Jennifer H Howse, Steve Jones and A Pali S Hungin

Screening and identifying diabetes in optometric practice:

a prospective study

Abstract

Background
Unconventional settings, outside general medical practice, are an underutilised resource in the attempt to identify the large numbers of people with undiagnosed diabetes worldwide.

Aim
The study investigated the feasibility of using optometry practices (opticians) as a setting for a diabetes screening service.

Design and setting
Adults attending high street optometry practices in northern England who self-reported at least one risk factor for diabetes were offered a random capillary blood glucose (rCBG) test. Those with raised rCBG levels were asked to visit their GP for further investigations.

Results
Of 1909 adults attending practices for sight tests, 1303 (68.2%) reported risk factors for diabetes, of whom 1002 (76.9%) had rCBG measurements taken. Of these, 318 (31.7%) were found to have a rCBG level of ≥6.1 mmol/l, a level where further investigations are recommended by Diabetes UK; 1.6% of previously undiagnosed individuals were diagnosed with diabetes or pre-diabetes as a result of the service. Refining the number of risk factors for inclusion would have reduced those requiring screening by half and still have identified nearly 70% of the new cases of diabetes and pre-diabetes.

Conclusion
Screening in optometric practices provides an efficient opportunity to screen at-risk individuals who do not present to conventional medical services, and is acceptable and appropriate. Optometrists represent a skilled worldwide resource that could provide a screening service. This service could be transferable to other settings.

Keywords
diabetes mellitus, type 2; optometry; prediabetes; primary care; screening.

INTRODUCTION

Between 20% and 50% of people with diabetes are thought to be undetected worldwide,[1–3] and may only be diagnosed with the condition when complications present. Diabetes is an increasing global problem, with an estimated 150 million people affected in 1995. This figure is predicted to rise to 300 million by 2025.[4] Late diagnosis of the disease is an international problem. While the prevalence is increasing, detection strategies are still largely confined to medical or hospital settings.[5,6]

Even with the increased awareness of diabetes and campaigns by national diabetes charities,[7] which may have reduced the proportion of people with undiagnosed disease, a 'hard-to-reach' group remains undiagnosed. There is also a substantial cohort of people with impaired glucose tolerance (IGT) and impaired fasting glucose (IFG), the majority of whom are at increased risk of developing diabetes and the associated complications.[8] Among adults in the US, the known prevalence of IGT is 11.2%. This increases with age, rising to 22.8% for those aged 65 to 74 years.[9] Similarly, the prevalence of IFG among adults is 6.9%, with 14.1% of those aged 75 years and over affected.[9] These figures are likely to be substantially higher in Middle Eastern and Asian countries.[10]

Identifying and targetting those who would benefit from screening are global challenges. Despite sustained efforts to detect diabetes in the UK, up to 22% of men with diabetes remain undetected.[3] While universal screening is not currently recommended, there is some evidence for targeted screening,[11] and different methods to identify those at risk have been evaluated. Screening has traditionally been the role of primary care physicians. In the UK, while there is no specific diabetes screening programme, fasting blood glucose or glycosylated haemoglobin (HbA_{1c}) measurements are included in the National Health Check programme for 40–74-year-old individuals, if certain conditions are present[12] (however, the service will be accessed through general practices). In the UK, health care is free at the point of access and cost is not a factor in accessing services. Still, there are many people who are not likely to use medical services for preventive care or for an earlier diagnosis. Unconventional settings may be an effective way to target these groups.

Testing for diabetes in other settings has considerable potential worldwide. Other healthcare professionals do have the ability to carry out screening tests and may be able to see individuals who would not present to their GP. Both pharmacists and chiropodists have evaluated the feasibility of screening within their normal practice settings in the UK,[13,14] Australia,[15] and Switzerland.[16] In the UK, pharmacists have been involved in providing screening services and have developed a protocol with Diabetes UK and the Royal Pharmaceutical Society of Great

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Submitted: 10 November 2010; **Editor's response:** 11 January 2011; **final acceptance:** 24 January 2011.

