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Keeping diabetes on TRACK in resource-limited settings: the Zimbabwe experience

Association between serum insulin and uric acid concentrations in type 2 diabetic subjects in Nigeria

Effect of distance on access to health services among women with type 2 diabetes in a rural community in Kenya

# From the Journals

#### Urine or blood ketones?

Brewster S, Curtis L, Poole R. Urine versus blood ketones. *Practical Diabetes* 2017; 34: 13–15.

Ketonuria is part of the diagnostic criteria for diabetic ketoacidosis (DKA); but how reliable is urine ketone testing? This question is particularly important as bedside meters are now available for blood ketone measurement - indeed, currrent United Kingdom (UK) guidelines for DKA diagnosis and management recommends blood rather than ketone measurement. This useful review article discusses the advantages of blood ketone testing. The three ketone bodies are betahydroxybutyrate (BOH), acetoacetate, and acetone. In DKA, BOH is the predominant ketone (about 80%). This is measured by blood ketone meters, but urine strips measure acetoacetate only. As DKA is treated successfully, BOH is oxidised to acetoacetate, so blood ketone levels will accurately reflect DKA resolution, but urine tests will remain positive despite clinical and metabolic improvements. Other advantages of blood ketone meters are that they give a quantitative result, and do not rely on a urine sample, which can sometimes be difficult to obtain. The downside, however, as may be expected is that blood testing is relatively expensive.

#### The artificial pancreas?

El-Khatib H, Bolliro C, Hillard MA et al. Home use of a bihormonal bionic pancreas versus insulin pump therapy in adults with type 1 diabetes: a multicentre randomised crossover trial. Lancet 2017; 389: 369-380. Standard insulin treatment of type 1 diabetes is sometimes described as "open loop". This means that insulin doses are decided upon by patients and/or healthcare workers depending on self-monitoring of blood glucose levels. It is not a very satisfactory system - hence the quest for "closed-loop" systems, either pancreas transplantation (segmental or islet cell) or the "artificial pancreas". The latter is an external or implantable device which infuses insulin in response to continued measurement of tissue glucose levels, the doses being decided by computerised algorithms. Such devices have been intermittently tested for some time, and have been becoming smaller and more sophisticated. This recent Lancet study reports a trial of a "bihormonal" system (i.e. delivering both insulin and glucagon), compared with standard open-loop insulin treatment. The trial was short-term (two 11 week periods) but there was improvement in glycaemic control and reduction in hypoglycaemia in the automated delivery group. This confirms previous studies, and suggests that larger trials (at least 6 months) are now needed. An accompanying Lancet editorial comments that the focus should now move to "commercialisation and real-world application". In fact, an automated insulin-only delivery system (Medtronic Minimed 670G) was approved for use in the USA in 2016. We will certainly be hearing more of this fascinating technology.

#### Atypical ketosis-prone diabetes

Lontchi-Yimagou E, Nguewa JL, Assah F et al. Ketosisprone atypical diabetes in Cameroonian people with hyperglycaemic crisis: frequency, clinical and metabolic phenotypes. *Diabetic Medicine* 2017; 34: 426–431. 'Atypical ketosis-prone' diabetes is a form of diabetes seen in Africa, or in African migrants. It is characterised by an abrupt onset with hyperglycaemia or ketoacidosis (DKA), followed by periods of partial or complete remission. The causes of this syndrome, and whether it is a variant of type 1 (T1DM) or type 2 (T2DM) diabetes remain uncertain. This paper from Cameroon has investigated a group of classical T2DM patients (n = 124) with a group with ketosis-prone diabetes (n = 49). The latter group included 34 in the ketotic and 15 in the non-ketotic phase of disease. Investigations carried out included assessment of endogenous insulin secretion (C-peptide) and insulin resistance (HOMA). There were no significant differences between the type 1 and nonketotic phase atypical diabetic patients. However, the ketotic-phase patients had lower BMI, lower C-peptide and lower HOMA-IR values. The authors conclude that atypical ketosis-prone diabetes is likely to be a variant of T2DM rather than T1DM. It also appears to be associated with transiently reduced insulin secretion at the time of and just after diagnosis, as well as during subsequent ketotic phases. The cause of the syndrome remains, however, mysterious.

#### Vitamin d and diabetic complications

Samefors M, Scragg R, Lanne T, Nystrom FH, Ostgren CJ. Association between serum 25(OH)D3 and cardiovascular morbidity and mortality in people with type 2 diabetes: a community-based cohort study. *Diabetic Medicine* 2017; 34: 372–379.

One of the possible explanations for the relatively low incidence of type 1 diabetes (T1DM) in the tropics is the "sunshine hypothesis" - that high levels of vitamin D may protect against T1DM. This would explain the increasing incidence as one moves more northerly or southerly from the equator. A new vitamin D-related report may have relevance to type 2 diabetes (T2DM) and its complications in the tropics. This paper studied a cohort of 698 people in Sweden with T2DM and followed them for over 7 years. Serum levels of 25(OH)D3 (vitamin D) were measured at baseline, and correlated with the later development of cardiovascular complications. Both cardiovascular mortality and morbidity was strongly associated with lower vitamin D levels (Hazard Ratio 0.98, p = 0.001), and the association remained after adjusting for other cardiovascular risk factors (e.g. obesity, hypertension etc). Cardiovascular complications of T2DM are seen much less frequently in Africa than in Europe, and the results of this Swedish study may suggest a new "sunshine hypothesis" - that high vitamin D levels in African T2DM patients may protect them from cardiovascular complications.

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Correspondence to: African Journal of Diabetes Medicine, FSG Africa 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

## Contents

#### **2 From the Journals**

#### **4 Review Article**

Keeping diabetes on TRACK in resource-limited settings: the Zimbabwe experience R Woodward and A Matimba

#### **6 Original Article**

Comparative evaluation of carotid intima-media thickness in paediatric type 1 diabetic children and healthy children in Ibadan and Lagos, Nigeria A C Nuhu, A M Agunloye, O O Jarrett, and A Oduwole

#### **11 Original Article**

Association between serum insulin and uric acid concentrations in type 2 diabetic subjects in Nigeria Y P Mamza, B R Aladeusi, R M Gali, D S Mshelia, R Y Genesis, and S A Habu

#### **14 Original Article**

Vitamin D supplementation improves insulin resistance in type 2 diabetes subjects in Lagos, Nigeria A C Anyanwu, O A Fasanmade, H A B Coker HAB, and A E Ohwovoriole

#### **18 Original Article**

Effect of distance on access to health services among women with type 2 diabetes in a rural community in Kenya L W Mwaura, S Wandibba, and C O Olungah

#### **21 Original Article**

Effectiveness of a targeted education module for healthcare professionals attending a diabetic retinopathy training session in Zimbabwe R Woodward and A Matimba

#### Editorial

#### **Diabetic retinopathy in Africa**

This issue of *AJDM* contains two articles (one review and one research) relating to diabetic retinopathy in an African setting. This is an important subject, as retinal screening and retinopathy treatment has in the past been neglected. Many older African studies on diabetic complications reported low rates of retinopathy. However, detection systems were often inadequate, and the populations studied frequently had short mean durations of diabetes (reducing the likelihood of retinopathy).

**May 2017** 

More recently, diabetes outcome (and therefore disease duration) has significantly improved in many parts of Africa, and retinal screening systems have become more accurate. A systemic review published in 2013, revealed overall retinopathy prevalence rates of 30.2 to 31.6%, including proliferative disease 0.9 to 1.3%, and maculopathy 1.2 to 4.5%.<sup>1</sup> The authors concluded that these figures were 'comparable with recent European and American studies'.

Diabetic retinopathy is frequently asymptomatic at its early stages. Proliferative retinopathy and maculopathy are potentially sight-threatening, and yet are highly treatable with laser photocoagulation. Though provision of retinopathy screening and treatment is difficult in resource-limited countries, there are a number of positive and encouraging initiatives in various parts of Africa. The aim must be for all diabetic patients in the continent to have access to these facilities.

Professor Geoff Gill

Editor, African Journal of Diabetes Medicine, Liverpool School of Tropical Medicine, Liverpool, UK

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### Keeping diabetes on TRACK in resourcelimited settings: the Zimbabwe experience

#### **R** Woodward and A Matimba

Closing the gap between evidence and practice in treating chronic diseases is especially challenging in resource-limited settings. There is growing awareness that translating evidence into user-friendly management algorithms, together with a one-off training session, can bring about improvement in the management of various medical conditions.<sup>1</sup> Infographics have recently become a popular way to simplify information in a visually engaging way in order to attract and inform a large audience. These powerful digital tools can provide insights into specific diseases, procedures and healthcare topics.

