoms develop.³⁰ Symptoms become apparent when most of the β cell population is destroyed and usually develop over a short period of time.³⁰ Early symptoms, which are mainly due to hyperglycaemia, include polyuria and polydipsia, polyphagia, weight loss, and blurred vision. Elevation of blood glucose, acidosis, and dehydration comprise the condition known as diabetic ketoacidosis or DKA. If diabetes is not diagnosed and treated with insulin at this point, the individual can lapse into a life-threatening coma.

Diagnostic criteria for diabetes in childhood and adolescence

Diagnostic criteria are based on blood or plasma glucose measurements and the presence or absence of symptoms,¹ and different methods can be used for the diagnosis (Table 1).^{1,2}

Complications

DKA and hypoglycaemia are the most significant acute complications of diabetes and its treatment, and both complications pose a significant risk of morbidity and mortality. Children with type 1 diabetes are also at risk for the long-term complications of diabetes, most notably microvascular complications such as retinopathy, nephropathy, and neuropathy. Longer term, macrovascular disease may occur, leading to strokes and heart disease.³²

Management

The main goals of treatment of type 1 diabetes are to achieve glycaemia as close to metabolic normality as possible, avoid acute complications, minimise the risk of long-term micro- and macrovascular complications, and assist the child and family in achieving normal growth and development, as well as normal psychological maturity

and independence. The basic elements of management are insulin administration (either by subcutaneous injection or insulin pump), nutrition management, physical activity, blood glucose testing, the avoidance of severe hypoglycaemia, and the avoidance of prolonged hyperglycaemia or DKA.³³

Most pre-adolescent children need about 0.7–1.0 insulin units/kg/day, while adolescents usually need about 0.8–1.2 units/kg/day. Sometimes requirements may rise substantially above 1.2 units and even up to 2.0 units/kg/day. This increased need in adolescence is due to increased insulin resistance during puberty.³⁴ However, during the ‘honeymoon period’, dose requirements may drop to less than 0.5 units/kg/day. The honeymoon period is the period when insulin requirements

often decline temporarily, usually starting 1–3 months after diagnosis, and is due to improved function of β cells with removal of the toxic effect of hyperglycaemia. The honeymoon period may last several months, occasionally 12 months or more.³⁴

Commonly used insulin regimens are either split/mixed or basal/bolus regimens. Using split/mixed regimens, most children and adolescents require at least two injections per day of short- and intermediate-acting insulin to achieve satisfactory metabolic control. The injections are administered shortly before breakfast and dinner. Using these regimens, patients usually need about two-thirds of their total dose in the morning and one-third in the evening. The doses usually are split between one-third regular/rapid-acting insulin and two-thirds isophane (NPH).³⁴

Basal/bolus regimens aim to achieve more physiological insulin concentrations with less between-meal insulin action. The basal insulin provides baseline or fasting insulin needs; the bolus doses provide insulin to cover food requirements and to correct postprandial hyperglycaemia. The basal insulin is provided by either rapid-acting insulin given with the basal rate of an insulin pump or with once or twice-daily injections of long-acting insulin analogues such as detemir or glargine. The bolus insulin is provided by acute doses of rapid-acting insulin, either through injections or through bolus doses given by an insulin pump.³⁴

Physical activity helps to lower blood glucose levels in addition to maintaining cardiovascular fitness and controlling weight. To maintain blood glucose levels within the target range during extra physical activity, patients will need to adjust their insulin and food intake. They also may need to check their blood glucose levels more frequently to prevent hypoglycaemia while engaging in physical activity.

To control diabetes and prevent complications, blood

glucose levels in children with type 1 diabetes should be managed as indicated in Table 2. However, goals should be individualised and different goals may be reasonable based on benefit–risk assessment. Furthermore, families need to work with their healthcare team to set target blood glucose levels appropriate for the child.

Type 2 diabetes

Type 2 diabetes used to occur mainly in adults who were overweight and older than 40 years. Now, as more children and adolescents in most societies become overweight or obese and inactive, type 2 diabetes is occurring more often in young people.³⁶ Type 2 diabetes is a complex metabolic disorder of heterogeneous aetiology with social, behavioural, and environmental risk factors unmasking the effects of genetic susceptibility.³⁷ There is a strong hereditary (likely multigenic) component to the disease, with the role of genetic determinants illustrated when differences in the prevalence of type 2 diabetes in various racial groups are considered.³⁸ Type 2 diabetes is more common in certain racial and ethnic groups such as African-Americans, American Indians, Hispanic/Latino Americans, and some Asian and Pacific Islander Americans.³⁹ In Japanese school children, type 2 diabetes is now more common than type 1.⁴⁰ The diagnosis of type 2 diabetes in children is made on average between 12 and 16 years of age, and rarely before age 10. However, the youngest patient reported was diagnosed at four years of age.⁴¹

Onset

The first stage in the development of type 2 diabetes is often insulin resistance, requiring increasing amounts of insulin to be produced by the pancreas to control blood glucose levels.⁴ Initially, the pancreas responds by producing more insulin, but after several years, insulin production may decrease and diabetes develops.³ Type 2 diabetes usually develops slowly and insidiously in children.

Symptoms

Some children or adolescents with type 2 diabetes may show no symptoms at all. In others, symptoms may be similar to those of type 1 diabetes. Sometime symptoms may include weight loss, blurred vision, frequent infections, and slow healing of wounds or sores. Some may present with vaginal or penile candidiasis. Extreme elevation of blood glucose levels can lead to DKA as a presenting feature. Because symptoms are varied, it is important for healthcare providers to identify and test those who are at high risk for the disease.⁴²

Signs of diabetes

Physical signs of insulin resistance include acanthosis nigricans, where the skin around the neck or in the armpits appears dark and thick, and feels velvety. It is present in up to 50–90% of children with type 2 diabetes. It is recognised more frequently in darker-skinned obese

individuals. Girls can have polycystic ovary syndrome with infrequent or absent periods, excess hair and/or acne. Lipid disorders and hypertension also occur more frequently in children with type 2 diabetes.⁴³

Diabetes risk factors and testing criteria

Current diabetes risk factors and testing criteria in Table 3 may help identify type 2 diabetes in children before the onset of complications.

Co-morbidities

Children with type 2 diabetes are also at risk for the long-term complications of diabetes and the co-morbidities associated with insulin resistance (lipid abnormalities and hypertension).

Management

The American Academy of Pediatrics has, very recently, published management guidelines on how to treat children and adolescents with type 2 diabetes.⁴⁴ The ideal goal of treatment is normalisation of blood glucose values and HbA1c.⁴² Therefore, it may be reasonable to use the values in Table 2 (for children with type 1) as a guide. All aspects of the regimen need to be individualised.

The cornerstone of diabetes management for children with type 2 diabetes is healthy eating with portion control, and increased physical activity.⁴⁵ If this is not sufficient to normalise blood glucose levels, glucose-lowering medication and/or insulin therapy are used as well.^{42,44} Many drugs are available for individuals with type 2 diabetes, although only metformin and insulin are currently licensed for use in patients under 18 years old.⁴² Advantages of oral agents include potentially greater compliance and convenience for the patient. Clinical features suggesting initial treatment with insulin include dehydration, presence of ketosis, and acidosis.

Other types of diabetes

In a small proportion of cases, diabetes has a simple inheritance pattern, suggesting causation by a single gene (monogenic diabetes), and clinical manifestations depend on the gene involved. In some cases, diabetes is secondary to a particular disease entity or a particular drug.² Rare monogenic forms of diabetes (neonatal diabetes or maturity-onset diabetes of the young) that occur in less than 5% of children are due to one of six gene defects that result in faulty insulin secretion.³³ These are discussed in detail below.

Maturity-onset diabetes of the young (MODY)

Maturity-onset diabetes of the young (MODY) is a group of diseases characterised by inherited young-onset diabetes (usually in adolescence or early adulthood) from a single gene mutation.⁴⁶ It is an autosomal dominant condition due to a defect in insulin secretion. About six genes are involved (MODY 1 to MODY 6).⁴⁷ MODY

patients are usually not obese and are not insulin resistant. The severity of the diabetes symptoms associated with MODY varies depending on the type of MODY diagnosed. MODY 2 appears to be the mildest form of the disease, often only causing mild hyperglycaemia and impaired glucose tolerance.⁴⁷ MODY 1 may require treatment with insulin, much like type 1 diabetes. Family members of people with MODY are at greatly increased risk for the condition.⁴⁶

MODY is often misdiagnosed initially as the more common type 1 or type 2 syndromes, but diagnosis should be considered in any of the following circumstances:³³

- Children with a strong family history of diabetes but without typical features of type 2 diabetes (non-obese, low-risk ethnic group).
- Children with mild fasting hyperglycaemia (i.e. 5.5–8.2 mmol/l; or 100–150 mg/dl), especially if young and non-obese.
- Children with diabetes but with negative auto-antibodies and without signs of obesity or insulin resistance.

Neonatal diabetes

This is a rare form of monogenic diabetes usually diagnosed within the first six months of life. Onset of diabetes in infancy should raise the possibility of neonatal diabetes. It is due to mutations in the genes encoding the adenosine triphosphate-sensitive potassium channel of the β cell (*KCNJ11*, encoding the Kir6.2 subunit, and *ABCC8*, encoding the SUR1 subunit) or a mutation in the insulin gene.⁴⁸ It is rare, estimated at 1:400 000 live births, and it can be transient or permanent.⁴⁹ In approximately half the cases it is transient (TNDM) and insulin requirements drop to zero by a few weeks or months of age. In permanent neonatal diabetes, problems tend to persist, requiring lifelong treatment usually with sulphonylureas.⁵⁰

Treatment varies: some children respond to diet therapy, exercise, and/or oral anti-diabetes medications that stimulate endogenous insulin secretion through binding to the sulphonylurea receptor (SUR1). However, in some instances long-term insulin is required for therapy.⁴⁹

Secondary diabetes

Secondary diabetes can occur in children with other diseases such as pancreatic diseases, Cushing's disease, cystic fibrosis, etc., or those using drugs such as glucocorticoids. These causes may account for 1–5% of all diagnosed cases of diabetes.²

Conclusion

Diabetes is the common end-point of a variety of disorders of insulin production and/or insulin action resulting in hyperglycaemia. It results from inadequate insulin secretion, which can be absolute or relative to increased requirements because of the defects of insulin action. Diabetes typically presents with increased urination, increased thirst, fatigue, and weight loss, although children and adolescents with

type 2 diabetes may be asymptomatic. It may also present with acute metabolic decompensation, with hyperosmolar dehydration and/or ketoacidosis. There is no single regimen to manage diabetes that fits all children. Blood glucose targets, frequency of blood glucose testing, type, dose and frequency of insulin, use of insulin injections with a syringe or a pen or pump, use of oral glucose-lowering medication, and details of nutrition management all may vary among individuals. The family and diabetes care team determine the regimen that best suits each child's individual characteristics and circumstances.

Author declaration

Competing interests: none.

References

1. World Health Organization. *Definition and Diagnosis of Diabetes Mellitus and Intermediate Hyperglycaemia: Report of a WHO/IDF Consultation*. Geneva, Switzerland: World Health Organization, 2006.
2. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2014; 37 (Suppl. 1): S81–90.
3. Josephine HO, Christopher TF, Daniele P, et al. Type 1 diabetes mellitus in children and adolescents: Part 1, overview and diagnosis. *Consultant* 360 2010; 9: 55–9.
4. Thomas R. Type 2 diabetes mellitus in children and adolescents. *World J Diabetes* 2013; 4: 270–81.
5. Stanley SS, Solomon E, Barbara EC, et al. The time is right for a new classification system for diabetes: rationale and implications of the β cell-centric classification schema. *Diabetes Care* 2016; 39: 179–86.
6. *International Insulin Foundation Fact Sheet on Diabetes in Sub-Saharan Africa*. London, International Insulin Foundation, 2005.
7. Craig ME, Jefferies C, Dabelea D, et al. ISPAD Clinical Practice Consensus Guidelines 2014. Definition, epidemiology, and classification of diabetes in children and adolescents. *Pediatric Diabetes* 2014; 15 (Suppl. 20): 4–17.
8. International Diabetes Foundation (IDF). *Diabetes Atlas*. 6th edn. Brussels, Belgium: IDF, 2013.
9. Ilonen J, Reijonen H, Green A. Geographical differences within Finland in the frequency of HLA-DQ genotypes associated with type 1 diabetes susceptibility. *Eur J Immunogenet* 2000; 27: 225–30.
10. Kukko M, Virtanen SM, Toivonen A. Geographical variation in risk HLA-DQB1 genotypes for type 1 diabetes and signs of beta-cell autoimmunity in a high-incidence country. *Diabetes Care* 2004; 27: 676–81.
11. Tajima N, Morimoto A. Epidemiology of childhood diabetes mellitus in Japan. *Pediatr Endocrinol Rev* 2012; 10 (Suppl. 1): 44–50.
12. Elamin A, Omer MI, Hofvander Y, et al. Prevalence of IDDM in school children in Khartoum, Sudan. *Diabetes Care* 1989; 12: 430–2.
13. Harjutsalo V, Sund R, Knip M, et al. Incidence of type 1 diabetes in Finland. *JAMA* 2013; 310: 427–8.
14. Lin WH, Wang MC, Wang WM. Incidence of and mortality from type 1 diabetes in Taiwan from 1999 through 2010: a nationwide cohort study. *PLoS One* 2014; 9: e86172.
15. Patterson CC, Dahlquist GG, Gyurus E, et al. Incidence trends for childhood type 1 diabetes in Europe during 1989–2003 and predicted new cases 2005–20: a multicentre prospective registration study. *Lancet* 2009; 373: 2027–33.
16. Gyurus EK, Patterson C, Soltesz G. Twenty-one years of prospective incidence of childhood type 1 diabetes in Hungary – the rising trend continues (or peaks and highlands?). *Pediatr Diabetes* 2012; 13: 21–5.
17. Derraik JG, Reed PW, Jefferies C, et al. Increasing incidence and age at diagnosis among children with type 1 diabetes mellitus over a 20-year period in Auckland (New Zealand). *PLoS One* 2012; 7: e32640.
18. Zeitler P, Fu J, Tandon N. Type 2 diabetes in the child and adolescent. *Pediatr Diabetes* 2014; 15 (Suppl. 20): 26–46.
19. Arslanian S. Type 2 diabetes in children: clinical aspects and risk factors. *Horm Res* 2002; 57 (Suppl 1): 19–28.