This is the full-length article (published online 27 Jun 2011) of an abridged version published in print. Cite this article as: **Br J Gen Pract 2011; DOI: 10.3399/bjgp11X583227.**

How this fits in

Screening for diabetes can be carried out outside general medical practice by other health professionals in other locations, such as within optometrists' practices. This may be successful in reaching people who would not routinely attend their GP. However, for screening to be successful, effective communication between GPs and optometrists is required.

Britain (RPSGB).[17] In the US, it has been determined that 60% of adults visit dentists at least once a year for routine care, and so this may be a suitable location to screen for diabetes.[18]

Likewise, optometrists (opticians) are providers of routine, non-emergency care and may be accessed by those who are not receiving medical care. The age of onset of presbyopia and the subsequent deterioration in near vision coincides with the age that screening for diabetes is recommended by both Diabetes UK and the American Diabetes Association (ADA). This again may provide opportunities for optometrists to provide tests to those who may not access other healthcare services, particularly if they have no other medical problems.

Optometrists provide eye health care worldwide and have the potential to provide services in both developed and developing countries. In the UK, 17 million sight tests are performed yearly, over one-third on people aged 60 years or over.[19] Optometrists are in a position to ask patients about diabetes risk factors during the course of a sight test. In Australia, it has been shown that around 80% of optometrists always or often ask patients aged over 40 years about diabetes.[20] Optometrists may be in a good position to reach a section of the population that may not routinely access other healthcare professionals. While the proportion of people attending optometrists who also regularly access GP services is not known, optometrists are aware that they see people who do not access other services.[21] Currently, although optometrists are involved in diabetic retinopathy screening in different countries,[20,22] they have not been involved in screening for diabetes itself. It has been shown that some optometrists would be willing to be involved in screening.[21]

The aim of this study was to ascertain the practicality of random capillary blood glucose (rCBG) testing in optometry practices, to detect high-risk individuals who may benefit from further investigations to identify diabetes and pre-diabetes.

METHOD

The study was set in optometry practices in northern England. Opticians were contacted by letter and meetings were arranged with those who expressed an interest in participating. Ten optometrists, from five practices representing a mix of practice size and organisation, agreed to participate. The participating practices were situated in three different primary care trusts (PCTs). These areas had a total population of 735 000 and were served by 75 optometry practices. Each practice covered a population of around 10 000. The programme was implemented for 4 weeks in each practice. As the aim was to evaluate the feasibility and practicality of the scheme, an attempt was made to minimise direct practice workload and healthcare assistants conducted the tests. Letters explaining the study procedures were sent to local general practices. Screening was carried out between 18 May and 11 September 2009.

Adults attending for sight tests with no prior diagnosis of diabetes were given an information sheet and list of inclusion criteria (Box 1). Those self-reporting at least one risk factor were invited to participate. They were seen by a healthcare assistant who had received training in the use of the blood glucose meters and the process of taking informed consent. The procedure was explained, consent obtained, and permission to report results to the participants' GP was sought. Capillary blood glucose levels were measured using a BayerCONTOUR® glucose meter, which was calibrated daily using control solutions to ensure accuracy. This meter gives a reading within 5 seconds, and the whole screening procedure took between 5 and 10 minutes. The risk factors reported and whether participants had been screened previously were recorded.

Participants were provided with the results of the test immediately, both verbally and in written form. Those who were not referred to their doctor received information regarding lifestyle advice. In keeping with current RPSGB and Diabetes UK guidelines for screening in pharmacies, those with a rCBG between 6.1 and 12.1 mmol/l were advised that they were at increased risk of IGT, IFG, or diabetes and should visit their GP for routine fasting tests, and those with rCBG of ≥12.2 mmol/l were advised to see their doctor urgently.[13] A letter was sent to

Box 1. Inclusion criteria (based on the Diabetes UK risk calculator).[7]