In the United States, The National Eye Institute (NEI) established the National Eye Health Education Program (NEHEP) in 1998 to help health and community professionals increase awareness about eye health. The NEHEP is designed to reach populations at higher risk for eye disease and vision loss, and to promote the use of vision rehabilitation services. The NEHEP Tool Kit for diabetes is a collection of educational modules that are available online, freely downloadable, and targeted for use by community diabetes educators. One acronym in particular, 'If You Have Diabetes, Keep Your Health on TRACK' was first used in 2005, and the related infographic is part of the current NEI online catalogue.<sup>2</sup>

Recognising that health literacy is vital in treating noncommunicable diseases and preventing complications, the ZRTP (Zimbabwe Retinopathy Telemedicine Project) searched for a simple tool that could help patients keep track of their visits to the retinal screening clinic and minimise gaps in knowledge and reinforce the steps they needed to take to help prevent diabetic eye disease. Recognising the appeal of healthcare information presented visually and succinctly, the ZRTP adapted the acronym, 'If You Have Diabetes, Keep Your Health on TRACK' for use in our diabetes retinopathy screening clinic. Our goal was to translate a set of healthcare information mesages into a simplified pictorial snapshot that used design elements to emphasise the importance of early detection of diabetic retinopathy, and the steps needed to help prevent diabetic eye complications. The card was designed in a culturally appropriate manner, translated into Shona and Ndebele, and printed on 3 × five inch thick paper stock (Figure 1).

R Woodward, Weill Cornell Medical College, New York, NY, USA and A Matimba, Department of Clinical Pharmacology, College of Health Sciences, University of Zimbabwe, Zimbabwe. Correspondence to: Richmond Woodward. Email: rlw2176@columbia.edu



Figure 1: 'TRACK' cards in (from top to bottom) English, Shona, and Ndebele

The TRACK card system has been well received by patients. At each screening session each patient is given a TRACK card, and the patient number used in the screening clinic is written on the back of the card. The card can also be used to write down questions or take notes during the educational sessions that accompany each retinal screening clinic. Based on feedback from patients, the initial translation in Shona was modified to be more respectful in order to reduce the possibility of the message not appealing to older patients. A short survey from the diabetic clinic on patients' views about the TRACK card indicate that patients believe it is informative, simple to understand, and provides a reminder of the important aspects of self-care management; especially for those patients who have already gone through the initial educational process of understanding what diabetes is, the disease process, management, and possible complications. However, the card alone is not a substitute for a more comprehensive diabetes education. For newly diagnosed diabetes patients the TRACK card gives general guideline on self-management, but these patients still need further education in order to appreciate the importance of the guidelines.

The access to knowledge that the TRACK card system provided is most notable for glycated haemoglobin (HbA1c) testing. Of 190 patients who had an initial screening for diabetic retinopathy at the telemedicine diabetic retinopathy screening clinic at Harare Central Hospital between 15 July 2016 and 16 December 2016, only 51 patients (27%) reported ever having had their HgbA1c checked.<sup>3</sup> Based on patient questions and comments, it was clear that providing patients with the TRACK card enhanced their knowledge of and interest in HbA1c testing, an area where understanding was previously lacking for many patients. Other parameters, such as blood pressure (BP) and cholesterol were already known by most of the patients to be diabetes control markers.

A future goal for the TRACK card system used by the ZRTP includes adding the normal ranges for HbA1c, BP, and cholesterol to the TRACK card. Patients requested this so that they could have an understanding of what constitutes normal and abnormal values. The normal ranges are covered during their education sessions, but many patients expressed the hope that the TRACK card could act as a reference for them for the normal ranges of these essential markers of diabetes control.

In conclusion, we have applied a relatively simple and inexpensive tool, i.e. the TRACK card, as part of an eye health programme contributing to a total diabetes health and educational programme well suited to lowresource areas.

#### Acknowledgements

The authors are grateful to Dr S. Guramatunhu, Dr J. Mangwiro, Sister Patience Rwizi, and the Zimbabwe Ministry of Health and Child Care for their support.

#### Author declaration

Competing interests: none.

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### Comparative evaluation of carotid intima media thickness in paediatric type 1 diabetic children and healthy children in Ibadan and Lagos, Nigeria

A C Nuhu, A M Agunloye, O O Jarrett, and A Oduwole

#### Abstract

Patients with type 1 diabetes are at greater risk of cardiovascular disease and atherosclerosis. Carotid intima-media thickness (CIMT) measured by ultrasound is a marker of atherosclerosis and can predict future cardiovascular events. The aim of this study was to measure the CIMT in paediatric type 1 diabetes patients in Ibadan and Lagos and compare results with the CIMT of non-diabetic healthy control children. Carotid ultrasound was performed and CIMT measured in 70 subjects (35 diabetic patients and 35 non-diabetic controls matched for age and sex). Mean age was 12.8±3.2 years. A slightly higher, but non-significant mean CIMT was seen in diabetic cases: mean values in type 1 diabetes patients were 0.475±0.068 and 0.476±0.069 (right and left respectively) while in controls, mean values were 0.467±0.064 and 0.468±0.054 (p=0.618 and 0.575 respectively). The CIMT in both groups correlated positively with age and body mass index (BMI). Significantly higher mean CIMT values were seen in males with type 1 diabetes on both sides. However, there was no significant correlation between CIMT and duration of illness, insulin dosage, or blood pressure. CIMT is a safe and convenient measurement, which may be helpful in predicting an increased risk of future cardiovascular disease in children with type 1 diabetes.

#### Introduction

Diabetes mellitus is a group of metabolic diseases characterised by hyperglycaemia resulting from defects in insulin secretion, insulin action, or both.<sup>1</sup>Type 1 diabetes

A C Nuhu and A M Agunloye, Department of Radiology, University College Hospita, Ibadan, Nigeria; O O Jarrett, Department of Paediatrics, University College Hospital, Ibadan, Nigeria; and A Oduwole, Department of Paediatrics, Lagos University Teaching Hospital, Lagos, Nigeria. Correspondence to: Dr Atinuke Agunloye, Department of Radiology, University of Ibadan and University College Hospital, Ibadan. Nigeria. Email: tinuagunloye@yahoo.com; tinuagunloye@comui.edu.ng often occurs in childhood, and potentially reversible atherosclerotic lesions have been demonstrated by autopsy studies and in animal models of paediatric type 1 diabetes.<sup>2</sup> Young adults with type 1 diabetes show a dramatic increase in morbidity and mortality caused by atherosclerotic cardiovascular disease compared with the non-diabetic population.<sup>3,4</sup> Early detection of cardiovascular disease is therefore important so that prompt therapeutic interventions can be instituted.<sup>5</sup>

Carotid ultrasound (CUS) is a non-invasive imaging method for measuring intima-media thickness, a sensitive indicator of cardiovascular risk;<sup>6</sup> it is safe, cheap, and readily available, and does not utilise ionising radiation. This makes it ideal for imaging paediatric and low-resource populations.

The aim of this study was to measure the carotid intima-media thickness (CIMT) in paediatric type 1 diabetes patients, and compare results with the CIMT of non-diabetic healthy children.

#### **Patients and methods**

This was a prospective, case-control study over a period of seven months from August 2013 to February 2014. Thirtyfive (35) normotensive children with type 1 diabetes aged up to 18 years were recruited from the endocrinology clinics of the children's outpatient departments of both the University College Hospital (UCH) Ibadan and Lagos University Teaching Hospital (LUTH), Nigeria. Both clinics were used in order to achieve the calculated sample size of 35, since there were only 20 registered paediatric type 1 diabetes patients at UCH at the time the study was conducted. Thirty-five (35) age- and sexmatched, normotensive, non-diabetic controls, aged 0–18 years were either healthy volunteers or recruited from the children's unit of the general outpatient department (GOPD) at UCH.

Two ethical approvals were obtained from the Joint University of Ibadan, UCH and LUTH Health Research Ethical Review Committees. Written informed consent was obtained. Relevant clinical history was obtained

	Type 1 diabetes (n=35)	Controls (n=35)	
Male	13	13	
Female	22	22	
Mean age (years)	12.8±3.2	12.8±3.2	
Age group (years)			
0–4	1	1	
5–9	1	1	
10–14	24	24	
15–18	9	9	
BMI (kg/m2)	17.9±3.9	17.9±3.9	
BMI group			
Underweight	5	5	
Normal	24	24	
Overweight	4	4	
Obese	2	2	
Educational status			
Nursery	1	1	
Primary	6	6	
Secondary	27	27	
Tertiary	1	1	
Socio-economic class			
Upper	22	24	
Lower	13	11	
Note: weight classification was according to percentiles of BMI. Underweight <5th centile, normal weight 5th to 85th centile, overweight 85th to 95th			

centile, and obese >95% centile.