20. Rodriguez BL, Fujimoto WY, Mayer-Davis EJ, et al. Prevalence of cardiovascular disease risk factors in U.S. children and adolescents with diabetes: the SEARCH for diabetes in youth study. *Diabetes Care* 2006; 29: 1891–6.
21. Reinehr T. Clinical presentation of type 2 diabetes mellitus in children and adolescents. *Int J Obes* 2005; 29 (Suppl 2): 105–10.
22. Awa WL, Boehm BO, Rosinger S, et al. HLA-typing, clinical, and immunological characterization of youth with type 2 diabetes mellitus phenotype from the German/Austrian DPV database. *Pediat Diabetes* 2013; 14: 562–74.
23. Schober E, Waldhoer T, Rami B, et al. Incidence and time trend of type 1 and type 2 diabetes in Austrian children 1999–2007. *J Pediatr* 2009; 155: 190–3.
24. Drake AJ, Smith A, Betts PR, et al. Type 2 diabetes in obese white children. *Arch Dis Child* 2002; 86: 207–8.
25. American Diabetes Association. Type 2 diabetes in children and adolescents. *Diabetes Care* 2000; 23: 381–9.
26. Skordis N, Efsthathiou E, Kyriakides TC. Epidemiology of type 1 diabetes mellitus in Cyprus: rising incidence at the dawn of the 21st century. *Hormones (Athens)* 2012; 11: 86–93.
27. Weets I, Kaufman L, van der Auwera B. Seasonality in clinical onset of type 1 diabetes in Belgian patients above the age of 10 is restricted to HLA-DQ2/DQ8-negative males, which explains the male to female excess in incidence. *Diabetologia* 2004; 47: 614–21.
28. Wandell PE, Carlsson AC. Time trends and gender differences in incidence and prevalence of type 1 diabetes in Sweden. *Curr Diabetes Rev* 2013; 9: 342–9.
29. Islam ST, Abraham A, Donaghue KC. Plateau of adiposity in Australian children diagnosed with type 1 diabetes: a 20-year study. *Diabet Med* 2014; 31: 686–90.
30. Couper JJ, Haller MJ, Ziegler A-G, et al. ISPAD Clinical Practice Consensus Guidelines 2014. Phases of type 1 diabetes in children and adolescents. *Pediat Diabetes* 2014; 15 (Suppl. 20): 18–25.
31. Reddy Y, Ganie Y, Pillay K. Characteristics of children presenting with newly diagnosed type 1 diabetes. *South Afr J Child Health* 2013; 7: 46–8.
32. Donaghue KC, Wadwa RP, Dimeglio LA, et al. ISPAD Clinical Practice Consensus Guidelines 2014. Microvascular and macrovascular complications in children and adolescents. *Pediatric Diabetes* 2014; 15 (Suppl. 20): 257–69.
33. American Diabetes Association. Standards of medical care in diabetes – 2011. *Diabetes Care* 2011; 34 (Suppl 1): 11–61.
34. Danne T, Bangstad HJ, Deeb L, et al. Insulin treatment in children and adolescents with diabetes. *Pediat Diabetes* 2014; 15 (Suppl. 20): 115–34.
35. American Diabetes Association. Children and Adolescents. *Diabetes Care* 2016; 39 (Suppl. 1): S86–93.
36. Han JC, Lawlor DA, Kimm SY. Childhood obesity. *Lancet* 2010; 375: 1737–48.
37. Kiess W, Böttner A, Raile K, et al. Type 2 diabetes mellitus in children and adolescents: a review from a European perspective. *Horm Res* 2003; 59 (Suppl 1): 77–84.
38. Florez JC. Clinical review: the genetics of type 2 diabetes: a realistic appraisal in 2008. *J Clin Endocrinol Metab* 2008; 93: 4633–42.
39. Centers for Disease Control and Prevention. *National Diabetes Fact Sheet: general information and national estimates on diabetes in the United States, 2011*. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention; 2011.
40. Kitawa T, Odawa M, Urakami T. Increased incidence of non-insulin dependent diabetes mellitus among Japanese school children correlates with an increased intake of animal protein and fat. *Clin Pediatr* 1998; 37: 111–5.
41. American Diabetes Association. Type 2 diabetes in children and adolescents. *Pediatrics* 2000; 105: 671–80.
42. Rosenbloom AL, Silverstein JH, Amemiya S, et al. ISPAD Clinical Practice Consensus Guidelines 2006–2007. Type 2 diabetes mellitus in the child and adolescent. *Pediat Diabetes* 2008; 9: 512–26.
43. Ogden CL, Carroll MD, Curtin LR, et al. Prevalence of high body mass index in US children and adolescents, 2007–2008. *JAMA* 2010; 303: 242–9.
44. Springer SC, Silverstein J, Copeland K, et al. Management of type 2 diabetes mellitus in children and adolescents. *Pediatrics* 2013; 131: 648–64.
45. Reinehr T. Lifestyle intervention in childhood obesity: changes and challenges. *Nat Rev Endocrinol* 2013; 9: 607–14.
46. Fajans SS, Bell GI. MODY: history, genetics, pathophysiology, and clinical decision-making. *Diabetes Care* 2011; 34: 1878–84.
47. Fajans SS, Bell GI, Polonsky KS. Molecular mechanisms and clinical pathophysiology of maturity-onset diabetes of the young. *N Engl J Med* 2001; 345: 971–80.
48. Gloyn AL, Weedon MN, Owen KR. Large-scale association studies of variants in genes encoding the pancreatic beta-cell KATP channel subunits Kir6.2 (KCNJ11) and SUR1 (ABCC8) confirm that the KCNJ11 E23K variant is associated with type 2 diabetes. *Diabetes* 2003; 52: 568–572.
49. von Muhlendahl KE, Herkenhoff H. Long-term course of neonatal diabetes. *N Engl J Med* 1995; 333: 704–8.
50. Sagen JV, Reader H, Hathout E. Permanent neonatal diabetes due to mutations in KCNJ11 encoding Kir6.2: patient characteristics and initial response to sulfonylurea therapy. *Diabetes* 2004; 53: 2713–8.

Subscribe to The African Journal of Diabetes Medicine

The journal is available for a flat-rate annual subscription of £50 (US\$85) including airmail postage to anywhere in the world.

For practicing African health professionals the cost is £30 (US\$50).

Please email editor@fsg.co.uk for further information.



www.africanjournalofdiabetesmedicine.com

Physical disability and functional impairment resulting from type 2 diabetes in sub-Saharan Africa: a systematic review

D Ganu, N Fletcher, and N K Caleb

Abstract

Sub-Saharan Africa, like the rest of the world, is experiencing an increasing prevalence of type 2 diabetes alongside other non-communicable diseases. All kinds of type 2 diabetes complications – such as retinopathy, nephropathy, neuropathy, and cardiac complications – are common in sub-Saharan Africa and the prevalence and burden of type 2 diabetes are projected to rise rapidly. Obesity is one of the most potent risk factors for type 2 diabetes. The rate of diabetes-related morbidity and mortality in this region could grow substantially. Forceful actions and positive responses from well-informed governments are urgently needed to control the incidence of type 2 diabetes in sub-Saharan Africa. This aim of this article is to review the prevalence and magnitude of the risk of physical disability and functional impairment originating from type 2 diabetes in sub-Saharan Africa.

Introduction

The prevalence of diabetes is increasing globally. The sub-Saharan Africa region, like the rest of the world, is experiencing an increasing prevalence of this condition alongside other non-communicable diseases (NCDs). In 2010 over 12.1 million people were estimated to be living with type 2 diabetes in Africa,¹ and this is projected to increase to 23.9 million by 2030.² The worrying trend is that type 2 diabetes is the most common form of diabetes, resulting from increases in life expectancy, obesity, changes in dietary and nutritional habits, and sedentary lifestyles. The risk factors for diabetes vary, but the major risk factors in sub-Saharan Africa are similar to those in other parts of the world. The rising prevalence of type 2 diabetes is often ascribed to changes in lifestyle and urbanisation; with the data now showing that the strongest and most consistent risk factors are

obesity and weight gain.³ It has been reported that chronic complications of diabetes are rarely seen in sub-Saharan Africa.⁴ This is because of the high mortality rate leading to low mean disease duration in the majority of diabetic individuals. Complications such as retinopathy, neuropathy, cardiovascular disease, nephropathy, and microalbuminuria have all been reported in sub-Saharan Africa.⁵⁻⁸ The World Health Organization (WHO) projects that NCDs, such as type 2 diabetes will overtake infectious, maternal, perinatal, and nutritional diseases as the leading cause of mortality on the African continent by 2030.⁹ During the year 2014, the International Diabetes Federation (IDF) reported that people living with diabetes worldwide were 387 million with a prevalence of 8.3%.¹⁰ Out of the total number of people living with diabetes, 77% were living in low- and middle-income countries and 50% of these died under 60 years of age. In the African region, 25 million people were living with diabetes in the year 2014 with an annual prevalence of 5.1%. Africa has the highest percentage of undiagnosed people living with diabetes, who are at a higher risk of developing harmful and costly complications. Diabetes affects people in both urban and rural settings worldwide, with 64% of cases in urban areas and 36% in rural areas.⁶ The annual prevalence of type 2 diabetes in sub-Saharan Africa in 2011 was 4.5%.¹¹ Sub-Saharan Africa is therefore faced with the increasing danger of an overwhelming double burden of disease. The aim of the study was to review the prevalence and magnitude of the risk of physical disability and functional impairment originating from type 2 diabetes in the sub-Saharan Africa region.

Methods

The data search used in this review was limited to studies published after 1995. Combined keywords such as 'type 2 diabetes in sub-Saharan Africa' and 'type 2 diabetes complications', were used to conduct a search on all papers published on type 2 diabetes in sub-Saharan Africa between January 1995 and March 2015. The search was conducted using largely the Medline and Embase bibliographic databases. The Cochrane collaboration database and other sources such as Ebscohost, Jostor, and Emerald were also used. The search was done on articles that provided data on type 2 diabetes prevalence

Daniel Ganu, Adventist University of Africa, Mbagathi, Nairobi, Kenya, PMB 00503 Mbagathi, Nairobi, Kenya; Njororai Fletcher, The University of Texas at Tyler, 3900 University Blvd, Tyler TX 75799, USA; Nyaranga K. Caleb, University of Eastern Africa Baraton, Kenya, PMB 2500, 30100 Eldoret, Kenya. Correspondence to: Daniel Ganu, Adventist University of Africa, Mbagathi, Nairobi, Kenya, PMB 00503 Mbagathi, Nairobi-Kenya, Email: ganud@aua.ac.ke.

and type 2 diabetes outcomes such as chronic diabetes complications, disabilities, and functional impairment. Grey literature – from sources including the websites of the IDF, Centers for Disease Control and Prevention (USA), the World Bank, and the WHO – were also reviewed. The data obtained were from case control studies, cross-sectional studies, hospital-based clinical studies, and randomised control trials. We defined sub-Saharan Africa as all mainland African countries south of the Sahara including Madagascar.

We established criteria for eligibility before beginning the review of search results. Data were included in the systematic review if they came from studies that fulfilled all of the following:

- Cross-sectional study, case control, hospital-based clinical studies, and randomised control trials
- Reported prevalence of type 2 diabetes, disabilities and functional impairment
- Reported data on impaired glucose tolerance (IGT) and/or impaired fasting glycaemia (IFG)
- Studies published between 1995 and 2015
- Only fully published articles

Reviews, reports, letters, editorials, commentaries, case studies, etc. were excluded from the study. The primary reviewer then performed a preliminary review by title and abstract to remove articles that were clearly not relevant to the study question or did not meet eligibility criteria. Two other reviewers independently reviewed the remaining articles in full text, and they each noted whether the article should be included or excluded, and

if so, the reason for exclusion. If an article had multiple reasons for exclusion, the primary reason was chosen for exclusion in the order in which they were listed in the inclusion and exclusion criteria (Figure 1).