- White aged >40 years, or black, Asian, and minority ethnic groups aged >25 years with first-degree family history of diabetes
- White aged >40 years, or black, Asian, and minority ethnic groups aged >25 years with body mass index (BMI) of ≥25 kg/m^2
- Waist measurement of ≥94 cm (≥37 inches) for white males aged >40 years and black males aged >25 years, and ≥90 cm (35 inches) for Asian males aged >25 years, and ≥80 cm (31.5 inches) for white females aged >40 years, and black and Asian females aged >25 years
- Individuals who have ischaemic heart disease, cerebrovascular disease, peripheral vascular disease, or treated hypertension
- Individuals who are known to have impaired glucose tolerance or impaired fasting glycaemia
- Individuals with severe mental illness
- Individuals with raised cholesterol
- Females who have had gestational diabetes who have tested normal following delivery
- Females who have given birth to a baby weighing >4 kg (8 lb 8 oz)
- Females with polycystic ovary syndrome
- Individuals experiencing symptoms of diabetes (increased thirst, going to the toilet all the time, extreme tiredness, weight loss, genital itching, or regular episodes of thrush, slow healing of wounds, blurred vision)
- Ocular signs/symptoms of diabetes — dot/blot haemorrhages, recurrent infections, variable refraction, complaints of visual disturbances, early appearance of cataract

the family doctor of all subjects with a rCBG level of ≥6.1 mmol/l, advising them of the need for further investigations.

Questionnaires were sent to all participants with a rCBG level of ≥6.1 mmol/l 4–8 weeks after the initial test, to determine whether they had attended their GP, whether any investigations had been carried out, and their outcomes. Reminder letters were sent to those who did not reply within 4 weeks.

All results were entered into an Access database and then analysed in SPSS (version 15.0). Pearson χ^2 tests and *t* tests were used where appropriate.

RESULTS

A total of 1909 adults attended the participating practices during the 20 weeks of the screening programme, of whom 1303 were eligible to participate. Of those who were not eligible for screening, 171 had previously diagnosed diabetes, representing 9% of the adults attending the practices.

One thousand and two agreed to participate (76.9% of those eligible), of whom 36.2% were male, and the mean age of participants was 54.4 years (standard deviation [SD] 16.3 years); 99% of participants were white and 75% of participants reported that they had not been tested previously.