Table 1: Socio-demographic factors in type 1 diabetes patients and control subjects

from all subjects.

For control subjects, fasting blood glucose (FBG) was measured to screen for diabetes, while fasting serum

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an	d in	all c	ontro	ls, to scr	een fo	r hype	erlipi	daem	ia.	

Carotid ultrasound was done on all subjects using a 7.5–10.0 MHz linear transducer on a portable SONOSITE ultrasound machine. The near and far walls of the common carotid (CCA), carotid bifurcation, and internal carotid (ICA) arteries were examined for the presence of atherosclerotic plaque. On a longitudinal view, the CIMT at three carotid sites were measured in the far wall of the vessels as the distance between the leading edge of the lumen–intima interface and the leading edge of the media–adventitia interface as described by Touboul et al.<sup>7</sup> The three sites were:

- 1. the common carotid artery at 1.5 cm proximal to the carotid bulb;
- 2. the carotid bulb;
- 3. the proximal internal carotid artery at 1 cm from the carotid bulb.

The final mean CIMT (in mm) on each side was the average of the values measured at the three sites. To reduce inter-observer variability, one of the authors (NAC) took all CIMT measurements at both study sites, while taking an average of three measurements at each site reduced intra-observer variability.

Using the Statistical Package for Social Sciences (SPSS) version 20 (SPSS Inc. Chicago, IL, USA), data were analysed and presented using frequency tables, percentages, graphs, and means±standard deviation (SD) as appropriate. Associations between categorical and continuous variables were explored using the independent t-test while correlations between continuous variables were explored using Pearson's correlation coefficient. Associations were deemed significant for p<0.05 at a 95% confidence interval; p values of 0.000 were denoted as p<0.001.

### Results

Of the 35 type 1 diabetes cases, 24 (68%) were recruited from Lagos, and 11 (32%) from Ibadan; the 35 controls were all recruited from Ibadan. The socio-demographic data of study subjects are summarised in Table 1. Age range for both groups was 2–18 years with a median age of 12 years and a mean age of 12.8±3.2 years. There were 26

(37%) males and 44 (63%) females, with a male:female ratio of 1.0:1.7. Most (94%) of the participants were above nine years old with the largest proportion 48 (68%) seen within the 10–14 year age group. A total of 54 (72%) of the participants were in secondary school while two (3%) were either in nursery school or at university. FBG levels were significantly higher in individuals with type 1 diabetes compared with controls (8.4±0.5 vs 4.4±1.6 mmol/l, p=0.021). Ten (34%) of the

	Minimum CIMT (mm)	Maximum CIMT (mm)	Mean CIMT + SD (mm)	Significance	
<b>Type 1 diabetes group</b> Right side Left side	0.29 0.29	0.60 0.59	0.476+0.069 0.475+0.068	p=0.618	
<b>Control group</b> Right side Left side	0.29 0.29	0.61 0.59	0.468+0.054 0.467+0.064	p=0.575	
CIMT, carotid intima-media thickness					

Table 2 CIMT values in type 1 diabetes patients and non-diabetic controls

Variables	Sex	Mean CIMT+SD (mm)	Significance
<b>Type 1 diabetes group</b> Right side	Male Female	0.49+0.07 0.46+0.06	p<0.001
Left side	Male Female	0.49+0.07 0.46+0.06	p<0.001
Control group Right side	Male Female	0.48+0.06 0.45+0.06	p<0.002
Left side	Male Female	0.48+0.06 0.45+0.06	p<0.001

Table 3: Comparison between right and left mean CIMT by gender

diabetic patients had a positive family history of diabetes, while none of the controls had such a history. Most of the type 1 diabetes subjects had had the disease for more than one year, with about two-thirds having had the disease for 1–6 years. The mean duration of diabetes was  $2.7\pm2.8$  years.

CIMT measurements: correlation with gender, age, duration of diabetes, insulin dosage, and blood pressure The mean CIMT was higher in those with type 1 diabetes (0.47±0.06mm on each side) when compared with controls (0.46±0.06mm and 0.46±0.05mm on the right and left side respectively). However, this difference in CIMT was not statistically significant (right, p=0.618; left, p=0.575). Side-to-side comparison shows no statistically significant difference between the right and left CIMT in both study groups. The data are shown in Table 2. Bilaterally, in both groups, males had higher mean CIMT than females (Table 3) and this observed gender difference was statistically significant. There was a positive and significant correlation between CIMT and age bilaterally for both groups. Pearson correlation coefficients were 0.493 and 0.491 for right and left CIMT respectively in type 1 diabetes patients, and 0.484 bilaterally for controls (p=0.003 for both sides, in both groups). This correlation was seen in both genders with p<0.001 for females bilaterally, and in males, p values were 0.005 and 0.004 on the right and left sides respectively. There was a weak positive nonsignificant correlation between duration of diabetes and CIMT bilaterally. The correlation between CIMT and insulin dosage was also weak and not statistically significant. Mean systolic and diastolic blood pressures were higher in the type 1 diabetes group (99±10 mmHg and 71±11 mmHg respectively) when compared with controls (98±10 mmHg and 67±10 mmHg), but the difference was also not statistically significant.

#### CIMT, BMI, and serum lipids

The mean CIMT values (right and left side) were higher in patients with type 1 diabetes  $(0.51\pm0.07 \text{ mm and} 0.50\pm0.07 \text{ mm})$  and controls  $(0.50\pm0.08 \text{ mm and} 0.50\pm0.06 \text{ mm})$  mm) who were overweight and obese when compared with mean CIMT of patients with type 1 diabetes (0.47±0.05 mm and 0.47±0.05 mm) and controls (0.46±0.06 mm and 0.46±0.07 mm) with a normal BMI. These differences were statistically significant in both the type 1 diabetes group (p=0.041 and p=0.031 on the right and left sides respectively) and controls (p=0.044 and p=0.038 on the right and left sides respectively). Bilaterally, there was a positive correlation between CIMT and BMI in the diabetic and non-diabetic groups, but this positive correlation was higher in controls than in type 1 diabetes patients. In patients with type 1 diabetes (r = 0.392) and controls (r = 0.414), the correlation was noted to be significantly higher on the right side when compared with the left (p<0.05). Serum lipid

profiles for type 1 diabetes patients and the control group showed no significant differences.

#### Discussion

This study has shown a higher mean CIMT in the diabetic group compared with the non-diabetic controls, although the difference was not statistically significant. Several case control studies have been conducted on CIMT in paediatric patients with type 1 diabetes, and these studies show contradictory findings, with the CIMT values in both diabetic and non-diabetic healthy controls varying significantly.8-15 The CIMT values in our study are closest to those of Rodriguez et al8 in Mexico who studied children with a similar age and recorded a mean CIMT of 0.463±0.04 mm and 0.441±0.04 mm in diabetic and non-diabetic Hispanic children respectively. The CIMT values are also close to those of Babar et al<sup>13</sup> who reported a mean CIMT of 0.48±0.02 mm and 0.46±0.04 in 21 American paediatric type 1 diabetes patients and 15 non-diabetic children with an age of 8.3±0.3 years. However, our values of CIMT were less than those recorded by Tołwińska et al<sup>15</sup> (0.52 mm and 0.43 mm in diabetic and non-diabetic patients respectively) in subjects with a higher mean age of 15.5±4.3 years. In agreement with their findings, we also showed a positive correlation between the mean CIMT and age in both diabetic patients and nondiabetic controls (p=0.003). Other authors have reported similar age correlations in both children and adults.9,10,16 Age-related physiologic carotid wall thickening occurs both in adults and children but the mechanism is poorly understood in children.<sup>17</sup> In adults, it has been suggested that an increase in blood pressure with age is related to an increase in CIMT.<sup>18</sup> The finding of an age correlation with CIMT is however at variance with studies by Babar et al<sup>13</sup> in the USA and Margeirsdottir et al<sup>12</sup> in Norway.