Results

Prevalence

Table 1 summarises type 2 diabetes prevalence in the sub-Saharan Africa region. The prevalence of type 2 diabetes was as low as 0.6% in rural Uganda and as high as 12.2% in urban Nigeria. Type 2 diabetes is the commonly documented diabetes and in most clinics accounts for about 90–95% of all cases of diabetes.²⁰ Studies done in eight countries in sub-Saharan Africa demonstrated that type 2 diabetes and IGT had a higher prevalence rate among urban dwellers than among rural dwellers. Between the years 2000 and 2011, the 1997 ADA and the 1998 WHO criteria were used in nine sub-Saharan Africa diabetes epidemiology studies. These studies examined the prevalence of type 2 diabetes and pre-diabetes in East Africa (Tanzania, Kenya, and Mozambique), West Africa (Cameroon, Nigeria, Ghana, and Guinea), and South Africa. The prevalence of type 2 diabetes and pre-diabetes in urban dwellers compared with rural dwellers was higher, although there was some inconsistency. Some studies reported crude prevalence rates, while others reported age-adjusted prevalence rates.^{21–25}

It is projected that type 2 diabetes, once considered a rare condition in Africa, will increase by 161% in the next 15 years. The number of adults with diabetes is predicted

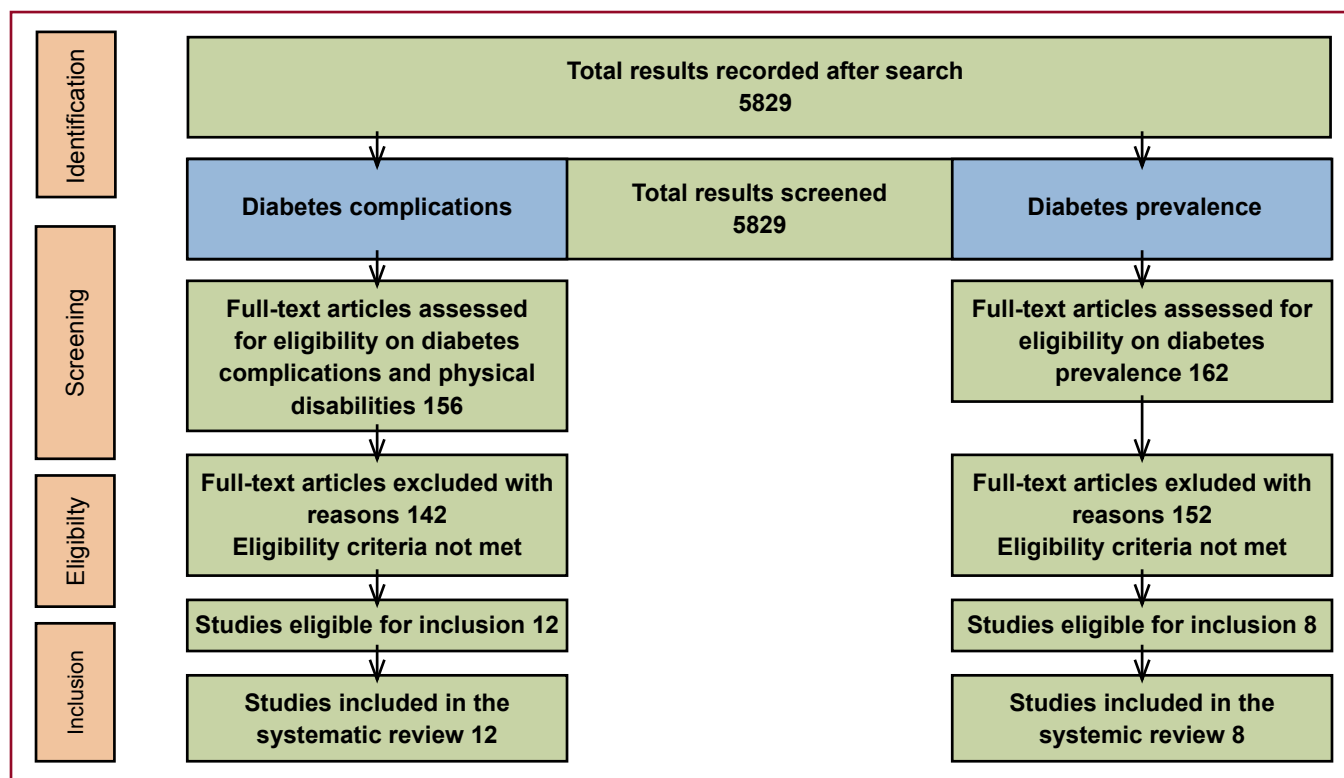


Figure 1. Diagram showing method of data extracted (adapted from Moher et al¹²)

Country	Study type	Number	Year	Prevalence	Other details
Cameroon	Cross-sectional	679	Sobngwi et al ¹³	Urban 2.0% Rural 0.8%	Urban 1.0% Rural 2.8%
Guinea	Cross-sectional	1537	Balde et al ¹⁴	Urban 6.7% Rural 5.3%	Male 13.4% Female 6.1%
Nigeria	Cross-sectional	2000	Oladapo et al ¹⁵	Rural 2.5%	
South Africa	Case-control	1025	Erasmus et al ¹⁶	Rural 3.9%	Male 3.5% Female 3.9%
Tanzania	Cross-sectional	1698	Aspray et al ¹⁷	Urban 5.9% Rural 1.7%	Male 5.7 % Female 1.1%
Uganda	Cross-sectional	6678	Maher et al ¹⁸	Rural 0.6%	
Zimbabwe	Cross-sectional	3081	MOH ¹⁹	Urban 10.0%	

Table 1. Type 2 diabetes prevalence in cross-sectional surveys in sub-Saharan Africa

Complication	Country	Year	Study	Number	Setting	Prevalence
Neuropathy	Kenya Cameroon	Ajala ²⁶ Ndip et al ²⁷	RCT Cross-sectional	88 300	Hospital Hospital	59% 27%
Nephropathy Microalbuminuria	Kenya Nigeria Tanzania	Wanjohi et al ²⁸ Agaba et al ²⁹ Lutale et al ³⁰	Cross-sectional Clinical Cross-sectional	100 65 153	Hospital Hospital Hospital	26% 49% 10%
Cardiac autonomic neuropathy	Nigeria	Odusan et al ³¹	Clinical	108	Hospital	34%
Coronary heart disease	South Africa	Kalk et al ³²	Clinical	744	Hospital	White 23%, Black 4%
Retinopathy	Nigeria Kenya South Africa Kenya South Africa	Omolase et al ³³ Mwendwa et al ³⁴ Read & Cook ³⁵ Mwale et al ³⁶ Pirie et al ³⁷	Cross-sectional Cross-sectional Clinical Cross-sectional Cross-sectional	100 100 248 96 292	Hospital Hospital Hospital Hospital Hospital	15% 7% 32% 22% 39%

RCT: randomised controlled trial

Table 2. Type 2 diabetes complications in sub-Saharan Africa (all studies were hospital-based)

to increase annually by 33000 per year in Tanzania, 48000 per year in Kenya, 21000 per year in Malawi, and 36000 per year in the Democratic Republic of Congo.¹¹

Complications

The proportions of patients with type 2 diabetes complications in sub-saharan Africa ranged from 7% to 32% for retinopathy, 27% to 59% for neuropathy, 10% to 49% for micro albuminuria, and 4 to 34% for cardiac complications (Table 2). Diabetes is also likely to increase the risk of several important infections in the region, including tu-

berculosis, pneumonia, and sepsis.

Discussion

This review shows that type 2 diabetes is a common health problem in the sub-Saharan Africa region. There were variations in type 2 diabetes prevalence between different countries in sub-Saharan Africa. Almost all the studies that distinguished between urban and rural areas, observed a higher type 2 diabetes prevalence in urban areas. All types of complications – such as retinopathy, nephropathy, neuropathy, and cardiac complications – are common in sub-Saharan Africa, and the prevalence and burden of type 2 diabetes are rising rapidly. Obesity is the most potent risk factor for type 2 diabetes and underlies the current global spread of the condition and

its complications.³⁸

In type 2 diabetes there may be insulin resistance and/or abnormal insulin secretion; either may predominate, but both are usually present. In sub-Saharan Africa, type 2 diabetes is the most common type of diabetes and can remain asymptomatic for many years. Its diagnosis is often made from connected complications, or incidentally through an abnormal blood or urine glucose test. Beatriz et al³⁹ asserted that more

than three-quarters of deaths due to diabetes in 2013 in sub-Saharan Africa were in people under the age of 60. During this same year of 2013, over 20 million people were living with diabetes, a prevalence of 4.9%, but over the next two decades the number of people with diabetes is expected to double, threatening many of the development gains Africa has achieved.³⁹

Retinopathy

Visual loss from diabetic retinopathy is largely preventable. A systematic review of diabetes in sub-Saharan Af-

rica between 1999 and 2011 reported that the prevalence of diabetes retinopathy varied from 7% to 63%.⁴⁰ Pirie et al³⁷ found in a hospital-based cross-sectional study that retinopathy developed in 39% of the participants in South Africa. Moreover, about a quarter of newly diagnosed type 2 diabetes patients present with retinopathy, and severe retinopathy may represent 15% of all cases.⁴¹ The major risk factors for the development of diabetic retinopathy include disease duration, degree of hyperglycaemia, hypertension, dyslipidaemia, and genetic factors.⁴² Also, Sidebe⁴³ reported that more than half of patients with type 2 diabetes had retinopathy, which accounted for 32% of all eye complications. Diabetes in sub-Saharan Africa greatly increases the risk of serious, costly complications.⁴⁴

Neuropathy

In a prospective longitudinal community-based study in Australia, Bruce et al⁴⁵ found that 28% of subjects had developed new mobility impairment and 18% had developed new Activities of Daily Living (ADLs) disability. It was also found that peripheral neuropathy was increased by 40%, stroke history 123%, and arthritis 82%. Evaluation of the prevalence of neuropathy relating to diabetes varies widely depending on diagnostic methodology. Macrovascular complications of diabetes are considered rare in Africa despite a high prevalence of hypertension. Abbas et al found that lower-extremity amputation varied from 1.5% to 7.0%, and about 12% of all hospitalised diabetic patients had foot ulceration.⁸ Also, a high proportion of patients had lower-limb arterial disease that contributed to the development of diabetic foot lesions. It is common to see patients with diabetic foot ulcers as the presenting complaint of diabetes. Data from Tanzania have shown that the vast majority (over 80%) of ulcers are neuropathic in origin and are not associated with peripheral vascular disease.⁸

Nephropathy

Diabetic nephropathy is the leading cause of end-stage renal disease worldwide.⁴⁶ Additionally, in Africa it is probably the third most common cause of chronic kidney disease after hypertension and glomerulonephritis. Nephropathy also accounts for a third of all patients requiring renal replacement therapies, which are not widely available in Africa due to their high cost and lack of expertise.⁴⁷ Various epidemiological and cross-sectional studies have reported marked variation in the prevalence of microalbuminuria. Cross-sectional and longitudinal studies have identified factors associated with a high risk of nephropathy such as elevated blood pressure and glycosylated haemoglobin, dyslipidaemia, smoking, advanced age, and insulin resistance.^{48–50} In type 2 diabetes patients, 20–40% of those with microalbuminuria progress to overt nephropathy and 20 years later, approximately 20% develop end-stage renal failure.⁵¹ The progression of diabetic nephropathy from the appearance of clinical pro-

teinuria to end-stage renal failure is usually irreversible.

Cardiovascular complications

Cardiovascular disease is a major cause of death and disability in people with diabetes, accounting for 44% of deaths in people with type 1 diabetes and 52% of deaths in people with type 2 diabetes worldwide in 2001.⁵² Macrovascular complications of diabetes are considered rare in Africa despite a high prevalence of hypertension. Cardiovascular disease is one of the major causes of mortality and morbidity in modern societies, and is set to overtake infectious diseases in the developing world as the most common cause of death. The increasing prevalence of major and emerging cardiovascular risk factors accounts for the growing burden of cardiovascular disease in the world. Diabetes in all its forms is one of the main risk factors. About two-thirds of diabetic patients will die as a result of cardiovascular complications, and many patients treated in cardiovascular intensive care units have diabetes. Approximately 15% of patients with stroke in sub-Saharan Africa have diabetes, and up to 5% of diabetic patients present with cerebrovascular accidents at diagnosis. Coronary heart disease affects 5–8% of diabetic patients in sub-Saharan Africa.⁵³ Nevertheless, although microvascular complications of diabetes are highly prevalent in sub-Saharan Africa, and may occur early on in the course of disease, macrovascular disease remains relatively uncommon.

In conclusion, diabetes and its complications are a major health burden in sub-Saharan Africa. Type 2 diabetes is on the rise in both rural and urban settings, bringing with it the risk of complications. Obesity is the most potent risk factor for type 2 diabetes, probably accounting for 80–85% of the overall risk of developing type 2 diabetes, and underlies the current global spread of the condition and its complications. The rate of undiagnosed diabetes is also high in most countries of sub-Saharan Africa and individuals who are unaware they have the disorder are at risk of developing chronic complications. Therefore, diabetes-related morbidity and mortality in this region could grow substantially. Aggressive action and positive responses from well-informed governments are urgently needed to curb the rise of diabetes in sub-Saharan Africa.

Author declaration

Competing interests: none.