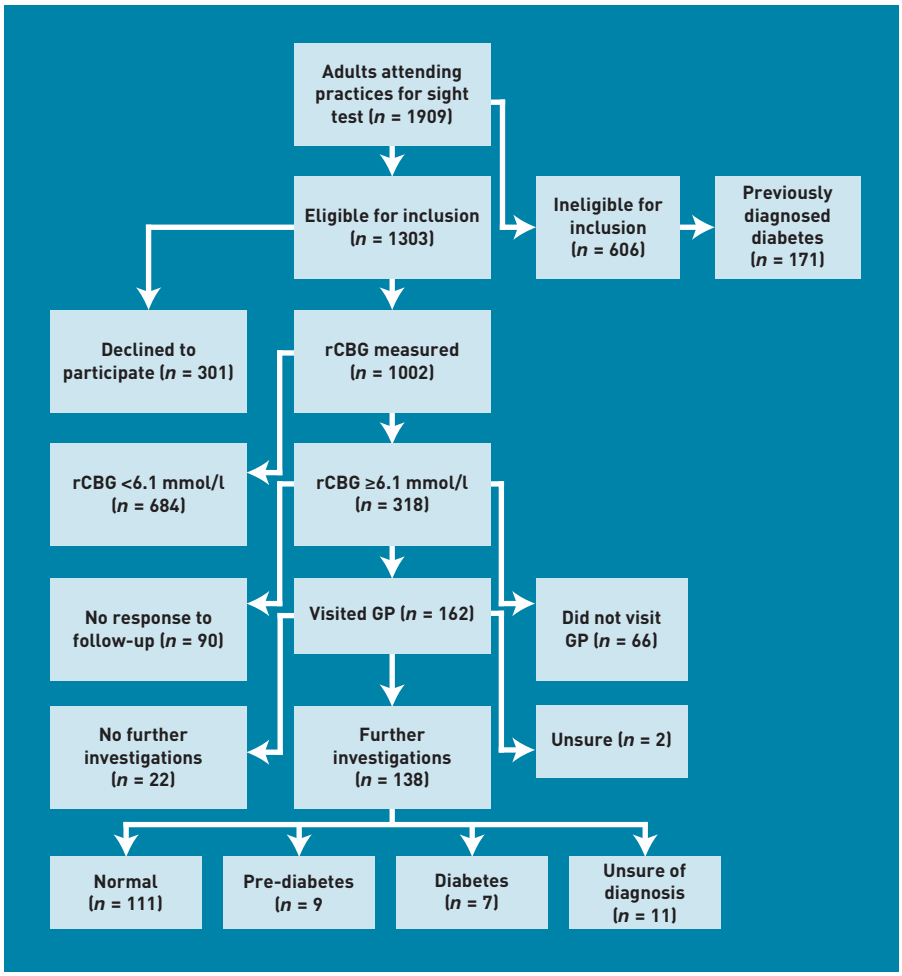

Figure 1. Summary of the outcome of the screening programme.

Table 1. Self-reported prevalence of the presence of risk factors and rCBG and mean risk factors by sex

	All participants		Male		Female	
Risk factor	*n*	%	*n*	%	*n*	%
Age and family history	207	20.7	65	17.9	142	22.2
Age and BMI	424	42.3	165	45.5	259	40.5
Age and waist size[a]	369	36.8	118	32.5	251	39.3
Hypertension[a]	295	29.4	121	33.3	174	27.2
IGT/IFG	16	1.6	6	1.7	10	1.6
Mental illness	20	2.0	7	1.9	13	2.0
Raised cholesterol	233	23.3	95	26.2	138	21.6
Gestational diabetes	13	1.3	—	—	13	2.0
Large baby (>4 kg)	154	15.4	—	—	154	24.1
Polcystic ovary syndrome	18	1.8	—	—	18	2.8
Symptoms of diabetes	531	53.0	191	52.6	340	53.2
Ocular signs	7	0.7	5	1.4	2	0.3
Mean age, years	54.4		55.1		54.0	
Mean rCBG, mmol/l[a]	5.78		5.91		5.70	
Mean number of risk factors[a]	2.28		2.13		2.37	

[a]*P<0.05 between sex. BMI = body mass index. IFG = impaired fasting glucose. IGT = impaired glucose tolerance. rCBG = random capillary blood glucose.*

Three hundred and eighteen (31.7%) had a rCBG of ≥6.1 mmol/l, and were advised to consult their doctor for further investigation. Five of these (0.5%) had a rCBG of ≥12.1 mmol/l and were advised to visit their GP urgently.

Of those found to have an increased rCBG, 50.9% reported that they had attended their GP after the optician's test; 85.2% of those who did attend their family GP reported that they were investigated further. A summary of the outcomes is shown in Figure 1.

The presence of symptoms of diabetes (53.0%), age and increased BMI (36.8%), and age and waist size (29.4%) were the most commonly reported risk factors. The only significant differences between the sexes were increased waist size in females, and a greater prevalence of hypertension in males. The mean number of risk factors reported was 2.28. Details are shown in Table 1.

The mean rCBG was 5.78 mmol/l, 95% confidence interval (CI) = 5.69 to 5.86 mmol/l, range 1.9–14.4 mmol/l. Males were found to have a higher mean rCBG and were more likely to have a rCBG of ≥6.1 mmol/l (Table 1). Multiple regression analysis showed that increasing age, male sex, risk factor A (age and family history) and risk factor B (age and increased BMI) were statistically significant predictors of having rCBG of ≥6.1 mmol/l.

The possibility of targeting screening to only high-risk groups was explored. If the strategy of offering rCBG tests to those aged over 40 years with either a family history of diabetes or a BMI of ≥25 kg/m^2 , or both, had been chosen, the number of screening tests would have been reduced from 1002 to 507; 193 (38.1%) of these patients would have been advised to seek further investigations as they had a rCBG of ≥6.1 mmol/l. Eleven of the 16 participants who were diagnosed with diabetes or pre-diabetes (four with diabetes and seven with pre-diabetes) had either a family history of diabetes or a BMI of ≥25 kg/m^2. This strategy would have identified 57% of the cases of diabetes that were found, and 78% of the diagnosed cases of pre-diabetes, while cutting the number of tests carried out by nearly half.

