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Blood glucose testing in the community: who are the users and do they have elevated blood glucose?

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ABSTRACT

INTRODUCTION: On-the-spot blood glucose testing is a health service performed in public spaces to raise diabetes awareness and screen for elevated blood glucose levels.

AIM: To describe the users of this service and the frequency of detecting elevated blood glucose.

METHODS: Data collected at point-of-testing on a standardised form over 20 months in two regions of New Zealand were audited. Descriptive and simple inferential statistics report on population demographics and presence of elevated blood glucose (mmol/L).

RESULTS: Data from 2156 individuals were audited. Most (1680, 78%) were female, the mean age was 52 years (standard deviation 18 years) and all major ethnic groups and socioeconomic quintiles were represented. For 53% of responders, this was their first blood glucose test. In total, 153 (7.1%) cases with elevated blood glucose were identified, including 94 who did not report a previous pre-diabetes or diabetes diagnosis. Blood glucose was not correlated with socioeconomic status ($r = 0.04$; $P = 0.07$), but weakly correlated with age ($r = 0.19$; $P < 0.001$). Blood glucose values did not appear to differ between ethnicities ($P = 0.052$). Men had a higher mean value than women ($P = 0.003$). People with elevated blood glucose access their general practitioner more often than people with normal blood glucose, irrespective of a diabetes diagnosis ($P = 0.002$).

DISCUSSION: On-the-spot blood glucose testing is a health service accessed by a wide range of people, although more commonly by women than men. Future interventions targeting men may better engage them in health screening. Alongside awareness raising, on-the-spot community testing identified previously unknown elevated blood glucose levels at a rate of 1-in-22, and may lead to the earlier identification and treatment of prediabetes or diabetes.

Keywords: Community services; diabetes awareness; hyperglycaemia; screening

Introduction

Diabetes is a leading contributor to heart disease, stroke, kidney disease and lower limb amputation.[1–3] Prevalence rates in New Zealand are similar to other developed countries, with 7% of adults diagnosed with diabetes and a further 25% with pre-diabetes, although many cases go undiagnosed.[4] A key factor in avoiding the progression from pre-diabetes into type 2 diabetes is its early identification.[5] Earlier detection of pre-diabetes and type 2 diabetes may also allow for the implementation of education and behavioural change strategies that reduce the associated risk of cardiovascular events and premature death.[6,7]

One strategy for the early detection of elevated blood glucose levels is the use of on-the-spot blood glucose testing. On-the-spot blood glucose testing is

screening undertaken in the community, takes a minute of time and does not cost people accessing the service. Furthermore, on-the-spot blood glucose testing may prompt people to consider broader aspects of health care.[8] On-the-spot blood glucose is typically a random measure, does not require fasting and does not constitute a diagnosis of prediabetes or type 1 or 2 diabetes.[9] Instead, on-the-spot testing is used to identify people who should follow up their initial results with their general practitioner for further testing.

WHAT GAP THIS FILLS

What is already known: On-the-spot blood glucose testing is a visible health screening service conducted in the community, often for free.

What this study adds: Our on-the-spot testing audit identified previously unknown elevated blood glucose at a rate of 1-in-22. On-the-spot community testing may lead to the earlier identification and treatment of prediabetes or diabetes.

To date, there has been almost no consideration of random blood glucose screening in the general community and its use in the early identification of abnormal blood glucose control. The purpose of this study, therefore, was to audit the information collected during on-the-spot community-based blood glucose testing in two regions of New Zealand to describe the users and the frequency rate of detecting elevated blood glucose levels.

Methods

This study received minimal risk health research (audit and audit-related studies) approval from the Human Research Ethics Committee of the University of Otago (HD19/054). Data were collected between April 2018 and November 2019.

Data tool

The information used in this audit was collected on a standard form in a blood glucose screening tool (see Supplementary Materials File S1). Consent to record details was obtained and indicated on the form. Questions to describe the health service users were: what is your age?; what is your sex?; what is your ethnicity?; what suburb or town do you live in?; are you enrolled with a general practitioner? (if so) how often do you go to them? Ethnicity answers were classified in line with the Ethnicity New Zealand Standard Classification 2005[10] prespecified answers.

Blood glucose readings were recorded on the form, as well as whether the reading was within a normal range (4–8 mmol/L), below a normal range (<4 mmol/L) or elevated (>8 mmol/L). We used 8 mmol/L as the threshold for hyperglycaemia in the absence of a recognised value following a random capillary blood glucose test, because of its use in previous research.[11] A flow chart of what to do for a reading in each category was printed with the forms and further details, such as previous diagnosis with diabetes, were captured. If participants' blood glucose values were outside of the normal range (4–8 mmol/L), they were advised by a practitioner nurse about going to see a general practitioner or diabetes and prediabetes self-care. A small card filled in with the day, time and blood glucose value was given to everyone with a reading outside the normal range with instructions to take to their general practitioner.