References

1. WHO. *The Global Burden of Disease: 2004 Update*. Geneva: World Health Organization, 2004.
2. Twei VC, Maiyoh GK, Ha CE. Type 2 diabetes mellitus and obesity in sub-Saharan Africa. *Diabetes Metab Res Rev* 2010; 26: 433–45.
3. Haffner SM. Epidemiology of type 2 diabetes: risk factors. *Diabetes Care* 1998; 21 (Suppl 3): C3–6.
4. Idemyor V, Pharm D. Diabetes in sub-Saharan Africa: health care perspectives, challenges, and the economic burden of disease. *J Nat Med Assoc* 2010; 102: 650–3.
5. Levitt NS, Bradshaw D, Zwarenstein MF, et al. Audit of primary diabetes care in Cape Town, South Africa: high prevalence of complications, uncontrolled hyperglycemia, and hypertension. *Diabet Med* 1997; 14: 1073–7.

6. Rotimi C, Daniel H, Zhou J, et al. Prevalence and determinants of diabetic retinopathy and cataracts in West African type 2 diabetes patients. *Ethnicity & Disease* 2003; 13 (suppl. 2): S110–7.
7. Alebiosu CO. A clinical review of diabetic nephropathy in Ogun State University Teaching Hospital, Sagamu. *West Africa Med J* 2003; 22: 152–5.
8. Abbas Z, Lutale J, Morback S. Outcome of hospital admissions for diabetic foot lesions at Muhimbili Medical Centre, Dar es Salaam, Tanzania. *Diabetologia* 2000; 43 (Suppl 1): A246.
9. WHO. *Global Status Report on Non-Communicable Disease*. Geneva: World Health Organization, 2004.
10. International Diabetes Federation (IDF). IDF Diabetes Atlas. 6th Edition Revision 2014. Retrieved on May 4, 2015 from http://www.idf.org/sites/default/files/DA-regional-factsheets-2014_FINAL.pdf
11. Whiting DR, Guariguata L, Weil C, et al. Global estimates of the prevalence of diabetes for 2011 and 2030. *Diabet Res Clin Prac* 2011; 94: 311–21.
12. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *PLoS Med* 2009; 6(6): e1000097.
13. Sobngwi E, Mbanya JC, Unwin NC, et al. Physical activity and its relationship with obesity, hypertension and diabetes in urban and rural Cameroon. *Int J Obesity Met Dis* 2002; 26: 1009–16.
14. Balde NM, Diallo I, Balde MD, et al. Diabetes and impaired fasting glucose in rural and urban populations in Futa Jallon, Guinea: prevalence and associated risk factors. *Diabetes Metab* 2007; 33: 114–20.
15. Oladapo OO, Salako L, Sodiq O, et al. A prevalence of cardiometabolic risk factors among a rural Yoruba southwestern Nigerian population: a population-based survey. *Cardiovasc J S Afr* 2010; 21: 26–31.
16. Erasmus RT, Fakeye T, Olukoga O, et al. Prevalence of diabetes mellitus in a Nigerian population. *Trans Roy Soc Trop Med Hyg* 1989; 83: 417–8.
17. Aspray TJ, Mugusi F, Rashid S, et al. Rural and urban differences in diabetes prevalence in Tanzania: the role of obesity, physical inactivity and urban living. *Trans Roy Soc Trop Med Hyg* 2000; 94: 637–44.
18. Maher D. Distribution of hyperglycemia and related cardiovascular disease risk factors in low-income countries: a cross-sectional population-based survey in rural Uganda. *Int J Epidemiol* 2011; 40: 160–71.
19. MOH. *National Survey: Zimbabwe Non-Communicable Disease Risk Factors (ZiNCoDs)*. Preliminary Report. Zimbabwe: Ministry of Health and Child Welfare, 2005.
20. Anthonia OO, Chukwuma E. Diabetes mellitus in Nigeria: the past, present and future. *World J Diabetes* 2014; 5: 905–11.
21. Amoah Albert GB, Owusu SK, Adjei S. Diabetes in Ghana: a community based prevalence study in Greater Accra. *Diab Res Clin Prac* 2002; 56: 197–205.
22. Christensen DL, Friis H, Mwanniki DJ, et al. Prevalence of glucose intolerance and associated risk factors in rural and urban populations of different ethnic groups in Kenya. *Diab Res Clin Prac* 2009; 84: 303–10.
23. Motala AA, Esterhuizen T, Gouws E, et al. Diabetes and other disorders of glycaemia in a rural South African community. *Diabetes Care* 2008; 31: 1783–8.
24. Nyenwe EA, Odia OJ, Ihekweaba AE, et al. Type 2 diabetes in adult Nigerians: a study of its prevalence and risk factors in Port Harcourt, Nigeria. *Diab Res Clin Prac* 2003; 62: 177–85.
25. Silva-Matos C, Gomes A, Azevedo A, et al. Diabetes in Mozambique: prevalence, management and healthcare challenges. *Diabetes Metab* 2011; 37: 237–44.
26. Ajala O. Challenges of the new globalization of diabetes: managing type 2 diabetes mellitus at Siaya District Hospital, Kenya, 2013. Retrieved on May 1, 2015 from <http://www.nmfonline.org/file/ge-international-scholar-presentations/2013-Kenya-Osagie-A.pdf>
27. Ndip EA, Tchakonte B, Mbanya JC. A study of the prevalence and risk factors of foot problems in a population of diabetic patients in Cameroon. *Int J Low Extrem Wounds* 2006; 5: 83–8.
28. Wanjohi FW, Otieno FC, Ogola EN, et al. Nephropathy in patients with recently diagnosed type 2 diabetes mellitus in black Africans. *East Afr Med J* 2002; 79: 399–404.
29. Agaba EL, Agaba PA, Puepet FH. Prevalence of microalbuminuria in newly diagnosed type 2 diabetic patients in Jos Nigeria. *Afr J Med Sci* 2004; 1: 19–22.
30. Lutale J, Hrafinkel T, Zulfiqarali A, et al. Microalbuminuria among type 1 and type 2 diabetic patients of African origin in Dar es Salaam, Tanzania. *BMC Nephrology* 2007; 8: 2–10.
31. Odusan O, Familoni OB, Raimi TH. Correlates of cardiac autonomic neuropathy in Nigerian patients with type 2 diabetes mellitus. *Afr J Med Sci* 2008; 37: 315–20.
32. Kalk WJ, Joffe BI. Differences in coronary heart disease prevalence and risk factors in African and White patients with type 2 diabetes. *Diabet Res Clin Prac* 2007; 77: 107–12.
33. Omolase CO, Adekanle O, Owuoye JF, et al. Diabetic retinopathy in a Nigerian community. *Singapore Med J* 2010; 51: 56–9.
34. Mwendwa FM, Otieno CF, Kayima JK, et al. Risk factor profile and the occurrence of microvascular complications in short-term type 2 diabetes mellitus at Kenyatta National Hospital, Nairobi. *East Afr Med J* 2005; 82: S163–72.
35. Read O, Cook C. Retinopathy in diabetic patients evaluated at a primary care clinic in Cape Town. *South Afr Med J* 2007; 97: 941–944.
36. Mwale C, Karimurio J, Njuguna M. Refractive errors in type 2 diabetic patients. *East Afr Med J* 2007; 84: 259–63.
37. Pirie FJ, Maharaj S, Esterhuizen TM, et al. Retinopathy in subjects with type 2 diabetes at a tertiary diabetes clinic in Durban, South Africa: clinical, biochemical and genetic factors. *J Clin & Translational Endocrinol* 2014; 1: E9–12.
38. Hauner H. Obesity and diabetes. In: Holt RIG, Cockram CS, Flyvbjerg A et al (Eds) *Textbook of Diabetes*, 4th edition. Oxford: Wiley-Blackwell, 2010.
39. Beatriz YJ, Sheree D, Courtney S, et al. Global diabetes score board: tracking progress for action, 2014. Retrieved on May 4, 2015 from <http://www.idf.org/global-diabetes-scorecard/assets/downloads/Scorecard-29-07-14.pdf>.
40. Hall V, Thomsen RW, Henriksen O, et al. Diabetes in sub-Saharan Africa 1999–2100, epidemiology and public health implications: a systematic review. *BMC Public Health* 2011; 11: 564–76.
41. Mbanya JC, Sobngwi E. Diabetes in Africa. Diabetic microvascular and macrovascular disease in Africa. *J Cardiovasc Risk* 2003; 2: 97–102.
42. Ding J, Wong TY. Current epidemiology of diabetic retinopathy and diabetic macular edema. *East Afr Med J* 2007; 84: 259–63.
43. Sidibe EH. Main complications of diabetes mellitus in Africa. *Ann Med Interne (Paris)* 2000; 151: 624–8.
44. De-Graft Aikins A. Healer-shopping in Africa: new evidence from a rural-urban qualitative study of Ghanaian diabetes experiences. *Diab Res Clin Prac* 2005; 62: 177–85.
45. Bruce DG, Davis WA, Davis TM. Longitudinal predictors of reduced mobility and physical disability in patients with type 2 diabetes. *Diabetes Care* 2005; 28: 2441–7.
46. Cordonnier D, Bayle F, Benhamou PY, et al. Future trends of management of renal failure in diabetics. *Kidney Int* 1993; 43: 8–13.
47. Diallo AD, Nochy D, Niamkey E, et al. Etiologic aspects of nephrotic syndrome in black African adults in a hospital setting in Abidjan. *Bull Société Pathologie Exotique* 1997; 90: 342–5.
48. Keller CK, Bergis KH, Fliser D, et al. Renal findings in patients with short-term type 2 diabetes. *J Am Soc Nephrol* 1996; 7: 2627–35.
49. Olivarius NF, Andreassen AH, Keiding N, et al. Epidemiology of renal involvement in newly-diagnosed middle-aged and elderly diabetic patients: cross-sectional data from the population-based study 'Diabetes Care in General Practice,' Denmark. *Diabetologia* 1993; 36: 1007–16.
50. Gall MA, Rossing P, Skott P, et al. Prevalence of micro- and macroalbuminuria, arterial hypertension, retinopathy and large vessel disease in European type 2 (non-insulin-dependent) diabetic patients. *Diabetologia* 1991; 34: 655–61.
51. Parving HH, Gall MA, Skott P, et al. Prevalence and causes of albuminuria in non-insulin-dependent diabetic patients. *Kidney Int* 1992; 41: 758–62.
52. Morrish NJ, Wang SL, Stevens LK, et al. Mortality and causes of death in the WHO multinational study of vascular disease in diabetes. *Diabetologia* 2001; 44 (Suppl. 2): S14–21.
53. Kengne AP, Amoah AG, Mbanya JC. Cardiovascular complications of diabetes mellitus in sub-Saharan Africa. *Circulation* 2005; 112: 3592–601.

Prevalence of diabetes and its associated risk factors in south-western Uganda

K Dickson

Abstract

Diabetes mellitus is a major pandemic disease globally with both high morbidity and mortality and a high health cost, especially in developing countries. Hence there is a need to establish its prevalence and risk factors. This article reports on a group of diabetic patients in Sheema district, south-western Uganda. The records of 701 adult diabetic out-patients were reviewed, as well as a cross-sectional study of 100 in-patients (both diabetic and non-diabetic) at Kitagata Hospital, Sheema District, south-western Uganda. Questionnaires were used for data collection and data analysis was done using the Statistical Package for Social Sciences (SPSS) version 16. The differences in proportion were tested using the Chi-square test, and p value significance was set at $p < 0.05$. The prevalence of diabetes in the hospital was 2.5%. Type 2 diabetes was the most predominant (79%), having an increased prevalence in those >30 years old; women were mostly affected (60%). There was a strong relationship between diabetes type and age ($p < 0.001$) and gender ($p = 0.035$). Risk factors included family history (74%, $p < 0.001$), smoking (48%, $p = 0.002$), hypertension (45%, $p < 0.001$), and alcohol intake (36%, $p = 0.795$). We conclude that diabetes is common in our hospital population, and major risk factors identified include family history, smoking, and hypertension. Everyone above the age of 35 years with a diabetic relative and/or with hypertension should be routinely screened for diabetes.

Introduction

Diabetes mellitus is a major pandemic disease globally with both high morbidity and mortality and a high health cost to individual patients, their families, and countries, especially in the developing world.¹ Type 2 diabetes is on the rise in both adults and young populations with a projection of a 1.5 times rise in 2030 from the 285 million in 2010 in adults above 20 years of age worldwide.² Most (69%) of the increase in type 2 diabetes is anticipated to occur in low-income countries, which will present a great burden to the already constrained health systems of these countries.³ In Uganda, the diabetes population has

drastically increased from an estimated 98 000 patients in 2000 to about 1.5 million in 2010 – from a population of 30 million people.⁴ It should be noted, however, that despite the increase in diabetic burden, interventions are poor and epidemiological data scarce. There is no national non-communicable disease (NCD) survey in Uganda, so information is from a few local surveys.³ Good data, however, are necessary for proper planning. Research has shown that genetic predisposition may be a key risk factor for diabetes, along with the interplay of environmental factors such as diet, sedentary lifestyle and overweight.⁴⁻⁶ This study was therefore planned to establish diabetic frequency and associated risk factors among our population.

Patients and methods

The study was carried out in Kitagata Hospital, a tertiary hospital in Sheema District, south-western Uganda. Ethical approval was sought from Kampala International University Research Committee and permission from the medical superintendent of Kitagata Hospital, as well as consent from the individual participants. The participants were diabetic and non-diabetic patients admitted to the facility from May to October 2014, who were from Sheema District and over 20 years of age.

In addition, 100 in-patients (both diabetic and non-diabetic) were studied in more detail in a randomised cross-sectional design study. They comprised 42 (42%) with diabetes, 41 (41%) without diabetes, and 17 (17%) with uncertain status.