Ninety participants who were found to have rCBG ≥6.1 mmol/l did not respond to the follow-up questionnaire. Non-responders were significantly younger (mean age 49.0 years) than those responding (mean age 60.7 years); however, there was no significant difference in rCBG measurements of the responders (7.28 mmol/l) and non-responders (7.10 mmol/l). Twenty-nine per cent of responders reported that they did not visit their GP. Of the 162 who did attend for further follow-up, 85.2% reported that they received some form of investigation. While those who attended their doctor had a significantly higher rCBG measurement than those who did not attend, there was no significant difference in rCBG between those who reported that their doctor carried out further tests (7.49 mmol/l, 95% CI = 7.25 to 7.74 mmol/l) and those who were not investigated further (7.08 mmol/l, 95% CI = 6.38 to 7.78 mmol/l). The range of rCBG

Table 2. Mean rCBG by diagnosis

Diagnosis	Mean rCBG (mmol/l)
Normal/no diagnosis	7.28
Hyperglycaemia (diabetes and pre-diabetes)	8.90[a]
Diabetes	10.06[a]
Pre-diabetes	8.00

[a]Mean rCBG significantly different from normal/no diagnosis, P<0.05. rCBG = random capillary blood glucose.

values of those who reported that the doctor did investigate further was from 6.1 to 13.6 mmol/l.

Of the 138 participants who reported that they underwent further testing, seven (5.1%) were given the diagnosis of diabetes and a further nine (6.5%) were diagnosed as having some form of non-diabetic hyperglycaemia. Of the 1002 participants, 1.6% were diagnosed with either diabetes or pre-diabetes as a result of participating. The two participants with a rCBG of ≥12.1 mmol/l who reported being tested by their doctor received a diagnosis of diabetes. The mean rCBG for each diagnosis is shown in Table 2.

There were seven new cases of diabetes in this group, representing 0.7% of adults participating in the study and 0.4% of all adults aged 18 years and over attending optometry practices. In the areas that the practices were located, the population prevalence of diagnosed diabetes is between 3.6% and 4.0%.[23–25] Finding a further 0.4% prevalence of undiagnosed disease would increase the prevalence to 4.0% to 4.4%, representing an increase of between 10% and 11%. In the study population, the prevalence of adults with diagnosed diabetes was 9%, increasing to 9.4% with the new cases diagnosed as a result of screening; this is an increase in prevalence of nearly 5% in a population that already has a prevalence of diabetes twice that of the region as a whole. This represents a significant increase in the number of people with diagnosed diabetes. This increase is despite only half of those who were advised to seek further investigations reporting that they did so, and therefore may be an underestimation.

DISCUSSION

Summary

Around one-third of participants had a rCBG level that required further investigation, similar to other studies using similar methods in different locations,[15,26] although this figure is lower than that found in a UK-based pharmacy.[13] This may be due to the higher number of South Asian participants in the pharmacy study.

It was found that around half of those referred attended their GP, with around one-fifth not attending for further follow-up. A small number of those who did attend their GP reported that they were not investigated further. This may reflect difficulties in communication between optometrists and some medical practitioners. Although optometrists can suggest that an individual may benefit from investigation, it is then up to the individual to take things further and for the GP to decide whether they feel it is appropriate to act on the information. No significant difference was found between the rCBG levels of those investigated further and those who reported that the GP did not take any action.

Strengths and limitations

The study relied on participants attending their own GP and then reporting the outcome of any investigations to the researchers. Although the prevalence of IGT, IFG, and diabetes could have been determined more accurately if fasting and oral glucose tolerance tests had been carried out by the researchers using a consistent protocol, this would not reflect the way a screening service would run. The strength of using this method is that it imitates real life and demonstrates how a screening service would run if implemented in high street practices. However, effective communication and coordination between screening and subsequent care is required. For a service to be effective, the reasons for not investigating screening results need to be outlined. It may be that some of the people referred for further tests had been investigated previously by the GP and diabetes excluded.