Data collection

Data were collected at 12 different supermarkets, shopping centres, clubs, council offices and community events around Dunedin over a 20-month period by nurses and volunteer staff or by four pharmacies in two regions of New Zealand (Otago and Southland) who offer on-on-the-spot blood glucose testing. Most tests were taken at events recognising World Diabetes Day in November 2018 and 2019. Standardised point-of-care blood glucose meters and test strips (CareSens N, i-SENS Inc., Seoul, South Korea) were used to measure capillary blood glucose levels. The form was completed within 1 min by a nurse, or by an assistant, while administering the blood glucose test.

Data collation

After ethical approval for the audit was obtained, the data were provided to the research team. Paper records were then entered into Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). The New Zealand index of Deprivation

Table 1. Baseline characteristics of participants (n = 2156)

Characteristics	Values
Number of women (based on 2152 answers)	1680 (78)
Age in years (based on 2154 answers)	52 s.d. 17.6
Ethnicity (based on 2183 total response counts)	
NZ European	1917 (88)
Māori	113 (5)
Pacific	46 (2)
Asian	75 (3)
MELAA	20 (1)
Other	12 (1)
NZiDEP (based on 1905 answers)	
Quintile 1 (least disadvantaged)	363 (21)
Quintile 2	290 (15)
Quintile 3	455 (27)
Quintile 4	593 (29)
Quintile 5 (most disadvantaged)	151 (8)
First time being tested (based on 1812 answers)	966 (53)
Frequency of going to GP (based on 1055 answers)	
Annually or less	253 (24)
Biannually	255 (24)
Between 1 and 6 months	373 (35)
Monthly or more	70 (7)
Random blood glucose reading (based on 2151 records)	
Low blood glucose (<4.0 mmol/L)	4 (0)
Normal blood glucose (4–8 mmol/L)	1994 (93)
Elevated blood glucose (>8 mmol/L)	153 (7)

Data are presented as n (%) unless otherwise stated.
s.d., standard deviation; NZ, New Zealand; MELAA, Middle Eastern/Latin American/African; NZiDEP, New Zealand Index of Deprivation.

(NZiDep2013) aggregated area unit decile was matched with the suburb participants provided for their address;[12] 304 (14%) recorded answers were excluded because a single NZiDep2013 could not be assigned with certainty to the suburb or township that participants listed. Descriptive statistics were used to characterise users of community-based blood glucose testing. Inferential tests such as unpaired *t*-tests or one way ANOVA were conducted in STATA 15 (StataCorp, College Station, TX, USA) to consider blood glucose value by each demographic variable.

Results

Data from 2,156 people who participated in community-based random blood glucose testing were audited. Their characteristics are shown in Table 1. On-the-spot blood glucose testing identified 157 readings outside of the normal blood glucose range. Four tests indicated low blood glucose (<4 mmol/L). The remaining 153 (7.1%) were for high blood glucose (>8 mmol/L), including tests from 59 participants reporting a previous diagnosis of prediabetes, type 1 or type 2 diabetes, indicating that approximately 1-in-22 participants were found to have elevated blood glucose without a previous diabetes-related diagnosis.

Differences in blood glucose value by demographic variables are shown in Table 2. Men had higher blood glucose values, with 12% having elevated blood glucose levels compared with 5% of women. Age was weakly correlated with blood glucose value ($r = 0.19$, $P < 0.001$). Ethnicity and NZiDep2013 as a measure of socioeconomic status did not appear to differ by blood glucose reading. Differences were visible in how frequently audited participants went to their general practitioner, as people with a high (>8 mmol/L) blood glucose value visited more frequently than people with normal blood glucose, as shown in Figure 1. This increased frequency in attending their general practitioner appeared irrespective of whether participants had a previous diabetes diagnosis.

Discussion

This study is the first audit we know of to routinely collect data to identify the users of community-based blood glucose screening and to consider its effectiveness in identifying elevated blood glucose levels in New Zealand. Participants in the audit represent a range of ages, ethnicities and socioeconomic levels. Our results indicate that community-based random blood glucose testing identifies situations of elevated blood glucose at a rate of 1-in-22 in people without a previous prediabetes or diabetes diagnosis.

A key finding was that although fewer men approached on-the-spot blood glucose testing than women, men had a higher mean blood glucose level than women. There may be differences in