A structured questionnaire with both open and closed questions was administered to the patients, and filled in by the researchers during the interaction. The data obtained were analysed using Epi-Information systems and the Statistical Package for Social Sciences (SPSS) version 16 to generate descriptive statistical information; Chi square tests were used for comparison of data, with a significance set at $p < 0.05$.

Results

During the study period, there were 28 122 patients admitted, of whom 701 had diabetes. This gave a period prevalence rate of 2.5% (25 per 1000 patients). Type 2 diabetes was predominant at 79%, and the most affected age was 31–69 years (77%) (Figure 1). Females were the most affected group (60%) for both type 2 and type 1 diabetes. Further analysis showed that diabetes type was strongly affected by gender ($p = 0.035$) and age ($p < 0.001$).

Kajoba Dickson, Kampala International University
(Western Campus), PO Box 71 Bushenyi, Uganda.
Correspondence to: Kajoba Dickson. Email
kajobadickson@yahoo.com

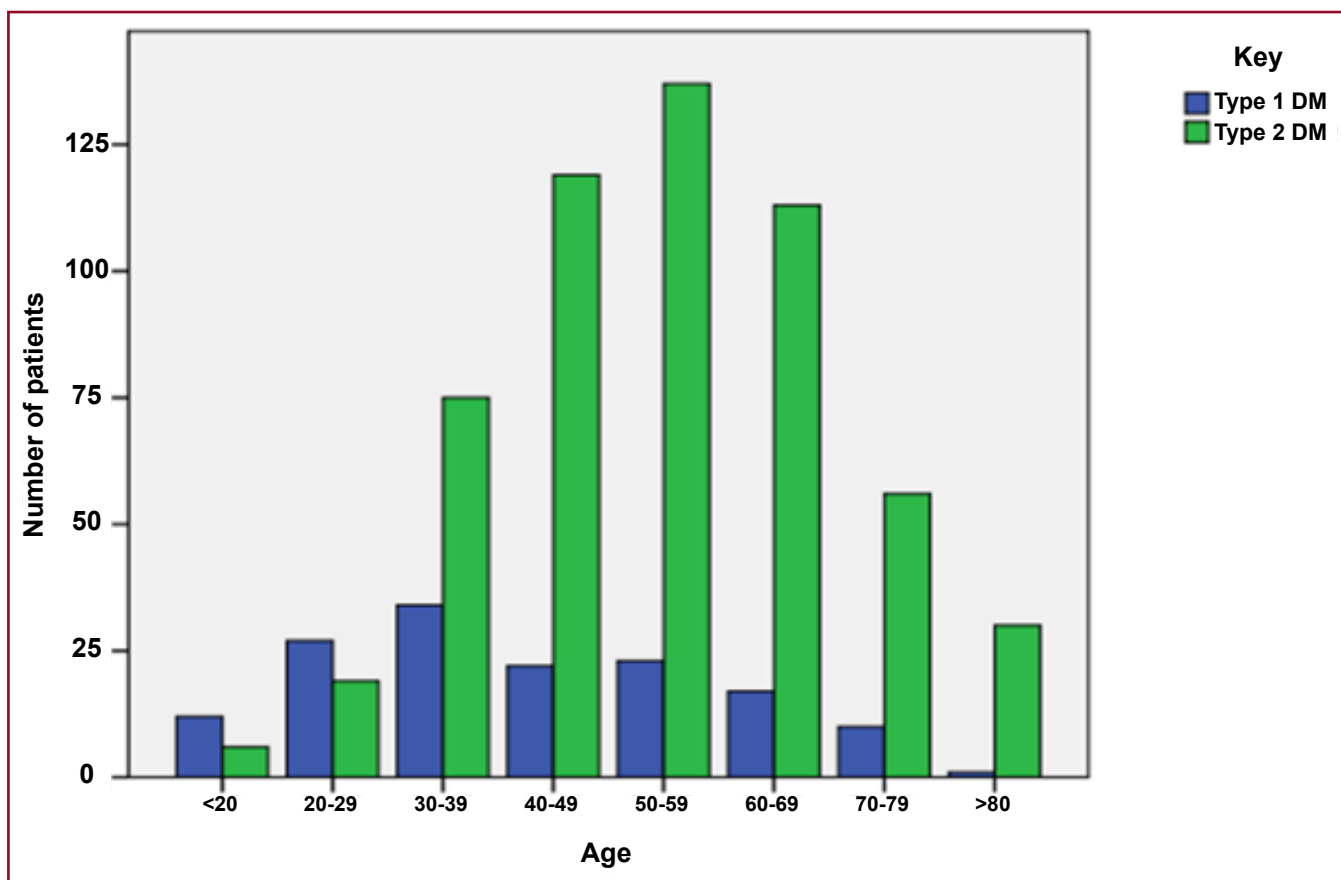


Figure 1. Frequency of diabetes by age among adult patients attending Kitagata Hospital in Sheema District, Uganda; between May and October 2014

In the cross-sectional study, 6% of those who smoked had diabetes ($p=0.002$), and 83% of those with hypertension also had diabetes ($p<0.001$). Of those who drank alcohol, 47% had diabetes, which was not statistically significant ($p=0.795$). Family history was positively associated with diabetes – 60% of those with a diabetic relative had the disease themselves ($p<0.001$). With regard to risk factors for diabetes (defined as smoking, hypertension, and alcohol consumption), of those who were aware of their associations, 32% had diabetes, which was statistically significant ($p<0.001$).

Discussion

The prevalence of diabetes in the hospital in our study was 2.5%, which is lower than the estimated prevalence in Africa of 4.9% in 2013,⁷ and the 5% estimated for Uganda in 2010.⁴ However, this figure is higher than the prevalence of 1% reported in rural Uganda in 2013.⁸ Type 2 diabetes constituted 79% of the cases in our study, probably related to patients' lifestyles, particularly those who are obese or overweight.^{5,9} It should be emphasised that our study assessed hospital prevalence, and is therefore not directly comparable with community prevalence studies.

Smoking was associated with diabetes ($p=0.002$), and this risk may increase with the amount smoked by causing oxidative and inflammatory stress.¹⁰ Heredity

is a key risk factor for diabetes with a 60% contribution, and this agrees with other research concerning the role of heredity in diabetes.^{5,11} Hypertension commonly co-exists with diabetes and vice versa. This is evidenced by the fact that 50% of diabetic patients in India have hypertension, and this may herald the onset of diabetes.⁸

In our study, 32% were alcohol users, though there was no statistical relationship ($p=0.795$) between alcohol use and diabetes. Knowledge of more than three risk factors for diabetes was associated with having diabetes ($p<0.001$).

In conclusion, hospital diabetes prevalence was 2.5% in our study, with type 2 diabetes the most predominant (79%), also having an increased prevalence in those >30 years. The major risk factors were heredity, smoking, and hypertension, and knowledge of these factors was common among diabetic patients. We recommend that all those over 35 years of age with a diabetic relative and/or hypertension should be screened for diabetes, and appropriate education given to all those with diabetes.

Acknowledgements

I am grateful to Professor Lazaro Martinez of Kampala International University (Western Campus); and also the administration of Kitagata Hospital, Sheema District, south-western Uganda. Finally, I thank Pastor Kajoba and family for supporting the study.

Author declaration

Competing interests: none.

References

1. Nwaokoro JC, Okokon BE, Nwaokoro AA. Problems associated with treatment compliance among type 2 diabetic patients at a tertiary health institution in Nigeria. *Afr J Diabet Med* 2014; 22: 24–6.
2. Rahati S, Shahraki M, Arjomand G, et al. Food pattern, lifestyle and diabetes mellitus. *Int J High Risk Behav Addict* 2014; 3: e8725.
3. Mayega RW, Guwatudde D, Makumbi F, et al. Diabetes and pre-diabetes among persons aged 35 to 60 years in eastern Uganda: prevalence and associated factors. *PLoS One* 2013; doi 10.1371.
4. Nyanzi R, Wamala R, Atuhaire KL. Diabetes and quality of life: a Ugandan perspective. *J Diab Res* 2014; doi 10.1155.
5. Azevedo M, Alla S. Diabetes in sub-Saharan Africa: Kenya, Mali, Mozambique, Nigeria, South Africa and Zambia. *Int J Diabetes Dev Count* 2008; 28: 101–8.
6. Systems S, Ave G. *National Diabetes Education Programme Survey of the Public's Knowledge, Attitudes, and Practices Related to Diabetes: 2008* (revised December 2009). National Diabetes Education Programme, National Institutes of Health (NIH), 2009.
7. Ramon M. Prevalence of diabetes in the world. *Health Intelligence*. www.healthintelligence.org. 2013.
8. Mohan V, Seedat YK, Pradeepa R. The rising burden of diabetes and hypertension in south-east Asian and African regions: need for effective strategies for prevention and control in primary healthcare settings. *Int J Hypertension* 2013; 409083. doi: 10.1155/2013/409083.
9. Baalwa J, Byarugaba BB, Kabagambe KE, et al. Prevalence of overweight and obesity in young adults in Uganda. *Afr Hlth Sci* 2010; 10: 367–73.
10. Centers for Disease Control (CDC) Office on Smoking and Health. *Smoking and Diabetes*. CDC 2014.
11. Petit J-M, Bour J-B, Gallard-Jos C. Risk factors for diabetes mellitus and early insulin resistance in chronic hepatitis C. *J Hepatol* 2001; 35: 279–83.

Visit The African Journal of Diabetes Medicine website to view the latest issue and back issues

Volume 23 Number 1

May 2015

AJDM
The African Journal of
Diabetes Medicine



Volume 23 Number 2

November 2015

AJDM
The African Journal of
Diabetes Medicine



Cardiovascular disease in HIV-infected patients:
a focus on diabetes mellitus and hypertension?
Compliance with diabetic retinopathy screening

AJDM
The African Journal of
Diabetes Medicine

INCORPORATING DIABETES INTERNATIONAL

www.africanjournalofdiabetesmedicine.com

A qualitative study of healthcare professionals' perceived trust in and willingness to recommend alternative medicines for the management of diabetes mellitus

M F Mahomoodally, C D Ruhee, and T F M Holmes

Abstract

This small qualitative study, conducted through the University of Mauritius, examined healthcare professionals' engagement with and willingness to recommend alternative therapies (AT) for adjunctive management of diabetes, particularly type 2 diabetes. Fifteen (15) healthcare practitioners were selected to participate, completing a questionnaire regarding their opinions about the appropriateness of AT to support type 2 diabetes patients. The results highlight nutritionists' and dieticians' relative familiarity with AT, for personal use and with clinic patients. However, nurses and medical doctors were often sceptical, unwilling to discuss or recommend AT, and knew little about potential benefits. There appears an emerging need to improve training of Mauritian healthcare professionals regarding AT, to improve their ability to provide up-to-date clinical information to the many diabetic patients in the community who often use AT.

Introduction

The prevalence of diabetes is increasing worldwide, and sub-Saharan Africa including Mauritius is no exception. Recently, 14.2 million people were estimated to be living with diabetes in Africa, projected to increase to 34.2 million by 2040.¹ According to the International Diabetes Federation (IDF), over two-thirds of African people with diabetes remain undiagnosed, representing the highest global percentage of undiagnosed diabetes, placing patients at risk of developing harmful and costly complications.¹

The tropical island Mauritius has an extremely high prevalence of diabetes mortality by global standards, causing an alarming economic burden. Use of alternative therapies (AT) is anchored in local Mauritian culture in a community with moderate ongoing poverty, and persists

as cornerstone therapy for the management of many diseases. Nonetheless, there is a dearth of literature describing healthcare professionals' perceived trust in and willingness to recommend AT to support diabetic patients.

In Mauritius, the majority of diabetics suffer from type 2 diabetes. With its rapid urbanisation and prevalent Asian genetic background, combined with today's sedentary lifestyle and obesity epidemic, Mauritius is at the forefront of this scourge.² Managing diabetes is a primary goal of patients, and many turn to AT to assist with symptom management. Studies show widespread use of AT among diabetic patients, gaining momentum in many countries. Indeed, bioactive components from natural products have become popular therapeutic agents to manage diabetes and related complications.³

Health professionals are in an optimal position to influence AT use among patients. However, it is unclear to what extent the knowledge and attitudes of health providers are useful to guide those with diabetes in relation to AT. As far as could be established, as yet no qualitative studies have been geared toward investigating the views of healthcare professionals with respect to their trust in and willingness to recommend AT to manage diabetes in Mauritius. This qualitative study was designed to gather descriptive data to promote understanding of the perceptions of health professionals regarding recommending AT. It is anticipated that by improving knowledge and familiarity with relevant AT, especially herbal medicines, healthcare professionals may improve their relationships with patients, allowing them to capitalise on ATs' therapeutic actions to manage diabetes symptoms and mitigate associated complications.

Methods

A qualitative research method was adopted to obtain descriptive data that build an understanding of the reasons healthcare professionals are willing to recommend or are uncomfortable recommending AT products. The questionnaire was designed to gather opinions of a particular cohort, within a limited time scale, some of whom would be unreachable using interviews or focus groups

M F Mahomoodally and C D Ruhee, Department of Health Sciences, University of Mauritius, Mauritius and T F M Holmes, School of Social and Political Sciences – Anthropology, University of Melbourne, Australia.
Correspondence to: Dr. M Fawzi Mahomoodally. Email: f.mahomoodally@uom.ac.mu

alone. The questionnaire could be given to respondents at their own convenience, to answer questions out of order, allowing sufficient time to write constructive comments.

