# Point-of-care testing of HbA1c levels in community settings for people with established diabetes or people at risk of developing type 2 diabetes

Gourlay, Anna; Sutherland, Calum; Radley, Andrew

*Published in:*
BMJ Open

*DOI:*
10.1136/bmjopen-2023-072882

*Publication date:*
2023

BMJ Open

# Point-of-care testing of HbA1c levels in community settings for people with established diabetes or people at risk of developing type 2 diabetes: a systematic review and meta-analysis protocol

Anna Gourlay,[1] Calum Sutherland,[1] Andrew Radley [2]

**To cite:** Gourlay A, Sutherland C, Radley A. Point-of-care testing of HbA1c levels in community settings for people with established diabetes or people at risk of developing type 2 diabetes: a systematic review and meta-analysis protocol. *BMJ Open* 2023;**13**:e072882. doi:10.1136/bmjopen-2023-072882

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2023-072882).

Received 16 February 2023
Accepted 03 May 2023



[1]School of Medicine, University of Dundee, Dundee, UK
[2]Directorate of Public Health, NHS Tayside, Dundee, UK

**Correspondence to**
Dr Andrew Radley;
andrew.radley@nhs.scot

## ABSTRACT

**Introduction** Diabetes mellitus has increased in prevalence worldwide and is causing an increasing burden on health services. The best patient outcomes occur with early diagnosis to prevent health complications. Glycated haemoglobin (HbA1c) is used to assess glycaemic control over 3–6 months and inform clinical management. Point-of-care (POC) HbA1c devices can be used in community settings, independent of clinical laboratories. This review aims to evaluate how these devices have been implemented in community settings and what patient outcomes have been documented.

**Methods and analysis** This protocol follows the Preferred Reporting Items for Systematic Review and Meta-Analysis guidance. A systematic search was undertaken in October 2022, using the defined PICOS (population, intervention, comparison, outcomes, study type) statement to identify all relevant articles: CINAHL, Cochrane, PubMed, Scopus and Web of Science were searched (updated February 2023). Studies will be included if they report outcomes of community POC testing for HbA1c for people with diabetes or at risk of diabetes. We will review the PROSPERO database and trial registers.

Title, abstract screening and full-text review will be carried out by two reviewers. The Cochrane risk-of-bias tool will be used to assess randomised studies and the National Institutes of Health (NIH) Quality Assessment tool for observational cohort and cross-sectional studies. Publication bias will be assessed visually with a funnel plot and statistical approaches if necessary. If a group of sufficiently comparable studies are identified, we will perform a meta-analysis applying a fixed or random effects model as appropriate. We will investigate heterogeneity using visual inspection of forest plots along with review of evaluative approaches such as $X^2$ and the $I^2$ statistic. Strength of evidence will be assessed using Grading of Recommendations, Assessment, Development and Evaluation.

**Ethics and dissemination** Ethics approval is not required for this literature review. The results will be disseminated through peer-reviewed publication and conference presentations. Furthermore, this systematic review will be used to inform the design of a community pharmacy-based prediabetes intervention.

**PROSPERO registration number** CRD42023383784.

## STRENGTHS AND LIMITATIONS OF THE STUDY

⇒ We aim to create the most comprehensive systematic review of the effectiveness of point-of-care testing on enhancing healthcare in community settings.
⇒ We will use the rigorous methodology in accordance with the Cochrane Handbook and the results will be reported as stated by Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.
⇒ The search algorithm was developed by an experienced librarian and customised to five large databases.
⇒ An English language restriction will be applied in the selection of the studies.
⇒ The certainty of the evidence of this systematic review may be limited by the limited number of studies available and the possible low quality of the individual studies.

## INTRODUCTION

The prevalence of diabetes mellitus, and in particular type 2 diabetes (T2D), is rising globally, with projections suggesting that the number of adults with the condition will increase from 415 million to 642 million between 2015 and 2040.[1] Diagnosis depends on declining control of blood glucose, and thresholds of fasting blood glucose (>7 mM) and/or glycation of haemoglobin (concentration of the glycated form glycated haemoglobin (HbA1C)>48 mmol/mol) are used to establish when that control has deteriorated to the point of high risk of development of vascular disease. Type 1 diabetes (T1D) results from autoimmune destruction of the cells that make insulin, while T2D results from declining tissue responses to insulin and resultant insulin insufficiency. T2D is associated with dietary choices and increasing adiposity, and glycaemic control declines in line with falling insulin sensitivity, although a few individuals develop insulin insufficiency although

they are not overweight.[2] Many cases, (~175 million worldwide), are currently undiagnosed and perhaps 230 million people may have non-diabetic hyperglycaemia; a high-risk state for T2D.[3] For example, in Scotland, the number of people with T2D increased from 190 772 in 2008 to 267 615 in 2018[4] with a greater impact on disadvantaged communities. This rise in prevalence brings an increased burden on health services. Diabetes mellitus is a metabolic disorder that can result in progressive damage to the main organs in the body, especially the heart, brain, feet and legs, eyes, kidneys and nerves. In 2021 alone, there were 6.7 million deaths worldwide relating to diabetes due to the resultant high risk of cardiovascular disease.[5]

Until recently, HbA1c testing required a healthcare professional to draw a venous blood sample and send it to an accredited biochemistry laboratory for analysis. The equipment to accurately measure HbA1c was expensive and required specific training to use. This limited access to testing and speed of reporting. There are now cheaper point-of-care (POC) devices for HbA1c measurement available, which would allow widespread and rapid assessment of this useful clinical marker for progression and severity of diabetes.[6] POC devices are intended to be used in community settings such as GP practices. The test procedure involves taking a finger prick blood sample and instruments can provide immediate reports. If POC tests prove clinically reliable, they would provide many opportunities to improve healthcare, personal disease management and streamline care pathways. The implementation of POC devices should be accompanied by appropriate quality assurance systems.