We have showed gender variation in the CIMT values with males having significantly higher values than females. Similar findings have been reported by some workers, <sup>9,19</sup> but not by others. It is also known that the eventual macrovascular complications of diabetes are more common in males than in females, and this may be evident from childhood.<sup>20</sup>

The mean duration of diabetes in this study was 2.7±2.8 years and no correlation was found between CIMT and duration of diabetes, in agreement Gunczler et al.<sup>14</sup> However, other studies in subjects with longer duration of diabetes have found a positive and significant correlation between CIMT and disease duration.<sup>9,10</sup> Other factors such as level of glycaemic control may also contribute to the difference in study findings.

It is estimated that the mean CIMT progression in the general population ranges from 0.001 to 0.030 mm per year,<sup>21</sup> and in type 1 diabetes its progression to atherosclerosis begins in childhood.<sup>22</sup> As such, intensive insulin therapy may slow the progression of CIMT.<sup>23</sup>

Ten of our diabetic patients had a positive family history of diabetes. The presence of a positive family history of diabetes and hypertension in childhood type 1 diabetes are important risk factors for cerebrovascular disease (CVD).<sup>24,25</sup>

Even though the majority (60%) of our subjects had a normal BMI, a positive and significant correlation was found between CIMT and BMI, but no correlation was found between CIMT and serum lipids. This may suggest that the rate of progression of atherosclerosis may be determined by risk factors such as BMI which is also implicated in adult coronary heart disease.<sup>22</sup> Reduction in BMI has been shown to slow the yearly rate of increase in CIMT in adults,<sup>26</sup> and maintenance of a normal BMI in paediatric type 1 diabetes may therefore be beneficial. In support of this finding, Järvisalo et al<sup>27</sup> suggested that the diffusely increased CIMT in paediatric type 1 diabetes reflects intimal changes related to early atherogenesis. Rodriguez et al<sup>8</sup> in Mexico documented no correlation between CIMT and BMI in their study, while Abdelghaffar et al<sup>28</sup> in Egypt also found no correlation between CIMT and serum lipids, in agreement with this study.

Autopsy studies have shown that atherosclerosis begins in childhood and is accelerated in the presence of risk factors such as raised total and low density lipoprotein (LDL) cholesterol levels.<sup>19</sup> Thus, an increase in CIMT has been reported in children with familial hypercholesterolemia.<sup>29</sup> We found no plaques in our patients' carotid arteries, which may not be surprising as the study population was less than 20 years of age, and plaques are uncommon below this age.30 However, histological atherosclerotic vascular changes in the form of fatty streaks may be found in the walls of the arteries even below the age of two years.<sup>30</sup>

We have confirmed the feasibility of measuring CIMT in paediatric patients with type 1 diabetes using ultrasound. In our clinical practice, CIMT is not yet routinely measured in children, but it has been found to be a suitable surrogate end point in clinical studies and correlates well with cardiovascular risk factors and coronary atherosclerosis.<sup>22</sup> Routine CIMT measurement at presentation with annual follow-up may in future be included as part of the management of paediatric type 1 diabetes in order to identify patients who may be at risk of future cardiovascular disease. Long-term prospective

studies are needed to evaluate the progression of CIMT and vascular changes in relation to duration of diabetes, glycaemic control, and progression through the stages of puberty into adulthood.

#### Author declaration

Competing interests: none.

Any ethical issues involving humans or animals: none. Was informed consent required: yes - documentation on file.

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### Association between serum insulin and uric acid concentrations in type 2 diabetic subjects in Nigeria

Y P Mamza, B R Aladeusi, R M Gali, D S Mshelia, R Y Genesis, and S A Habu

#### Abstract

Diabetic patients who are hyperuricaemic appear to be at increased risk for developing diabetic complications, renal disease, and cardiovascular disease. The present study was undertaken to determine the association between serum insulin and uric acid concentrations in individuals with type 2 diabetes and control subjects attending the University of Maiduguri Teaching Hospital (UMTH) in Nigeria. One hundred and sixty (160) subjects with an age range of 30-75 years participated in the study: 100 confirmed type 2 diabetes subjects and 60 non-diabetic controls. A significantly (p<0.05) high mean serum insulin was observed in type 2 diabetes subjects as compared with controls (9.3±2.0 vs 5.1 $\pm$ 0.6  $\mu$ lU/L). No significant difference (p>0.05) was observed in the mean serum uric acid of diabetic and control subjects (358±89 vs 334±66 µmol/L). There was a positive and significant correlation (r = 0.410; p<0.05) between serum insulin and uric acid levels in type 2 diabetes subjects. This may relate to the insulin resistance that characterises type 2 diabetes.

#### Introduction

Diabetes mellitus, one of the most common diseases worldwide is considered a major health problem with increasing prevalence, and is the leading cause of morbidity, mortality, and complications.<sup>1,2</sup> Diabetes is a metabolic disorder characterised by hyperglycaemia and insufficiency of secretion or action of endogenous insulin.

Type 2 diabetes is a heterogeneous disease associated with variable degrees of insulin resistance, impaired insulin secretion, and increased glucose production. Insulin resistance occurs when cells become less sensitive to the effects of insulin.<sup>3</sup> The 'insulin resistance syndrome' consists of a group of metabolic abnormalities that increase

Y P Mamza, B R Aladeusi, and R M Gali, Department of Medical Laboratory Science, College of Medical Sciences University of Maiduguri, Nigeria; D S Mshelia, Department of Chemical Pathology, College of Medical Sciences University of Maiduguri, Nigeria; and R Y Genesis and S A Habu, Department of Chemical Pathology Laboratory, University of Maiduguri Teaching Hospital, Nigeria. Correspondence to: Dr Y P Mamza, Department of Medical Laboratory Science, College of Medical Sciences University of Maiduguri, PMB 1069, Maiduguri, Nigeria. Email:ymamza@yahoo.com the risk of cardiovascular disease (CVD) and diabetes.

Elevated serum uric acid levels or hyperuricaemia is a risk factor for insulin resistance, peripheral arterial disease, and other components of the metabolic syndrome.<sup>4</sup> For some time, it has been recognised that serum uric acid is positively associated with serum glucose levels in healthy subjects.<sup>5</sup> Recent studies have demonstrated that uric acid levels are higher in subjects with prediabetes and early type 2 diabetes, than in healthy controls.<sup>6</sup> Furthermore, hyperuricaemia was found to increase the risk of developing type 2 diabetes in individuals with impaired glucose tolerance (IGT).<sup>7</sup> An elevated uric acid level often precedes the development of obesity<sup>8,9</sup> and diabetes.<sup>10,11</sup>

However, hyperuricaemia is not always found in diabetic patients, and conflicting data exist regarding uric acid in type 2 diabetes, as low levels may be found in diabetic patients, while elevated levels are a feature of IGT.<sup>12</sup> Although several studies have implicated the role of uric acid in the progress of pre-diabetes to diabetes, this remains controversial and therefore deserves further analysis. The main purpose of this study was to examine the association of serum insulin and uric acid levels in type 2 diabetic subjects in Maiduguri, Nigeria.

Biochemical parameters	Type 2 diabetes subjects (n=100)	Controls (n=60)	p value
FPG (mmol/L)	8.3±0.5	4.4±0.1	<0.001
Insulin (µIU/L)	9.3±2.0	5.1±0.6	0.025
Uric acid(µmol/L	35±89	334±66	0.069

Table 1: Comparison of biochemical parameters in subjects with type 2 diabetes and controls (means±SD)

#### and methods

Patients

A total of 160 subjects were recruited for the study. They were 100 known diabetic

	Biochemical parameters	r value	p value
)	FPG and insulin	-0.038	0.707
	FPG and uric acid	-0.206	0.040
)	Uric acid and insulin	0.410	<0.001

known diabetic Table 2: Correlation between serum insulin, subjects attend- uric acid, and FPG in diabetic subjects

### **Original Article**



Figure 1: Correlation plot between FPG and serum uric acid in diabetic subjects



Figure 2: Correlation plot between serum insulin and uric acid

ing the University of Maiduguri Teaching Hospital (UMTH) Endocrinology Clinic and General Outpatient Department, as well as 60 non-diabetic individuals as controls. All were within the age range of 30-75 years. Creatinine estimation was carried out to rule out kidney disease in all subjects. Those with type 1 diabetes, liver diseases, or kidney diseases were excluded from the study. Informed consent was sought from the selected individuals using standard guidelines. Ethical approval was obtained from the Ethical Committee of the UMTH. Plasma glucose was measured using the glucose oxidase peroxidase enzymatic method as described by Trinder.<sup>13</sup> Insulin was measured by enzyme-linked immunosorbent assay (ELISA), as described by Gerbitz et al.14 Serum uric acid concentration was measured by the uricase-peroxidase method as described by Trivedi et al.15

The data generated were analysed using the Statistical Package for Social Sciences (SPSS) version 16.0. Student's t-test was used to compare the means of fasting plasma glucose, serum insulin, and serum uric acid of diabetic and control subjects. The correlations were done by Pearson's correlation coefficient. Scatter plots were determined by using Microsoft Excel. A p value of less than or equal to 0.05 was considered statistically significant

#### Results

The mean age of the diabetic patients (n=100) was 50 $\pm$ 1 years compared with 49 $\pm$ 1 years for controls (p=0.537). Mean body mass index was 27.8 $\pm$ 5.7 (diabetic group) versus 28.9 $\pm$ 5.1 (controls), also non-significant (p=0.324). Similarly, systolic blood pressure (BP) and diastolic BP were similar between the two groups (138 $\pm$ 2 vs 128 $\pm$ 3 mmHg, p=0.898; and 85 $\pm$ 1 vs 87 $\pm$ 2 mmHg, p=0.158).