Design and content of the questionnaire and research

The 27-item questionnaire focused on topics regarding herbal medicines, functional foods – i.e. foods with medicinal properties – and dietary supplements, these being the most commonly used ATs among diabetic patients in Mauritius. The questionnaire contained five sections, exploring broad topics of interest including personal use of AT, level of education, comfort in discussing AT with patients and families, and attitude regarding AT use. An enclosed short paragraph was intended to familiarise participants with the research topic and trigger discussion, and also described herbal medicines, functional foods, and dietary supplements. Participation was entirely voluntary, and informed written consent was obtained from participants. Data were treated with confidentiality and processed anonymously. Clearance to conduct the research was granted by the Department of Health Sciences, University of Mauritius.

Participants

Representatives of health professions from various clinical settings were recruited using purposive sampling. Registered dietitians, nutritionists, doctors, and nurses were recruited from public hospitals, private clinics, and regional healthcare centres under the auspices of the Ministry of Health and Quality of Life (MoHQL). Selection was based on professional involvement, providing clinical treatment and/or nutritional support and education for people with diabetes, and willingness to participate. The heterogeneity of the sample enabled comparison of different settings, persons, and situations, resulting in a broad, diverse array of data for understanding the research concepts.⁴

Analysis of data

Interviews were transcribed verbatim and content analysed as described elsewhere.^{4,5} Transcribed texts were read several times and relevant content of sentences and paragraphs was identified. After line-by-line analysis of the interview transcripts, meaning units were grouped into themes and sub-themes. These classifications were discussed and validated by the research team in each case, to ensure consistency. The main emergent themes focused on 'Personal use of AT', 'Sources of information', 'Trust in AT', and 'Need for AT'. Sub-themes were categorised as 'Formal learning of AT', 'Willingness to recommend AT without scientific documentation', 'Knowledge of the possible limitations of AT', 'Comfort recommending AT', 'Need for AT and possible barriers encountered', and 'Regulatory body and laws pertaining to AT'.

Results

The sample of 15 healthcare professionals agreed to

participate and willingly completed the questionnaire. Participants comprised two dietitians (13%) recruited from a private clinic, three nutritionists (20%), six doctors (40%) and four nurses (27%). In Mauritius, dietitians have a 4-year training programme, and usually work in clinical settings. Nutritionists train for three years and work in a variety of settings (including, for example, food companies, public health, fitness centres, etc.). Participants were categorised into four age groups, being 21–30, 31–40, 41–60, and over 60 years; and were also listed by the type of organisation they were sourced from – either a private clinic, a public hospital, or MoHQL healthcare centre. Data from five themes and sub-themes identified from participant interviews, of specific relevance for this paper, are summarised in the following sections.

1. Personal use of AT

Nutritionists and dietitians claimed to have used AT. They were comparatively less sceptical about such products, and some regularly included AT in their daily lives, and described ways of using ATs, and their purported health benefits. The most commonly consumed herbal medicines were green tea (*Camellia sinensis*), Ayapana (*Ayapana triplinervis*) leaves, and *Aloe vera*. Among dietary supplements, vitamin and mineral supplements were most commonly mentioned, and among functional foods, yoghurts with probiotics, fortified cereals, and juices were popular.

One nutritionist stated: 'I drink green tea every day before going to bed and at work. I try to convince colleagues and patients to do the same. I have used supplements during my pregnancy and lactating period. As for functional foods, cereals are part of my daily breakfast as well as orange juice. It helps boost my energy in the early morning and helps normalise my blood sugar.' (Nutritionist, age band 31–40 years, public hospital.)

Of six doctors who participated, only one used no AT. Most had used AT primarily as a means to treat wounds, upset stomach, and fevers. They recalled taking herbal medicines in their childhood as used by their parents and grandparents. One doctor commented: 'I have been taking vitamin and mineral supplements during my pregnancy and to cope with gestational diabetes. I do like drinking grapefruit juice every day for my breakfast. I still remember my mother and my grandparents used to make me drink fresh ginger and turmeric in milk when I was suffering from sore throats. The biggest advantage of living in a tropical island is that we get lots of exotic fruits rich in antioxidants. I also like to drink coconut water which is very refreshing.' (Doctor, age band 41–60 years, public hospital.)

Among the nurses, most lacked extensive knowledge about usage of AT. One had never heard of functional foods. From these results, it was obvious that nurses experience difficulty discussing AT, due to limited knowledge of the subject. One nurse recalled: 'My mother and grandmother used to give me decoctions prepared to

normalise blood sugar, with leaves that I don't know, but they were very beneficial and definitely had better taste compared to medicines.' (Nurse, age band 21–30 years, public hospital.)

2. Trust in AT

Nutritionists and dieticians were more supportive of AT use compared with the other healthcare professionals. They mentioned health benefits associated with AT and commented on the substantial research being conducted on such products, for example: 'Yes, its efficacy has been proven in clinical trials. Moreover, substantial research is carried out in this field.' (Nutritionist, age band 21–30 years, MoHQL.)

Both doctors and nurses expressed varied opinions of AT. Some nurses were positive, supporting the use of AT while others were reluctant. One doctor for instance said: 'Only if they are necessary as may help in cases of mild illnesses. ... I mostly advise my patients to take calcium and vitamin D supplements in cases of osteoporosis. Or I guess pregnant women will definitely need folic acid supplements. However it should not be mistaken that you can treat diabetes with only these therapies.' (Doctor, age band 31–40 years, public hospital.)

3. Knowledge of physiological effects of AT in the management of diabetes

Nutritionists and dieticians were proficient in providing nutritional advice and at ease discussing the physiological effects of AT. They understood the potential health benefits provided by such products and mentioned various mechanisms of action, such as insulin-mimicking properties or hypoglycaemic activity. Moreover, they demonstrated an adequate interest and knowledge of products that exhibit anti-diabetic effects, such as bitter melon (*Momordica charantia*), onion (*Allium cepa*), garlic (*Allium sativum*), turmeric (*Cucurbita longa*), mango (*Mangifera indica*), Aloe vera, babbar (*Cassia fistula*), and bel (*Aegle marmelos*). A nutritionist stated: 'Many herbal products obtained from natural products, such as garlic, onion, and aloe vera, are known to lower blood glucose levels as well as cholesterol levels. They block glucose uptake and absorption. Mango is used among Nigerian folk people to lower blood glucose levels. Bitter melon is a well-known anti-diabetic agent in India. Omega-3 fatty acids marketed as tablets and capsules, have been found to assist in lowering blood glucose levels, increasing insulin sensitivity and glucose metabolism. However, it should be accompanied by a balanced lifestyle.' (Nutritionist, age band 31–40 years, MoHQL.)

Doctors were less familiar with the physiological effects of AT for management of diabetes. Two doctors (from public hospitals), believed AT had no physiological effects compared with conventional medicines. Doctors were more sceptical about possible health benefits of AT, and unaware of mechanisms by which AT could help reduce blood glucose. Plant ingredients, bioactive

compounds, and even whole plants that provide anti-diabetic activity were less evidently in use by doctors, and were perceived as complex. On the other hand, nurses also rarely mentioned the physiological effects of AT, due to lack of knowledge and being unaware of associated physiological mechanisms. Most believed AT products could help patients lose weight easily; however, they were occasionally confused regarding precise physiological effects.

4. Knowledge of possible limitations of using AT

Nutritionists and dieticians appeared well informed about possible limitations of AT use. They mentioned various side-effects, unknown dosage which may lead to toxicity, drug-herb interactions, allergies, suspicious health claims, expensive prices, and lack of scientific evidence for some products. One dietician claimed: 'There is usually a lack of dosage instructions to guide patients to avoid toxicity. Moreover, herbal medicines may not entirely be used to treat diabetes. Drug-herb interactions are also possible... Many companies claim to be selling herbal medicines but these may be just marketing strategies to increase sales. It is important to be able to read labels correctly so that patients are not misguided. They should not be used as an alternative to treat diabetes and thus avoid taking their medications.' (Dietician, age band 21–30 years, private clinic.)

The majority of doctors were aware of the limitations of AT, and cited side-effects, safety issues, and the presence of artificial substances or chemicals that are not natural. A private-clinic doctor voiced this opinion: 'I personally do not believe in using herbal medicines only for management of diabetes. Diabetes is poorly controlled in AT users. Patients are fooled to believe herbal medicines can help. Any product labeled as 0% sugar free usually contains aspartame which is related to other health issues.' (Doctor, age band 21–30 years, private clinic.)

Doctors equally stated that companies may mislead consumers with unreliable health claims and distrustful publicity. In addition to doctors, nurses also claimed to have insufficient knowledge about the limitations of AT products. A public health-service doctor said: 'Herbal medicines contain artificial products, not much natural and healthy. They may result in potential side effects and may not be adequate for elderly persons with a fragile immune system. It is better to change lifestyle and consume more healthy foods than these blood glucose-lowering and cholesterol-lowering products. They are just here as marketing traps by companies to convince patients to buy them.' (Doctor, age band 21–30 years, public hospital – MoHQL.)

5. Level of comfort recommending AT, and possible informational barriers encountered

The study findings demonstrated that all the nutritionist and dietician participants were comfortable recommending and discussing AT with patients, for instance: 'Yes, I

am comfortable recommending AT. They are more natural and accessible to patients who report side-effects with conventional medicines. Compared to drugs, AT products have more taste and are appealing to patients. Some of them are cheaper and are known to provide benefits.' (Nutritionist, age band 31–40 years, MoHQL.)

However, doctors as well as nurses were generally reluctant to recommend AT to patients. Doctors and nurses expressed a need to have access to more information, and for patients to seek medical advice before trying AT products: 'Not really. As a doctor, I have no idea about the real physiological effects of these products. If I do recommend them that would imply that I should be responsible to answer to any question and doubt of my patients.' (Doctor, age band > 60 years, private consultation only.)

Discussion

No prior studies were found concerning healthcare professionals' trust in and willingness to recommend AT for the management of diabetes in Mauritius. The three groups of health professional participants showed divergent perceptions regarding AT. Nutritionists and dieticians were generally supportive and had greater knowledge about AT, such as familiarity with information about physiological effects, as well as limitations and safety issues surrounding AT. In contrast, doctors and nurses demonstrated scepticism and distrust toward AT, and unwillingness to recommend AT products. These findings reflect previous investigations, demonstrating that health professionals' attitudes to AT vary according to educational and professional background. Moreover, doctors and nurses in our study expressed curiosity to learn about AT, suggesting their trust would increase if they could receive appropriate information. They clarified that their training was to prescribe conventional drugs, which were unlike AT. A previous study suggests it may be unreasonable to expect doctors and nurses to communicate and counsel patients with respect to use of AT.⁶ These health providers may be unaware of potential clinical benefits of AT.

A significant gap in the ability of doctors and nurses to offer accurate advice to patients regarding AT use was noted. These practitioners were inadequately prepared to address patient queries or recommend AT. Perceived barriers to healthcare providers' use of AT, corroborating with our findings, have been described previously. In one study, health professionals expressed limited knowledge, lack of experience, and less confidence recommending AT to patients, while another study suggested physicians' perceived barriers were due to lack of time, poor knowledge, and sketchy results when dietary advice is given in medical practice.^{6,7}

Doctors and nurses from the present study were less familiar with physiological effects of AT in the management of diabetes than nutritionists and dieticians. Previous studies

report that doctors believe herbal medicines alone cannot manage diabetes successfully.^{6,7} Some were sceptical about herbal medicine, discouraging patients from taking herbal preparations due to limited clinical evidence. Another study notes medical students reported the lowest educational knowledge of AT, and substantially less acceptance of AT than student peers in other health professions.⁸

Results from the present study imply that a need exists for enhanced educational training of healthcare professionals about AT, to aid them in providing adequate guidance to patients, many of whom use ATs. It appears vital that medical doctors receive up-to-date information about AT to increase their knowledge about these products, through access to professional journals, attending relevant conferences or workshops, liaising with AT practitioners, and improving medical student exposure, in order to increase support and awareness of patient use of AT and possible therapeutic benefits of AT products.

In conclusion, there appears to be a need for improved training of medical professionals regarding AT. If provided with updated clinical information pertaining to AT, they would be better placed to provide adequate counselling to many diabetic patients in the community who regularly consume these products.

Acknowledgement

The authors acknowledge the University of Mauritius, private clinics, public hospitals, and MoHQL, for providing participants for this study. There are no potential conflicts of interest to declare.

Author Declaration

Competing interests: none.

References

1. International Diabetes Federation (IDF). 2015 *Diabetes Atlas: Diabetes by Country – Africa*. '4.1 Africa' PDF, available at <http://www.diabetesatlas.org/resources/2015-atlas.html#>.
2. Mauritius Research Council. Workshop Report: Consultative Workshop on the Collaborative Research Programme on Diabetes (CRPD). 2013. At: <http://www.mrc.mu/document2013/DiabetesWReport.pdf>.
3. Mootoosamy A, Mahomoodally MF. Ethnomedicinal application of native remedies used against diabetes and related complications in Mauritius. *J Ethnopharm* 2014; 151: 413–44.
4. Peytremann-Bridevaux I, Lauvergeon S, Mettler D, et al. Diabetes care: opinions, needs and proposed solutions of Swiss patients and healthcare professionals: a qualitative study. *Diab Res & Clin Prac* 2012; 97: 242–50.
5. Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Td* 2004; 24: 105–12.
6. Brown J, Cooper E, Frankton L, et al. Complementary and alternative therapies: survey of knowledge and attitudes of health professionals at a tertiary pediatric/women's care facility. *Compl Ther Clin Prac* 2007; 13: 194–200.
7. Landström E, Sidenvall B, Hursti UK, et al. Health-care professionals' perceived trust in and willingness to recommend functional foods: a qualitative study. *Appetite* 2007; 48: 241–7.
8. Baugniet J, Boon H, Ostbye T. Complementary/alternative medicine: comparing the view of medical students with students in other health care professions. *Fam Med* 2000; 32: 178–84.