Table 2. Blood glucose levels by demographic variables

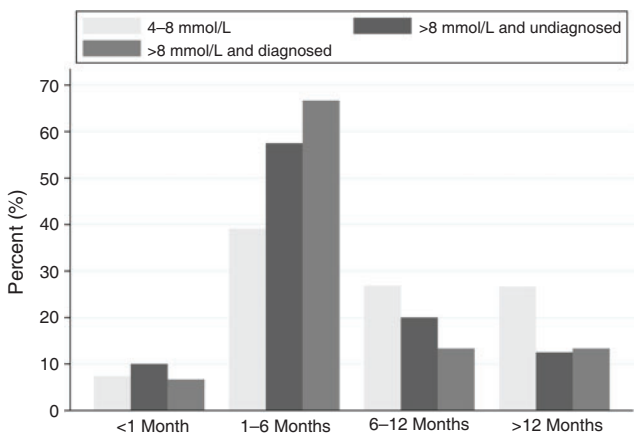
Variable	Mean blood glucose (mmol/L)	Standard deviation	P value
Women	5.95	1.45	0.003†
Men	6.18	1.24	
Major ethnicities			
NZ European	6.03	1.57	0.052‡
Māori	6.40	1.99	
Pacific	6.07	1.75	
Asian	6.39	1.51	
NZiDEP			
Quintile 1 (least disadvantaged)	5.95	1.19	0.123‡
Quintile 2	6.14	1.96	
Quintile 3	6.03	1.67	
Quintile 4	6.06	1.62	
Quintile 5 (most disadvantaged)	6.36	1.90	
Frequency of visiting general practitioner (months)			
<1	6.16	1.5	0.002‡
1–6	6.23	1.8	
6–12	5.94	1.9	
>12	5.75	1.1	

NZ, New Zealand; NZiDEP, New Zealand Index of Deprivation.
†unpaired *t*-test. ‡one way ANOVA.

motivators and barriers in accessing such health services between sexes, indicating the need to target men in future screening events, as has been done previously.[13] A second key finding was that people with a high blood glucose reading tended to access their general practitioner more often than people with a normal blood glucose reading, regardless of whether they had previously been diagnosed with prediabetes or diabetes. This may be due to the presence of comorbidities associated with elevated blood glucose levels.[14,15] Unfortunately, comorbidity data were not captured in the current study. Nevertheless, this remains an interesting finding from the current study that requires further investigation.

From a health system perspective, prevention is better than treatment.[16] Our audit from data collected over the last 20 months indicate that 2156 people directly benefited from on-the-spot blood glucose testing by learning more about their potential risk for elevated blood glucose. Of these people, 94 without a previous diabetes diagnosis were advised to see their general practitioner as they had elevated blood glucose levels.

Figure 1. Frequency of attending a general practitioner by blood glucose test level.



The threshold for hyperglycaemia of 8 mmol/L may be perceived as conservative when compared with a diabetes diagnostic value of >11.1 mmol/L;

however, directing people towards their general practitioner may enable a more global assessment of their health and a thorough assessment of the blood glucose reading not possible during on-the-spot community testing.

On-the-spot blood glucose testing services are organised and run by non-government organisations and registered charities as a complementary health service and a platform to raise health awareness. These services rely on volunteer time, as well as corporate donations, meaning they are conducted at very low direct cost. The visibility of a health service available in the community for free is, however, important. The presence of such health promotional events are an effective way of engaging people in conversations about health, as well as prompting people to access formalised health care for other reasons. Previous research has found that random blood glucose testing of people with elevated risk can prompt them to make lifestyle changes.[17] There could be wide-reaching and unidentifiable outcomes from conducting such a visible service such as talk between family members and the wider community regarding health concerns or health-promoting behaviours that are triggered by seeing or taking part in on-the-spot blood glucose testing.

This study has several strengths. To our knowledge, this is the largest study of its kind to provide evidence that on-the-spot blood glucose testing is effective at identifying elevated blood glucose levels in people without a previous diagnosis of diabetes. Data were collected on a standardised form, enabling confidence in consistent recording across data collection sites. The questions asked took 1–2 min with answers taken while the capillary blood sample was drawn and assessed, suggesting that data collection did not change the nature of the health service being audited. This study also has limitations that are worth noting. Data were collected in two regions of New Zealand and may not be representative of other populations. We were unable to follow up with the 94 participants without diagnosed prediabetes or diabetes who were advised to contact their general practitioner due to receiving a high random blood glucose level. Therefore, it was beyond the scope of the current project to measure how often a high random blood glucose test may identify underlying problems.

Given the findings of this study, future interventions could consider targeting men to better engage them in health screening. Further research is required to understand if an initial on-the-spot glucose test indicating elevated blood glucose levels may lead to a diabetes diagnosis. Such a study may best be conducted in primary care. Considering the comorbidities often associated with diabetes and their monetary cost to health services and social cost to the community, the benefits of early detection and early intervention are substantial. Further research as a result of this study should also consider if the frequency that a patient attends their general practitioner is an indicator of the need for a blood glucose test.

On-the-spot glucose testing in the community is one way to promote early detection while potentially raising awareness of other health-promoting behaviours or stimulating discussions about broader health risks. We have considered, perhaps for the first time, who are the users of this service and found them to be from a wide range of socioeconomic quantiles, ethnicities and ages. We have also identified that 1-in-22 people who accessed this screening had a high random blood glucose level without a previous diabetes diagnosis. This study therefore hints at the usefulness of this community-based health service in potentially reducing inequities, as well as use of community screening for the early identification of dysglycaemia. Although seeing or participating in blood glucose testing in the community may raise health awareness, further work is needed to provide greater context to the clinical relevance of receiving a high random elevated blood glucose test.

Competing interests

The authors declare no conflicts of interest.

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