The mean fasting plasma glucose (FPG) and serum insulin were significantly (p<0.05) higher in diabetic subjects than in the control subjects. However, there was no significant difference (p>0.05) in serum uric acid levels of diabetic and control subjects as shown in Table 1.

As shown in Table 2, there was no significant correlation between FPG and serum insulin (r = 0.038; p > 0.05). The correlation between FPG and serum uric acid was negative and significant (r = 0.206, p < 0.05) which is further illustrated by the scatter plot in Figure 1. A positive and significant correlation was observed between serum uric acid and insulin (r = 0.410; p < 0.001), and the scatter plot in Figure 2 also shows this.

#### Discussion

This study was undertaken to determine the association between serum insulin and uric acid concentrations in type 2 diabetes subjects attending the UMTH. As may be expected, FPG and insulin levels were higher in our diabetic group compared with controls, but there was no significant difference in serum uric acid levels (Table 1).

Hyperglycaemia and insulin resistance occurs when the beta cells of the pancreas become less sensitive to the effects of insulin. This results in hyperglycaemia and a drop in energy production. To compensate for the insulin resistance and to attempt to maintain normoglycaemia, the pancreas produces more insulin. If left unchecked, the cells become even more resistant to insulin, as the pancreas secretes greater amounts in an attempt to bring the system back under control. This results in high blood levels of insulin.<sup>16</sup>

In this study, the similar serum uric acid levels in subjects with type 2 diabetes and control subjects is in agreement with the findings of Sudhindra and Bino.<sup>17</sup> The negative correlation observed between FPG and insulin was not significant. The insignificant decrease in glucose with increase in insulin may be due to insulin resistance and failure of the pancreas to maintain the state of compensatory hyperinsulinaemia, which is the maintenance of normal blood glucose via elevated plasma concentrations of insulin.

Anegative and significant correlation was shown between FPG and serum uric acid. The significant decrease in FPG with increase in uric acid may be related to insulin resistance. The mechanisms by which uric acid is involved in glucose concentrations or beta cell function and even the development of type 2 diabetes are uncertain.<sup>20</sup> It is accepted that the most important mechanism may be that of the association between insulin resistance and renal absorption of urates.<sup>18</sup>

In this study we also observed a positive and significant correlation between serum uric acid and insulin in our type 2 diabetes subjects. Whenever there is an increase in insulin level, there appears to be an increase in uric acid level. This may be due to the elevation of serum uric acid which is associated with IGT. Elevated uric acid is also a feature of hyperinsulinaemia and insulin resistance.<sup>19</sup> The result in this study is similar to that reported by Choi et al<sup>20</sup> and Anju et al.<sup>16</sup>

Based on our research work, it could be deduced that there is a positive correlation between the serum uric acid and insulin levels in type 2 diabetic subjects attending the University of Maiduguri Teaching Hospital. Further work is needed to elucidate the exact cause of this relationship, and its clinical implications.

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### Vitamin D supplementation improves insulin resistance in type 2 diabetes subjects in Lagos, Nigeria

A C Anyanwu, O A Fasanmade, H A B Coker HAB, and A E Ohwovoriole

#### Abstract

Type 2 diabetes is a disease caused by both insulin resistance and an insulin secretory defect. Reports suggest that vitamin D<sub>3</sub> supplementation improves insulin resistance and pancreatic beta-cell function, but there is paucity of data on vitamin D and glycaemia in type 2 diabetes in Nigeria. We have therefore performed a single blind prospective randomised placebo-controlled trial, involving type 2 diabetes participants in Lagos, Nigeria. The participants consisted of 42 type 2 diabetes patients with vitamin D deficiency. These participants were randomised into two equal groups of treatment and a placebo arm. Vitamin  $D_3$  (3000 IU daily) was given to the participants in the treatment arm. Insulin resistance (HOMA-IR) and pancreatic beta-cell (HOMA-B) function were determined at baseline and after 12 weeks of vitamin D<sub>3</sub> supplementation, or placebo treatment. There was a reduction from baseline in the mean insulin resistance level in both the treatment and placebo groups. However, this reduction was only statistically significant in the treatment group (p < 0.01). The proportion of subjects with improvement in insulin resistance status (homeostatic model assessment insulin resistance score (HOMA-IR)<2.0) was significantly higher in the treatment arm (p < 0.05). There was a reduction in the mean insulin secretory capacity in the treatment group while it increased in the placebo group, though this difference was not statistically significant. We conclude that vitamin D<sub>3</sub> supplementation results in a reduction in insulin resistance, but has no effect on pancreatic beta-cell function in type 2 diabetes.

A C Anyanwu, O A Fasanmade, and A E Ohwovoriole, Department of Medicine, College of Medicine, University of Lagos, CMUL, Lagos University Teaching Hospital, Lagos, Nigeria and H A B Coker, Faculty of Pharmaceutical Sciences, College of Medicine, University of Lagos, CMUL, Nigeria. Correspondence to: Dr Anthony Chinedu Anyanwu, Endocrinology Unit, Department of Medicine, Federal Medical Centre, Owerri, PMB 1010, Owerri, Imo State, Nigeria. Email chattony2000@yahoo.com

#### Introduction

Type 2 diabetes is a disease caused by both insulin resistance and an insulin secretory defect.<sup>1</sup> The effect of vitamin D on beta-cell function and insulin sensitivity has been observed in both animal and human studies.<sup>2</sup> Dietary vitamin  $D_3$  supplementation has been shown to improve glycaemic control and insulin sensitivity in people with diabetes and in normal populations.<sup>3</sup>

Vitamin D is required for and improves the production of insulin; and also improves insulin sensitivity.<sup>4</sup> Insulin secretion is impaired in the vitamin D-deficient pancreas, and it is improved by dietary vitamin  $D_3$ supplementation.<sup>2</sup>Vitamin Dhas been shown to facilitate the biosynthetic capacity of pancreatic beta-cells and also accelerates the conversion of pro-insulin to insulin.<sup>5</sup> One study has shown a significant correlation between changes in vitamin D levels and first- phase insulin secretion, with a decrease in insulin resistance after one month of vitamin  $D_3$  supplementation.<sup>6</sup>

Reports suggest that vitamin  $D_3$  supplementation improves insulin resistance and pancreatic beta-cell function. However, there is paucity of data on the relationship between vitamin D and glycaemia in type 2 diabetes in Nigeria. The objective of this study was therefore to determine the effect of vitamin  $D_3$  supplementation on insulin resistance and pancreatic beta-cell function in vitamin D-deficient type 2 diabetes subjects.

#### Patients and methods

This study was carried out at the Diabetes Clinic of the Lagos University Teaching Hospital (LUTH). It was a single blind prospective randomised placebo-controlled trial, involving type 2 diabetes participants. The study subjects were 42 type 2 diabetes participants with vitamin D deficiency selected following a prior cross-sectional study on 114 type 2 diabetes patients for determination of vitamin D status. The participants were randomised into two equal groups for the treatment and placebo arms of the study.

Laboratory tests carried out include analysis for: fasting glucose, HbA1c, calcium, albumin, phosphate, serum insulin, creatine, and alanine transaminase. Vitamin D

#### 4 3.5 3 Mean HOMA-IR 2.5 2 baseline 1.5 2.91 2.51 post-treatment 1 1.9 T = SEM1.32 0.5 0 Treatment Placebo Subject groups

Figure 1: Effect of vitamin D3 on insulin resistance after 12 weeks of treatment. There was a significant reduction in the baseline mean HOMA-IR after 12 weeks of vitamin D3 supplementation in the treatment group. The reduction in mean HOMA-IR in the control group was not statistically significant.