Prevalence of hyperglycaemia in children seen at a paediatric emergency unit

U I Umar

Abstract

Hyperglycaemia is known to be of common occurrence in paediatric emergency units, particularly in patients with severe disease. This study aimed to determine its prevalence and describe the disease conditions and clinical features associated with hyperglycaemia among children presenting to an emergency unit. A total of 1000 children aged 1 month to 14 years were enrolled in a cross-sectional study of prevalence of hyperglycaemia in two paediatric emergency units. In all cases, blood glucose (BG) level was determined, as well as clinical information. Hyperglycaemia was defined as blood glucose ≥ 7.8 mmol/l. The BG levels ranged between <0.6 and 27.4 mmol/l (mean \pm standard deviation (SD): 6.5 ± 3.0 mmol/l). Fever was seen in 84%, polyuria and polydipsia in 3%, cough in 33%, vomiting in 35%, and diarrhoea in 33% of patients. Hyperglycaemia was observed in 16.5% of the study children. The mean age of hyperglycaemic patients was 56 ± 48 months. Children older than 6 years had the highest frequency of hyperglycaemia (33%), while infants had the lowest (14%). The only factor significantly associated with hyperglycaemia was a history of fever ($p=0.001$). Study subjects with gastroenteritis had the highest frequency of hyperglycaemia (4.4%), followed by severe malaria with 2.7%, and protein energy malnutrition (PEM) 2.3%. The mortality in hyperglycaemic children was higher than that in children with no hyperglycaemia (22.4% vs 7.5%, $p=0.001$). In conclusion, hyperglycaemia is not uncommon in emergency paediatric admissions, and it occurs more in patients with severe acute diseases. Children with hyperglycaemia should be monitored closely since they are at increased risk of death.

Introduction

Hyperglycaemia is a condition in which an excessive amount of glucose circulates in the blood, and it can occur as a transient or persistent problem.¹ It could be attributable to stress of an illness, impaired glucose tolerance, or diabetes mellitus.^{2,3} However, it has been

documented that a wide variety of illnesses form part of the stressful states that evoke a common metabolic endocrine response leading to stress hyperglycaemia.⁴ The severity of hyperglycaemia is significantly associated with the severity of the illness rather than a particular diagnostic category.⁵⁻⁸

The International Diabetes Federation (IDF) and the International Society for Pediatric and Adolescent Diabetes (ISPAD) define pre-diabetes hyperglycaemia as impaired glucose tolerance (IGT) of $7.8-11.1$ mmol/l or impaired fasting glucose (IFG) of $5.6-6.9$ mmol/l,⁹ although various studies have used different cut-off values to represent hyperglycaemia.^{10,11} The global burden of IGT and diabetes is increasing, and incidental hyperglycaemia is known to be of common occurrence in paediatric emergency units.^{5,12} The prevalence reported from studies varies from as low as 3% to as high as 86%.^{10,13,14}

Prolonged hyperglycaemia in critically ill patients has been shown to be associated with a number of deleterious consequences,¹⁵ contributing to greater risks of morbidity and mortality, even in the absence of pre-existing diabetes.¹⁶⁻¹⁸

Some clinical conditions like fever, respiratory illnesses, and neurological diseases (which are very common in our setting) are found to be associated with a high prevalence of hyperglycaemia in several studies.^{1,2,5,19} The aim of this study, therefore, was to determine the prevalence and describe the disease conditions associated with hyperglycaemia among children presenting to an emergency unit in our environment.

Patients and methods

This study was carried out at the Children's Emergency Units of Aminu Kano Teaching Hospital (AKTH) and Hasiya Bayero Paediatric Hospital in Kano, Nigeria over a nine-month period (July 2014–March 2015). The subjects were consecutively admitted

Age group (months)	Total
≤ 12	203 (20%)
13–23	206 (21%)
24–30	197 (20%)
31–72	224 (22%)
≥ 73	170 (17%)
Total	1000 (100%)

Table 1. Age and sex distribution of study subjects

Dr. Umar Isa Umar, Consultant Paediatrician, Paediatric Endocrinology Unit, Department of Paediatrics, Aminu Kano Teaching Hospital/Bayero University Kano, PMB 3452, Kano State, Nigeria, Postal Code 700001.
Correspondence to: Dr U I Umar.
Email: umarpaed@gmail.com

	Hyperglycaemia		Total		
	Present n (%)	Absent n (%)	Total (n)	χ^2	p-value
Fever					
Yes	123 (15%)	720 (85%)	843	14.206	0.000
No	42 (27%)	115 (73%)	157		
Headache					
Yes	17 (24%)	53 (76%)	70	3.312	0.069
No	148 (16%)	782 (84%)	930		
Convulsion					
Yes	28 (17%)	139 (83%)	167	0.010	0.919
No	137 (16%)	696 (84%)	833		
Cough					
Yes	42 (13%)	288 (87%)	670	5.088	0.024
No	123 (18%)	547 (82%)	330		
Vomiting					
Yes	72 (20%)	283 (78%)	355	5.713	0.017
No	93 (14%)	552 (86%)	645		
Diarrhoea					
Yes	67 (20%)	262 (80%)	329	5.315	0.021
No	98 (15%)	573 (85%)	671		
Abdominal pain					
Yes	17 (20%)	66 (80%)	83	1.042	0.307
No	148 (16%)	769 (84%)	917		
Body swelling					
Yes	10 (21%)	37 (79%)	47	0.817	0.366
No	155 (16%)	798 (84%)	953		
Polyuria					
Yes	7 (23%)	24 (77%)	31	0.859	0.354
No	158 (16%)	811 (84%)	969		
Polydipsia					
Yes	7 (23%)	24 (77%)	31	0.859	0.354
No	158 (16%)	811 (84%)	969		
Weight loss					
Yes	7 (19%)	30 (81%)	963	0.163	0.686
No	158 (16%)	805 (84%)	37		
Total	165 (16%)	835 (84%)	1000		

Table 2. Association between clinical features and presence of hyperglycaemia

children aged between one month and 14 years.

Written informed consent was obtained from the caregivers of all the recruited subjects, and written informed

assent was also sought and obtained from all children old enough to give assent before enrolling them in the study. Ethical clearance was obtained from the Ethical and Research Committee of AKTH, and the Hospital Management Board of Kano State.

Demographic data, time of admission, interval of last meal, duration of illness before admission, presenting complaints, and blood glucose values were obtained. Patients who ingested food or glucose-containing fluids less than two hours prior to presentation, and referred patients who had received any intravenous infusion within the last six hours, were excluded from the study. All the patients had their blood glucose (BG) determined at admission (before any intervention) with a bed-side glucose meter (Accu-Chek Active) using the glucose oxidase method. For quality control, after every 50 testings, a blood sample was sent to the laboratory for BG testing using photometric analysis. The bed-side meter testing was done by the principal investigator and trained assistants. Hyperglycaemia was defined as blood glucose ≥ 7.8 mmol/L.⁹

Data generated were analysed using the statistical programme SPSS version 20. Qualitative variables were expressed in the form of frequencies and percentages. Categorical data were analysed using the Chi-square test. Continuous variables were summarised using means, medians, and standard deviations (SD). A p-value of ≤ 0.05 was considered significant using a 95% confidence interval. Data are expressed as means ± 1 standard deviation (SD), unless otherwise specified.

Results

During the study period, 1000 patients aged 1–168 months (mean of 41 ± 38 months) were studied. There were 558 (66%) males and 442 (44%) females, giving a male to female ratio of 1.3:1.0. Most subjects (627 or 63%) were aged one–six years. Two hundred and three (20%) were infants and 170 (17%) were older than six years (see Table 1).

The BG levels in the study patients ranged between <0.6 and 27.4 mmol/l (mean, 6.5 ± 3.1 mmol/l); 165 (16.5%) had hyperglycaemia. The hyperglycaemic patients consisted of 87 males and 78 females and were aged 2–168 months (mean, 56 ± 48 months). Children over six years old had the highest

frequency of hyperglycaemia (56 or 33%) while infants had the lowest (29 or 14%); this was a significant difference ($p=0.001$).

Factors	β	OR (95% CI)	p-value
Fever			
No	-	1.000	
Yes	0.531	1.700 (1.110–2.605)	0.015
Cough			
No	-	1.000	
Yes	0.303	1.354 (0.912–2.009)	0.133
Vomiting			
No	-	1.000	
Yes	0.184	0.832 (0.526–1.316)	0.832
Diarrhoea			
No	-	1.000	
Yes	0.390	0.677 (0.417–1.099)	0.115
β , coefficient of regression; OR, odds ratio; CI, confidence interval. Group with OR=1.000 represents the reference group			

Table 3. Logistic regression model of factors associated with hyperglycaemia

Table 2 shows the association between clinical features and the presence or absence of hyperglycaemia. Only 31 (3%) had a history of polydipsia and polyuria. The following factors were significantly associated with hyperglycaemia: fever ($p=0.001$), cough ($p=0.024$), vomiting ($p=0.017$), and diarrhoea ($p=0.021$). Most patients had a history of fever (84%), and 75% had a documented fever of $>37.5^{\circ}\text{C}$. The result of multivariate analysis is shown in Table 3, and this showed that only fever (and not cough, vomiting, or diarrhoea) remained significantly associated with hyperglycaemia – odds ratio (OR) 1.700 ($p=0.015$).

Table 4 shows the association between hyperglycaemia and individual diagnostic categories. Hyperglycaemia was most common in patients with gastroenteritis: 44/1000, or 4.4% of the total group. Next most common was malaria at 27/1000 (2.7%), followed by protein-energy malnutrition (PEM) at 23/1000 (2.3%).

The overall mortality rate in hyperglycaemic children was 37/165 (22.4%), and this was higher than that of children without hyperglycaemia (63/835 (7.5%)). This difference was highly statistically significant ($p=0.001$).

Discussion

The prevalence of hyperglycaemia in children admitted to this emergency unit was found to be 16.5%. However, this is lower than the prevalence reported in India by Rakesh et al⁶ (27%) and Deepak et al²⁰ (28%) in Washington. These two studies were carried out in the more stressful environments of paediatric intensive care units (PICUs) among critically ill and peri-operative patients with traumatic brain injury, respectively. The prevalence of hyperglycaemia is said to be more common in severely ill patients.^{5–8} The stress of illness is known to induce hyperglycaemia by activation

of neuro-endocrine phenomenon leading to activation of an inflammatory cascade causing the release of several hormones (e.g. cortisol) and inflammatory cytokines and humoral mediators, leading to inhibition of insulin release and its peripheral sensitivity.²¹

In this study, a history of fever was significantly associated with hyperglycaemia. This finding is similar to that reported by Bhisikul et al⁵ in 1994 where it was found that the higher the temperature, the greater the risk of hyperglycaemia. Valerio et al²² in 2001 also found that hyperglycaemia was 14% versus 4% among children with high and low temperatures, respectively. Fever, mainly due to infection, is known to cause stress responses and hormonal release likely to lead to hyperglycaemia (as discussed above).^{23,24}

In the present study, a history of diarrhoea and vomiting was not associated with hyperglycaemia, although a study by Ronan et al²⁵ did find a significant association between hyperglycaemia and diarrhoea. All the hyperglycaemic patients in their study were severely dehydrated, while in the present study this was not the case.

Hyperglycaemia during diarrhoea has been attributed to a number of different causes. These include hypernatraemia,²⁶ acidosis,²⁷ or hypokalaemia; and a stress response caused by either infection²⁸ or marked hypovolaemia.²⁹ The findings of the Ronan study are consistent with a stress response to marked hypovolaemia as the cause of hyperglycaemia,²⁵ since in their study, compared with normoglycaemic patients, patients with hyperglycaemia had significantly increased concentrations of the hormones adrenaline, noradrenaline, cortisol, growth hormone, and glucagon; all of which have an anti-insulin effect.³⁰ A decrease in intravascular volume is one of the most potent stimuli for the release of catecholamines and cortisol.³¹

There was no association between gender and hyperglycaemia in this study, but there was a significant association between age and hyperglycaemia, with older children of more than six years being more likely to have hyperglycaemia. This finding is in contrast to a study in Washington by Deepak et al²⁰ in 2008, and another by Klein et al⁷ in New York in 2008 where a strong association was found between age, gender, and hyperglycaemia. These workers reported that younger children less than four years and female children were more likely to have hyperglycaemia.

The current study identified a higher prevalence of hyperglycaemia among some specific diagnostic disease conditions, i.e. sepsis, gastroenteritis, protein energy malnutrition, seizure disorder, bronchopneumonia, severe malaria, and meningitis. Some previous studies, especially by Krinsley³² and Osier et al,² found that hyperglycaemia was more prevalent among participants with similar disease conditions.