Comparison with existing literature

In this study, while it was suggested that further investigations should be carried out, exact tests were not specified and the diagnosis of IGT or IFG was not emphasised. If fasting blood glucose and oral glucose tolerance tests had been carried out on all participants, this would have ensured that prediabetic conditions were considered as well as diabetes, however the purpose of the study was to evaluate the feasibility of testing in optometry practices, with follow-up in general practice. It is known that there is sometimes a reluctance to screen for and diagnose IGT.[27,28] This may be a cause of the low prevalence of prediabetic

Funding body

The study was funded by the School of Medicine and Health, Durham University and the Francis J Bell Fund, County Durham Foundation. Jennifer H Howse had tuition fees paid by Francis J Bell Fund.

Ethics committee

The study was approved by Durham University, School of Medicine and Health ethics committee.

Provenance

Freely submitted; externally peer reviewed.

Competing interests

The authors have declared no competing interests.

Acknowledgements

We are grateful to the optometrists, practice staff, and participants who took part in the study.

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hyperglycaemia found in this study, with people not being diagnosed as such. The National Health Check programme includes diagnosis with IGT or IFG as a possible outcome of screening, but it was found that relatively few people in the study population knew that they had pre-diabetes, either previously or newly diagnosed. Only 25 of those attending for sight tests reported pre-diabetes, compared with 178 with diabetes. Whether this reflects a low prevalence of pre-diabetes in the population or under-diagnosis of the condition is not known.

The study did not exclude individuals who had been previously screened. The American Diabetes Association recommends that screening should be repeated every 3 years.[29] Three participants subsequently diagnosed with hyperglycaemia reported that they had been tested previously. It may be that cost-effectiveness of the service could be improved by not retesting people who have been recently screened. However, there will be some benefit to retesting those who have not been screened for several years. While only 25% reported that they had been screened previously, only 16% reported that they had considered going elsewhere for a test.[30] Of the 16 people who were diagnosed with hyperglycaemia, only two would have thought about going to see their GP. They may have been diagnosed within general practice in the near future. The majority had not considered the need for screening. For this group, screening within the optometry practice may represent a real opportunity to identify disease earlier.

Although the use of rCBG as a screening tool results in a number of false-positive referrals, this method of screening was found to be equally acceptable to those who screened both positive and negative.[30]

This study did not use HbA_{1c}, which has been suggested as a screening tool.[31] This might have the advantage that it gives a long-term indication of glycaemic levels, but it would not have been possible to receive immediate results and the findings from this study would also not have been applicable to settings where HbA_{1c} tests are difficult to access.

Implications for practice and research

The aim of this study was to establish the feasibility of using optometry practices as a location for screening. As it has been shown that there are optometry practice users who are willing to be screened in this location and that new cases of diabetes and pre-diabetes can be detected, the next step would be to establish whether the practice staff can successfully deliver the service themselves and to implement a larger-scale trial of the service with effective interface with primary care. In many practices, optical assistants carry out screening tests for glaucoma and visual field loss and have been shown to be effective at doing this.[32] While the cost of the materials for the test itself is relatively low, the price of time is a consideration.[21] Expenses could be minimised by using optical assistants who are already experienced in screening to carry out the procedure.

Successful implementation of screening programmes would need to consider how the service would be funded, as it could not be carried out within the normal sight test fee,[21] and how best to improve engagement between optometrists, GPs, and service users.

Screening in optometry practices has the potential to play a role in the identification of undiagnosed diabetes and pre-diabetes. Although this study used a sample of practices in northern England, the authors feel that the method of screening would be suitable for implementation in practices worldwide. The screening test used is less invasive and time consuming than fasting blood glucose or an oral glucose tolerance test, and can be used outside healthcare establishments in unconventional settings, widening access to earlier diagnosis for many 'at risk' groups.

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