Figure 2: Effect of vitamin D3 on pancreatic beta-cell function

levels were determined using high-performance liquid chromatography (HPLC). Vitamin D<sub>3</sub> supplements (3000 IU daily for 12 weeks) were given to the participants in the treatment arm, and a placebo (50 mg of corn starch) was given to the placebo arm. The doses of participants' oral anti-diabetic medications were kept constant during the study period. Insulin resistance and pancreatic beta-cell function were determined at baseline and after 12 weeks of follow-up. Insulin resistance and beta-cell function were estimated with the homeostasis model assessment (HOMA-IR),<sup>7</sup> defined as the product of fasting serum insulin ( $\mu$ U/ml) and fasting blood glucose (FBG mmol/L) divided by 22.5. A score of ≥2.0 defined IR.<sup>8</sup> Insulin secretion function (IS or HOMA-B) was defined as the product of 20 and fasting insulin ( $\mu$ U/ml) divided by FBG (mmol/l) minus 3.5. Ascore of <100 defined reduced IS (betacell function).<sup>8</sup>

Participants were aged 35-65 years with type 2 diabetes and on oral antidiabetic medication. They gave informed consent, and had previously documented vitamin D deficiency. Patients excluded from the study included those with type 1 diabetes on insulin, pregnant women, and those with chronic diseases including renal insufficiency (glomerular filtration rate (GFR)<30ml/min), chronic liver disease or alanine transaminase (ALT) >5 times the upper reference limit, tuberculosis, diarrhoea, or malabsorption states.

The sample size was calculated using the formula described by Whitley and Ball.<sup>9</sup>Statistical analysis was done using the Statistical Package for Social Sciences (SPSS) version 20. Results were expressed as means (±SD) and percentages. Comparisons between treatment groups were made using Wilcoxon, Chi square and Z-tests. A p value<0.05 was considered statistically significant.

#### Results

Patients' adherence was assessed by tablet counts at each visit. There was an overall adherence of 62% and 60% in the treatment and placebo groups respectively.

The mean age of the participants was  $52\pm 2$  years in the treatment group and  $51\pm 2$  years in the placebo group (p value not significant (pNS)). There were 10 (59%) fe-

males and seven (41%) males in the treatment group, and nine (56%) females and seven (44%) males in the placebo group (pNS). The mean (±SD) body mass index (BMI) was 28.4±4.0 vs 26.5±0.9 in the treatment and placebo arms respectively (pNS).

Figure 1 shows a reduction from baseline in the mean insulin resistance (HOMA-IR) level in both the treatment and placebo groups. The mean baseline values (95% CI) were 1.9 (1.0–2.8) and 2.9 (1.1–4.7) respectively; and the post-treatment values were 1.3 (0.8–1.9) and 2.5 (1.5–3.5) respectively. However, this reduction was only statistically significant in the treatment group (p<0.01).

The proportion of subjects with improvement in insulin resistance status (HOMA-IR<2.0) was significantly higher

### **Original Article**

in the treatment arm , 80% (4 out of 5) compared with the placebo arm, 12% (1 out of 8).

Figure 2 shows the effect of vitamin  $D_3$  supplementation on pancreatic beta-cell function (HOMA-B) in both groups. There was a reduction in the mean HOMA-B (insulin secretory capacity) in the treatment group (p=0.29) while it increased in the placebo group (p=0.18). These differences were, however, not statistically significant.

There was an appropriate reduction in the mean HOMA-B in the treatment group while it increased in the placebo group.

Out of the 16 subjects with impaired pancreatic beta-cell function, one subject improved in the treatment group; whereas there was no change in the HOMA-B status in the placebo group.

#### Discussion

Vitamin D deficiency is a global healthcare concern. A growing number of studies have reported widespread vitamin D deficiency and insufficiency in both apparently healthy populations and patients with various pathologies including diabetes.<sup>10</sup> It has been estimated that one billion people worldwide are affected by various degrees of vitamin D deficiency.<sup>11</sup> Since the first report on the influence of vitamin D on insulin secretion,<sup>12</sup> evidence has suggested a role for vitamin D in both the occurrence<sup>13</sup> and treatment of type 2 diabetes.<sup>14,15</sup> There is now convincing evidence that vitamin D has some role in both pancreatic insulin secretion and insulin sensitivity, and thereby affects the pathogenesis of the disease.<sup>14,15</sup>

Vitamin D receptors (VDRs) are found throughout the body including in pancreatic beta-cells.<sup>16</sup> Vitamin D appears to play a role in the regulation of insulin release in response to glucose intake.<sup>16,17</sup> Direct effects may be mediated by binding of the active form 1,25 (OH)D to beta-cell VDRs.<sup>18</sup> Vitamin D may indirectly affect insulin secretion via regulation of calcium-mediated insulin release by regulating calcium influx through the cell membrane.<sup>16</sup> Vitamin D may also enhance insulin responsiveness for glucose transport by directly stimulating the insulin receptor.<sup>16,17</sup> It may indirectly influence insulin action via regulation of calcium influx through the cellular membrane, thereby ensuring normal calcium-mediated insulin release.<sup>16,17</sup>

Vitamin D may promote beta-cell survival by modulating the effects of inflammatory cytokines and decreasing beta-cell destruction.<sup>17</sup> Vitamin D may prevent generation of cytokines by interfering with the promoter gene for transcription factors and up-regulation of cytokine binding proteins.<sup>16,17</sup>

The finding of an improvement in insulin resistance after vitamin  $D_3$  supplementation in this study is consistent with findings from previous studies.<sup>19,20</sup> A randomised, placebo-controlled trial concluded that improving vitamin D status in insulin-resistant women resulted in improved insulin resistance and sensitivity, but no change in insulin secretion.<sup>20</sup> We found no significant effect of

vitamin D<sub>3</sub> supplementation on pancreatic beta-cell function (HOMA-B) in individuals with type 2 diabetes compared with controls. This finding is similar to that reported by von Hurst et al.<sup>20</sup> In Caucasian patients with impaired fasting glucose, oral supplementation with vitamin D and calcium reduced the progression of insulin resistance and increased insulin sensitivity.<sup>21</sup>

It is somewhat surprising that the pancreatic betacell function (insulin secretory capacity) reduced after supplementation in the treatment group compared with the placebo group. This is probably due to the improvement in insulin sensitivity noted in the treatment group. Interpretation of the beta-cell function should not be done in isolation as one might conclude erroneously that the participants in the treatment arm had failing beta cells as opposed to appropriately low secretion.<sup>22</sup>

Our study does have some limitations. Participants were assumed to have kept their doses of anti-diabetic medication constant during the intervention period. They were also assumed not to be taking vitamin D-containing complementary medicines during the intervention period. Also, HOMA, an indirect index of beta-cell function, was used to assess insulin resistance instead of the euglycaemic clamp (due to cost and unavailability). Finally, changes in lifestyle, diet, or physical activity may have occurred among study participants during the period of vitamin  $D_3$  supplementation, but this was difficult to account for as a confounder.

In conclusion, this study revealed a significant improvement in the insulin resistance status of vitamin D-deficient type 2 diabetes subjects following vitamin  $D_3$  supplementation. However, supplementation of vitamin D did not improve pancreatic beta-cell function. Reports of improvement in glycaemic control in persons with type 2 diabetes after administration of vitamin D may stem from this beneficial effect of vitamin D on insulin resistance.

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### Effect of distance on access to health services among women with type 2 diabetes in a rural community in Kenya

L W Mwaura, S Wandibba, and C O Olungah

#### Abstract

This cross-sectional and descriptive survey has determined the extent to which distance to the formal healthcare facilities influences the health-seeking behaviour of women suffering from diabetes in Kiambu County, Central Kenya. The lottery method and systematic sampling were used to select the study sub-counties and study sample size of 200 women. Data were collected using face-to-face interviews through survey methods, key informant interviews, and focus group discussions and narratives. The age of the respondents ranged from 18 to 85 years, while their modal range of age was 63-67 years. Over a half (54.0%) had primary education, 23.5% had secondary school education, and 18.5% had no formal education. Others (2.0%) reported that they had either university education or adult literacy classes. The range of distance covered was 1–141 km and the modal range of the distance travelled was 15–19 km. This study indicated that distance impacts choice of a health facility, cost of health services, frequency of clinic attendance, and mode of transport from home to the health facility. Taking health services closer to persons suffering from diabetes could benefit healthseeking behaviour.