In our study, the mortality in hyperglycaemic patients was significantly higher than in non-hyperglycaemic patients, 37/165 (22.4%) versus 63/835 (7.5%), respectively ($p<0.001$). This is similar to the Kenyan study by Osier et al² where they found a significantly higher mortality in

Diagnosis	All cases n (%)	Hyperglycaemia n (%)	No hyperglycaemia n (%)
Sepsis	170 (17.0%)	19 (1.9%*)	151 (15.1%)
Gastroenteritis	169 (16.9%)	44 (4.4%)	125 (12.5%)
Seizure disorder	33 (3.3%)	6 (0.6%)	27 (2.7%)
Meningitis	49 (4.9%)	3 (0.3%)	46 (4.6%)
Sickle cell disease	72 (7.2%)	13 (1.3%)	59 (5.9%)
PEM	177 (17.7%)	23 (2.3%)	154 (15.4%)
Severe malaria	140 (14.0%)	27 (2.7%)	113 (11.3%)
Poisoning	11 (1.1%)	3 (0.3%)	8 (0.8%)
Bronchopneumonia	76 (7.6%)	16 (1.6%)	60 (6.0%)
Malignancy	31 (3.1%)	1 (0.1%)	30 (3.0%)
Tuberculosis	23 (2.3%)	1 (0.1%)	22 (2.2%)
UTI	17 (1.7%)	2 (0.2%)	15 (1.5%)
Others	32 (3.2%)	7 (0.6%)	25 (2.5%)
Total	1000 (100%)	165 (16.5%)	835 (83.5%)
*The % for patients with and without hyperglycaemia are proportions of all patients, not just those with particular diagnosis. PEM, protein energy malnutrition; UTI, urinary tract infection.			

Table 4. Comparison of presence of hyperglycaemia among the various diagnoses

hyperglycaemic children: 13/92 (14.0%) versus 112/2963 (3.8%), respectively ($p < 0.001$). However, in both studies the prevalence was found to be higher among children with severe diseases – such as severe malaria, protein energy malnutrition, severe pneumonia, and poisoning. A study by Fauston and Apkon reported higher mortality in children admitted to intensive care units than emergency wards.³³ Therefore, the types of patients managed probably determines the overall outcome and prevalence of hyperglycaemia.^{10,33}

Although hyperglycaemia could be a marker of stress, adult data support the theory that hyperglycaemia is directly injurious to critically ill patients.³⁴ Hyperglycaemia is known to activate different potentially deleterious pathways, such as protein kinase C, polyol, glycation, and reactive oxygen species.¹⁰ Furthermore, the morbidity and mortality from hyperglycaemia may be explained partly by its ability to exacerbate ischaemic neurological injury.³⁵ This was shown in animal studies to be due to a reduction in brain adenosine production. Because adenosine, a cerebral vasodilator, can

inhibit the release of neuronal excitotoxins as well as affect neutrophil–endothelial interactions, it has been proposed as an endogenous neuroprotector. Thus the attenuation of adenosine and its metabolites may be a factor in the pathogenesis of increased ischaemic brain injury associated with systemic hyperglycaemia.³⁵ Hyperglycaemia was also shown to be significantly related to distinct changes of humoral and cellular immune functions.³⁶

This study and others have demonstrated that certain diseases are associated with hyperglycaemia, but why a particular diagnosis will be associated with hyperglycaemia in one patient and normoglycaemia in another is not fully understood. It may be related to the way individuals react to stress, and this may also be influenced directly or indirectly by hormonal and metabolic interplay. The overall effect of stress states on glucose metabolism is increased gluconeogenesis via cortisol and glucagon, increased glycogenolysis via adrenaline, and peripheral insulin resistance via glucagon and adrenaline.¹¹

In conclusion, hyperglycaemia is a common occurrence in children admitted to emergency units in Africa. Where facilities for blood glucose estimation exist, it should be measured in all children sick enough to warrant admission, particularly those severely ill or malnourished. Children with hyperglycaemia should be the object of closer surveillance since they are at increased risk of mortality.

Acknowledgements

It is a pleasure to acknowledge my indebtedness to Dr. Oduwale Abiola, Chief Coordinator, Paediatric Endocrinology Training Centre West Africa (PETCWA), for her support during the course of this work. I also wish to express my appreciation to Dr. Elizabeth Oyenusi and Dr. Yahaya Alkali for their assistance and guidance. Professor Marc Maes reviewed the manuscript, and I thank all the paediatricians and the clinical team in the Department of Paediatrics of Aminu Kano Teaching Hospital and Hasiya Bayero Paediatric Hospital. Finally, I thank the parents, care-givers and the children who participated in the study. The study was funded by the International Society for Paediatric and Adolescent Diabetes (ISPAD).

Author declaration

Competing interests: none.

References

1. Silvio E, Inzucchi MD. Management of hyperglycaemia in the

- hospital setting. *N Engl J Med* 2006; 355: 1903–11.
2. Osier FHA, Berley JA, Sanderson F, et al. Abnormal blood glucose concentrations on admission to a rural Kenyan district hospital: prevalence and outcome. *Arch Dis Child* 2003; 88: 621–5.
3. Drobac S, Wendy B, Smith T, et al. Evaluation of a type 2 diabetes screening protocol in an urban paediatric clinic. *Pediatrics* 2004; 114: 141–8.
4. Piyush G, Girija N, Agarwal KN. Transient hyperglycaemia in acute childhood illnesses: to attend or ignore? *Ind J Pediatr* 1997; 64: 205–10.
5. Bhisikul DM, Vinik AI, Morrow AL, et al. Prevalence of stress hyperglycemia among patients attending a paediatric emergency department. *J Pediatr* 1994; 124: 547–51.
6. Rakesh L, Bhutia T, Kabra S, et al. Day 1 blood glucose and outcome in critically ill children. *Indian Pediatrics* 2009; 46: 809–10.
7. Klein G, Hojask J, Schmeidler J, et al. Hyperglycemia and outcome in the paediatric intensive care unit. *J Pediatr* 2008; 153: 379–84.
8. Rueda A, Ormond M, Gore M, et al. Hyperglycemia in diabetics and non-diabetics: effect on the risk for and severity of pneumococcal pneumonia. *J Infection* 2010; 60: 99–105.
9. Global IDF/ISPAD Guideline for Diabetes in Childhood and Adolescence. International Diabetes Federation, 2014.
10. Srinivasan V, Spinella PC, Drott HR, et al. Association of timing, duration and intensity of hyperglycaemia with intensive care unit mortality in critically ill children. *Pediatr Crit Care Med* 2004; 5: 329–36.
11. Laird AM, Miller PR, Kilgo PD, et al. Relationship of early hyperglycaemia to mortality in trauma patients. *J Trauma* 2004; 56: 1058–62.
12. Michael F. Classification of diabetes: not all hyperglycemia is the same. *Clinical Diabetes* 2007; 25: 74–6.
13. Ruiz MP, Aparicio LC, Lopez-Herce CJ, et al. Metabolic changes in critically ill children. *Ann Esp Pediatr* 1999; 51: 143–8.
14. Elusiyan JBE, Owa JA. Hyperglycaemia in ill children: a study of 13 cases. *Nig J Paediatr* 2006; 33: 8–12.
15. McCowen KC, Malhotra A, Bistrian BR. Stress-induced hyperglycemia. *Crit Care Clin* 2001; 17: 107–24.
16. Capes SE, Hunt D, Malmberg K, et al. Stress hyperglycemia and prognosis of stroke in non-diabetic and diabetic patients: a systematic overview. *Stroke* 2001; 32: 2426–32.
17. Umpierrez GE, Isaacs SD, Bazargan N, et al. Hyperglycemia: an independent marker of in-hospital mortality in patients with undiagnosed diabetes. *J Clin Endocrinol Metab* 2002; 87: 978–82.
18. Siu-wai Choi B, Shuk-Woon M, et al. Acute hyperglycemia and oxidative stress: direct cause and effect? *Free Radical Biology & Medicine* 2008; 44: 1217–31.
19. Guillermo E, Umpierrez S D, Niloofar B, et al. Hyperglycemia: an independent marker of in-hospital mortality in patients with undiagnosed diabetes. *J Clin Endocrinol Metab* 2002; 87: 978–82.
20. Deepak S, Rohini C, Onuma C. Incidence and risk factors for perioperative hyperglycemia in children with traumatic brain injury. *J Anesth Analg* 2009; 108: 81–9.
21. Medhanick JI. Metabolic mechanisms of stress hyperglycaemia. *J Parent Ent Nutr* 2006; 30: 157–63.
22. Valerio G, Franzese A, Carlin E, et al. High prevalence of stress hyperglycaemia in children with febrile seizures and traumatic injuries. *Acta Pediatr* 2001; 90: 618–22.
23. McCowen KC, Malhotra A, Bistrian BR. Stress-induced hyperglycaemia. *Crit Care Clin* 2001; 17: 107–24.
24. Grimble RF. Inflammatory status and insulin resistance. *Curr Opin Clin Nutr Metab Care* 2002; 5: 551–9.
25. Ronan A, Azad AK, Rahman O, et al. Hyperglycaemia during childhood diarrhoea. *J Pediatr* 1997; 130: 45–51.
26. Levin S, Geiler-Bernstein C. Alimentary hyperglycaemia simulating diabetic ketosis. *Lancet* 1964; 2: 595.
27. Spirer Z, Bogair N. Blood sugars in infants with diarrhoea. *Lancet* 1970; 2: 1311–2.
28. Rabinowitz L, Joffe BI, Abkiewicz C, et al. Hyperglycaemia in infantile gastroenteritis. *Arch Dis Child* 1984; 59: 771–5.
29. Perkins KC. Hyperglycaemia without ketosis or hypernatraemia. *Am J Dis Child* 1974; 128: 885.
30. Rolih CA, Ober KP. The endocrine response to critical illness. *Med Clin North Am* 1995; 79: 211–24.
31. Woolf PD. Endocrinology of shock. *Ann Emerg Med* 1986; 15: 1401–5.
32. Krinsley J. Association between hyperglycemia and increased hospital mortality in a heterogeneous population of critically ill patients. *Mayo Clin Proc* 2003; 78: 1471–8.
33. Fauston EV, Apkon M. Persistent hyperglycaemia in critically ill children. *J Pediatr* 2005; 146: 30–4.
34. Van den Bergh G, Wouters PJ, Bouillon R, et al. Outcome benefit of intensive insulin therapy in the critically ill; insulin dose versus glycaemic control. *Crit Care Med* 2003; 31: 359–66.
35. Sieber FE, Traystman RJ. Special issues: glucose and the brain. *Crit Care Med* 1992; 20: 104.
36. Wasmuth HE, Dagmar K, Stanzel S, et al. Hyperglycaemia at admission to the intensive care unit is associated with elevated serum concentrations of interleukin-6 and reduced ex vivo secretion of tumor necrosis factor-alpha. *Crit Care Med* 2004; 32: 1109–14.

Call for articles

The Editor welcomes articles on diabetes medicine, and the management of diabetes, from all health professionals, medical and non-medical.

We publish Review Articles, Original Articles, Short Report, Case Reports, and Letters.

Please see 'Guidance to Authors' on page 23 and email your manuscripts to editor@fsg.co.uk.



INCORPORATING DIABETES INTERNATIONAL

www.africanjournalofdiabetesmedicine.com



The Editors welcome articles on diabetes, and the management of diabetic diseases, from all health professionals, medical and non-medical. The philosophy of the journal is to reflect as much as possible the multi-disciplinary nature of diabetic care. The *African Journal of Diabetes Medicine* seeks to fulfil a role in continuing medical education and, therefore, welcomes in particular review articles which provide practical updates on the management of diabetic patients. Original research studies will constitute an important minority of the articles published. In assessing the suitability of research papers for publication, the Editors will favour those contributions which will provide readers with information of practical use in their day-to-day practice. Advice and assistance will, wherever possible, be provided to potential authors on the scope of their research or method of presenting papers.

Manuscripts

Review articles

These are particularly welcome as we receive relatively few. They can be on any aspect of diabetes, though preferably of general interest to our readers. Review articles do not need an abstract, and should be no more than 2500 words long (excluding references). A reasonable number of figures and/or tables can be used.

Original articles

These should be research-based articles, divided in a standard way into abstract (unstructured), introduction, methods, results and discussion. In length they should be no more than 2000 words (excluding references) with no more than three tables or figures, and 30 references.

Short reports/case reports

These should be up to 800 words long (excluding references), have one table or figure only, and up to 10 references. The sub-divisions of the report should be the same as for original articles, but the abstract should be very brief – usually two or three sentences.

Letters, news and notes, editorials etc.

We welcome news items, conference reports, letters to the editor, etc. We normally write editorials 'in house', but if you think you have a useful editorial to offer, we'd be glad to see it.

Illustrations

These must be supplied as jpeg, tiff or PDF files, in CMYK format with a resolution of at least 300 d.p.i.

General guidance

Articles should be sent by email – to our Cambridge office (editor@fsg.co.uk) – as a Word attachment (saved as a text-only document please). For all contributions referencing should be numerical and in the Vancouver style. Please note that all articles submitted to the *African Journal of Diabetes Medicine* are deemed to have been offered exclusively to the journal, unless otherwise stated. Copyright in papers published will be vested in the publishers. The Editors reserve the right to shorten or to make other alterations to articles at their discretion.