#### Introduction

Diabetes, a long-term metabolic condition, requires self-care, family support, and care at health facilities in order to reduce health-related risks, improve health outcomes, and promote better quality of life.<sup>1</sup> Physical access to health services is considered an important barrier to provision of both preventive and curative services, particularly for rural populations residing in resource-scarce countries.<sup>2,3</sup>

L W Mwaura, Kenya Medical Research Institute, Nairobi, Kenya; S Wandibba, Institute of Anthropology, Gender & African Studies, University of Nairobi, Kenya; C O Olungah, Institute of Anthropology, Gender & African Studies, University of Nairobi, Kenya. Correspondence to: Dr Lydia W Mwaura, Kenya Medical Research Institute, Nairobi, Kenya. Email: lydmwaura09@gmail.com Geographical access to healthcare can be measured in travel time or distance travelled to a health facility, taking into consideration physical barriers and poor road networks.<sup>4</sup> Road networks and infrastructure in optimum condition are necessary for easier travel to health facilities, and for timely referrals in emergencies such as those that occur in persons suffering from diabetes. Conversely, lack of adequate road infrastructure and reliable transport services, as seen in resource-deprived regions and countries such as Kenya, is a notable barrier to access to healthcare. In remote rural health facilities this means that more time and finances are required, which act as obstacles to obtaining care, especially for women and the poor.<sup>5</sup>

Underprivileged and vulnerable populations mainly use public health facilities for their healthcare needs. These health facilities are, however, often not within reach of the majority of individuals living in rural areas.<sup>6</sup> Although a primary healthcare facility should ideally be at least within a 15 minute walking distance,<sup>7</sup> most walk long distances to get to such facilities. The policy of the government of Kenya is to make healthcare facilities easily accessible to all and, therefore, increase utilisation for better diabetes care.

This study was conducted to determine the role of distance in accessing healthcare by women in a rural setting in Kenya. The findings could help the government in the implementation of intervention programmes that enable women to access healthcare whenever they need to and wherever they reside.

#### **Patients and methods**

This was a cross-sectional and descriptive clinic-based survey involving 200 women with diabetes aged 18–85 years, drawn from two out of twelve sub-counties in Kiambu County, Central Kenya. Central Kenya is among three other regions in the country with a high burden of diabetes compared with other regions. The lottery method was used to select the two sub-counties. A sample size of 200 respondents, selected using a statistical formula recommended for cross-sectional studies, was considered adequate to provide pertinent information required during the face-to-face interviews.

A structured questionnaire, the main research



Figure 1: Distance that patients travelled to the health facility

Clinic attendance	Frequency (%)
No response	1 (0.5%)
Weekly	5 (2.5%)
Two weeks	13 (6.5%)
Three weeks	4 (2.0%)
Monthly	46 (23.0%)
Two months	26 (13.0%)
Three months	85 (42.5%)
Over four months	20 (10.0%)
Total	200 (100%)

Table 1: Frequency of diabetes clinic attendance

pilot study, face-to-face interviews were conducted to collect data on the extent and nature of formal healthcare obtained, predisposing factors and constraints to utilisation of formal healthcare.

During the second phase, key informant interviews were conducted with four health providers comprising nurses and social workers in the diabetes clinics. Case narratives, derived from purposively sampled narrators, were also conducted during this phase. Phase three involved conducting focus group discussions on healthseeking behaviour of the study elements. Qualitative data, obtained in these two phases, complemented the quantitative data collected during phase one of the study. Information collected during the interviews included age, marital status, educational status, main occupation, income, type of facility, distance to the facility, and mode of transport used, as well as predisposing, enabling, need, and restrictive factors.

To obtain distances from home to diabetes clinics, the Geographical Information System (GIS) was used. The

instrument, consisted of openended and closedended questions. The questionnaire was piloted during the first phase of the study in a neighbouring sub-county. This was aimed at pre-testing and refining the survey instrument. Subsequent to the system was used to compile county and sub-county administrative boundaries, villages, roads, and public health facilities. Specific villages of interest, where the study sample resided, were identified and plotted as points. Using a measuring tool, ground distances were measured from the identified points in the villages along the roads to the main health facilities. Distances were measured in kilometres.

Data were analysed quantitatively and qualitatively using the Statistical Package for the Social Sciences (SPSS) programme Version 21.0, and through content and thematic analyses, respectively. The narratives were recorded verbatim without any attempt to alter meaning.

#### Results

In total, 200 respondents were interviewed in this study. The respondents travelled varying distances from their places of residence to the health facilities of their choice (see Figure 1). More than one third (37.5%) of the respondents travelled a distance of 10-19 km, followed by one quarter (25.0%) who covered a distance of 0-9 km. Other respondents (19.0%) travelled 20-29 km, while 10.5% covered a distance of 30–39 km. There were 3.0% who covered a distance of 60–69 km, 2.5% travelled 40-49 km, while 1.5% covered a distance of over 70 km. Lastly, a small proportion (1.0%) indicated that they travelled a distance of 50-59 km. The respondents' modal range of distance travelled was 15–19 km. The range of distance travelled was 1–141 km. Using Pearson's correlation coefficient test, results indicated that an increase in the distance travelled to the health facility was associated with a decrease in the frequency of seeking medical treatment (p < 0.05).

#### **Diabetes clinic attendance**

Frequency of clinic attendance was determined by prevailing individual health needs. Table 1 shows the frequency of clinic attendance for the 200 patients. Most (42.5%) attended the clinic every three months, with 78.5% attending a clinic at intervals of between one and three months.

#### Mode of transport from home to health facility

Mode of transport to a health facility has a bearing on cost, and such cost is also influenced by distance. There were 179 (89.5%) who used public minibuses (matatu), and 56 (28.0%) who used motorbikes. Only 13 (6.5%) walked to the clinic, 8 (4.0%) used a personal car, and 7 (3.5%) travelled by taxi.

### **Original Article**

#### Discussion

This study was conducted in a rural area with over a half of the respondents having attained primary education and slightly more than half engaged in subsistence farming. These demographic characteristics, inter alia, influence health-seeking behaviour in different ways. The results also indicate that distance to the health facilities was considered by the respondents as one of the limiting factors to seeking care in health facilities.

In low-income countries, the distance that persons travel to health facilities has been reported to be a determinant of health-seeking behaviour. For example, recent studies on health services utilisation in Pakistan and Zambia respectively, observe that physical distance to the health facility influences health seeking-behaviour and use of health services.<sup>8,9</sup> In our study, some of the women chose to travel from their rural homes to residences of their relatives who lived closer to the health facilities in order to report to the clinic on time. Similar observations were made in Tanzania regarding distance, indirect costs, and use of public transport.<sup>10</sup> The findings on the complications that distance adds to accessing formal health services in the foregoing studies are consistent with some recent studies in Kenya,6,11 on geographical distance from place of residence to a health facility as a factor for consideration in the choice and use of health services.

Distance influences frequency of clinic attendance and the overall management and treatment of diabetes. The debilitating nature of diabetes potentially results in long-term damage, malfunction, and eventual failure of different body organs.<sup>12</sup> This requires the women to attend diabetes clinics at designated intervals for screening and monitoring diabetes control, blood pressure, weight, etc. Uptake of health services, based on the level of illness, is dependent on predisposing, enabling, and need-forcare factors.<sup>13-15</sup> The need to cover varying distances by the respondents and accompanying costs influenced the follow-up protocol at the health facility.

Challenges of geographical accessibility to health facilities cause patients to use different modes of transport to access biomedical treatment. In this study, women with diabetes in Kiambu County walked, used public and private means of transport, and, in a few cases hired vehicles in order to reach health facilities. Use of transport has an impact on healthcare expenditure. When women were accompanied to and from health facilities, the cost of transport increased. In some cases, depending on their general health status, two adults accompanied them. Accompanying an ill person to a health facility constitutes indirect costs of illness, which is an increase in the burden on the household budget.3,16 Limited access to transportation and costly public transport are among the challenges facing women while seeking treatment, particularly in resource-poor settings.<sup>17</sup>

In conclusion, this study revealed that distance from place of residence to the health facility invariably influences the frequency of clinic attendance, mode of transport, and cost of transport for persons suffering from diabetes.

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### Effectiveness of a targeted education module for healthcare professionals attending a diabetic retinopathy training session in Zimbabwe

**R** Woodward and A Matimba

#### Abstract

The Zimbabwe Diabetes Retinopathy Telemedicine Project (ZRTP) was created to develop a pilot programme to screen for diabetic retinopathy among patients attending a diabetes clinic in a public hospital. As part of the project, mid-level healthcare professionals (HCPs) attended one of four half-day training sessions in Harare, Zimbabwe; and took a five-question quiz before and after a 40-minute lecture reviewing the pathophysiology of diabetes and the detection and effects of diabetic retinopathy. Analysis of the preand post-lecture quiz results suggest that mid-level HCPs are deficient in some basic knowledge about diabetic retinopathy and diabetes, but this could be significantly improved by a relatively brief but focused lecture session.

#### Introduction

The International Diabetes Federation estimates the number of adults with diabetes in Africa will double in 20 years, from 19.8 million in 2013 to 41.5 million in 2035.<sup>1</sup> One complication in particular, diabetic retinopathy, is associated with disability and escalating costs to society when it leads to permanent visual impairment. The management of diabetic retinopathy in sub-Saharan Africa is hindered by a lack of awareness of the benefits of regular eye screening, as well as a lack of suitable systems for routinely screening patients.<sup>2</sup>

In order to address this problem, The Zimbabwe Diabetes Retinopathy Telemedicine Project (ZRTP) held training sessions for mid-level healthcare professionals (HCPs) to prepare them to assist patients participating in a pilot diabetic retinopathy-screening programme. Each training session included a 40-minute lecture reviewing diabetes and diabetic retinopathy. An identical five-question quiz was given to each attendee before

R Woodward, BA, Medical Student, Weill Cornell Medical College, New York, NY, USA and A Matimba, PhD, Department of Clinical Pharmacology, College of Health Sciences, University of Zimbabwe, Zimbabwe. Correspondence to: rlw2176@columbia.edu and after the lecture. The purpose of this study was to analyse the pre- and post-lecture data to determine the effectiveness of the lecture in improving knowledge of diabetes and diabetes retinopathy among mid-level HCPs in Harare, Zimbabwe.

#### **Methods**

A total of 56 HCPs attended one of four half-day training sessions that took place in 2014 at two different health facilities, one a large public hospital (Facility 1) and the other a private clinic (Facility 2). Most of the HCPs were general nurses (RGN), but nursing students, nursing tutors, hospital registrars, and junior doctors were among the attendees. Each attendee was asked to note their answers and not to write their name on the paper. The five questions (Appendix A) were presented as part of a PowerPoint presentation where each question was read out loud and shown on the screen. After the questions were given and answered, the quiz papers were collected from each participant. A lecture using PowerPoint slides as a visual aid was then given. Immediately after the lecture, the attendees were told, 'To reassess your basic knowledge after the lecture, we will ask the questions again.' The quiz was then administered again in an identical fashion to the pre-lecture quiz.

Each quiz was graded on a scale of 0–5, with zero indicating no correct answers and five indicating five correct answers. An independent sample t-test with pooled variance for the difference between two means was chosen to test the hypothesis that mid-level HCPs can achieve a better knowledge of diabetes and diabetic retinopathy though the targeted lecture. Pooled variance was applied because there were an unequal number of observations before and after the lecture (as a few individuals may have left the lecture early and did not complete the postlecture quiz, or some individuals arrived after the first quiz was given but took the post-lecture quiz).

#### Results

A total of 42 participants completed the pre-lecture quiz and a total of 48 participants completed the post-lecture quiz. The maximum and minimum scores for each group

	Scores					
	Pre-lecture minimum	Pre-lecture maximum	Pre-lecture mean	Post-lecture mean		
Facility 1						
Morning	1	5	2.7	5.0		
Afternoon	2	5	3.6	3.7		
Facility 2						
Morning	2	5	3.4	3.9		
Afternoon	2	5	3.7	4.1		

Table 1: Group minimum, maximum, and mean quiz scores sorted by session

Interval Plot of Before, After: Combined Score 95% CI for the Mean 4.4 4.2 4.0 3.8 3.6 3.6 3.6 3.4 3.4 3.4 3.2 Before After

Figure 1: Mean (+ 95% confidence intervals) test scores before and after the lecture

and the means of the morning and afternoon session for each day are shown in Table 1. The results comparing the means of the pre- and post-lecture scores showed a significant difference in the mean pre-lecture scores (3.4+1.2)and post-lecture scores (4.1+0.9). This was statistically significant (p=0.001), and results are shown in Figure 1.

#### Discussion

Pre- and post-lecture exam testing as a tool to assess student learning has been studied in various areas of higher education. The differences between pre- and post-lecture test scores are considered to be a valid measure of student learning in many business schools.<sup>3</sup> The impact of pre- and post-testing on learning outcome has also been studied in the context of continuing medical education (CME) and has been found to have a positive effect.<sup>4</sup>

Areview of the literature related to diabetes education for HCPs has shown instances where pre- and post-

testing has been used to document effectiveness of educational programmes for physicians. Pre- and post-tests demonstrated the effectiveness of a webbased CME programme designed to improve the management of diabetic retinopathy,<sup>5</sup> and pre- and post-testing was used to show the benefit of a sixweek course to train 11 general practitioners (GPs) in screening for diabetic retinopathy.<sup>6</sup>

Unlike other studies where pre- and post-tests were used to assess knowledge gain over an extended period of time among physicians, most of the attendees in our study population were mid-level HCPs and the study period was a single lecture. Our results show that the mean quiz score after the lecture was significantly higher than the mean score before the

lecture, which suggests that we achieved the goals of increasing knowledge of diabetes facts and awareness of complications among attendees.

Possible limitations to our study results include the fact that the study design restricted outcome to knowledge gain, and not to outcome consisting of performance in a clinical setting. In addition, the results did not test if the knowledge gain endured over time. Our study did not account for the distinction between knowledge improvement enhanced by taking the quiz and listening and viewing the lecture compared with the impact of

the lecture alone. The number of quiz questions, totalling five in our study, was intentionally kept brief to maintain focus on the lecture and keep the total lecture and pre- and post-lecture quiz time to no more than 1 hour. It is notable that a ceiling effect, manifested by a pre-test score that is too high and not allowing for finding change, did not occur. This suggests that even though the five-question quiz was brief, the selection of questions was appropriate for the participants' educational background and level of training.

In conclusion, we have shown that a single, short targeted lecture can produce noteworthy knowledge acquisition about diabetes and diabetic retinopathy among mid-level HCPs, and that the knowledge gain was unlikely to be a chance occurrence. The fact that scores went up also suggests mid-level HCPs are deficient in some basic knowledge about diabetic retinopathy and diabetes, but it is clearly open to improvement. By incorporating pre- and post-lecture quizzes into curriculae targeted for nurses and mid-level health professionals in Zimbabwe, we can increase knowledge of diabetes and diabetes complications, and identify gaps in knowledge. In this way, our study is a first step in creating a standard for knowledge about diabetic retinopathy, and other areas of diabetes, that is applicable for nurses and mid-level HCPs in Zimbabwe and potentially in other countries in sub-Saharan Africa.

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Appendix The five quiz questions are shown below, with the correct choice in bold				
Number	Questions			
1	Diabetes is:	<ul> <li>A. A major pubic health problem</li> <li>B. Causes blindness in young adults</li> <li>C. Is due to the body's inability to handle carbohydrates</li> <li>D. Is best controlled by keeping on TRACK (Take medications prescribed by doctor, Reach a healthy weight, Add physical Activity, Control ABC's (A1C, blood pressure, cholesterol), Kick smoking habit)</li> <li>E. Is a silent killer</li> <li>F. All of the above</li> </ul>		
2	Diabetes control means:	<ul> <li>A. Taking your tablets/medication</li> <li>B. Watching diet and exercise</li> <li>C. Knowing your blood sugar, blood pressure, and lipid levels</li> <li>D. Seeing your doctor regularly</li> <li>E. Having eyes and feet examined every year</li> <li>F. All of the above</li> </ul>		
3	Diabetic retinopathy	<ul> <li>A. Causes permanent blindness</li> <li>B. Is preventable</li> <li>C. Is asymptomatic at first</li> <li>D. Is best detected by an ophthalmologist in a yearly exam</li> <li>E. Is best treated before permanent vision loss occurs</li> <li>F. All of the above</li> </ul>		
4	You can catch diabetes from someone else	A. True B. False		
5	Eating too much sugar causes diabetes	A. True B. False		



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