POC devices can identify poor glycaemic control, which will allow the person to access preventative treatment and achieve remission from T2D (now available in many regions in Scotland). Community testing of HbA1c would theoretically greatly improve the diagnostic rates of prediabetes as more patients will have access to testing. This should also reduce the thousands of people estimated to be living with undiagnosed diabetes in the UK. Early intervention, delaying the onset of T2D reduces the development of serious health complications and reduces the impact of diabetes on the life span.[7] It also reduces the cost of prolonged medical treatment for diabetes (currently around 10% of the NHS budget).[8]

To implement the great potential of POC testing for improvement in diabetes prevention and care requires evidence that the POC technology has been successfully employed in community settings and that the technology had influenced care provision. This review aims to assess available evidence for the successful implementation of POC testing in community settings with demonstration of an effect on HbA1c measurements.

## METHODS AND ANALYSIS

This systematic review will be conducted according to the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) guidance.[9]

The PICOS statement developed for the study is:

- *Population*: those at risk of developing diabetes or those with established diabetes.
- *Intervention*: HbA1c testing using a POC device in a community setting.
- *Comparison*: POC testing compared with standard laboratory testing.
- *Outcome*: identifying, monitoring and managing diabetes.
- *Study*: any qualitative or quantitative design, not reviews.

Eligibility criteria

There were no limits on the age of participants and studies will consider either T1D or T2D mellitus or gestational diabetes mellitus. Any articles not in English will be excluded. Studies must assess POC HbA1c devices in a community or primary care setting. Any studies comparing exclusively the accuracy of POC devices in comparison to laboratory testing will be excluded.

### Information sources

Formal searches of five databases (CINAHL, Cochrane, PubMed, Scopus and Web of Science) will be undertaken in February 2023. A customised search strategy will be designed for each database. We will also review the PROSPERO database and trial registers. Reference lists of published studies will be reviewed to identify additional studies. The search headings used will be 'HbA1c', 'point of care' and 'setting', with the search terms relating to each of these headings (full search strategy included in online supplemental material).

### Data records and management

The search results from each of the databases will be imported to Endnote X9. Any duplicate studies or studies with irrelevant titles will be removed. Abstracts will be reviewed independently by two reviewers (AG and AR) using the PICOS (population, intervention, comparison, outcomes, study type) statement. The full texts of all included studies will then be reviewed independently by the same reviewers. Any disagreements will be resolved through discussion with an independent reviewer (CS). A full study selection process will be detailed.

### Effect measures

We will report the treatment effects demonstrated through use of the POC instruments compared with routine care. These will be reported as a mean difference and SD for eligible studies.

### Risk of bias

The Cochrane risk-of-bias tool[10] will be used to assess randomised studies and the National Institutes of Health (NIH) Quality Assessment tool for observational cohort and cross-sectional studies.[11] For randomised studies, the classification of high risk, low risk or some concern: selection bias, performance bias, detection bias, attrition bias and reporting bias, will be employed. The NIH tool will

allow for studies to be given a quality rating of poor, fair or good.

### Data synthesis

The included studies will be summarised, highlighting the year published, country, study design, care location, group, intervention, comparator and the number of participants.

A narrative synthesis will be undertaken and key themes describing the finding of the studies will be described.

If possible, we will categorise the results separately for every setting (eg, community setting, general practice), considering the different participant and environment characteristics.

We will perform a meta-analysis applying a fixed or random effects model as appropriate, considering the assessed heterogeneity between the studies. We will try to minimise the heterogeneity by grouping the trials by setting and similar intervention. We will investigate remaining heterogeneity within a pooled group of trials using a combination of visual inspection of the forest plot along with consideration of the $\chi^2$ test (with statistical significance set at $p<0.10$), and the $I^2$ statistic results as described in the recommendations from the Cochrane Handbook.

Only studies identifying a change in HbA1c with implementation of a POC instrument over time will be included in the meta-analysis. This will be performed using R Studio V.1.2.5033. The mean difference of the fixed effect model and heterogeneity will be calculated. The results will be presented in Forest and Funnel plots.

We will perform a sensitivity analysis according to overall study quality; low risk of bias, some concerns and high risk of bias, by comparing random and fixed-effect model and by including and excluding possible outlying studies, if the visual inspection of the forest plot shows poorly overlapping CIs.

We will explore the possibility of publication bias by constructing funnel plots and by conducting appropriate statistical tests for groups of more than 10 studies.

### Confidence in cumulative effect

The strength of evidence will be assessed using the Grading of Recommendations, Assessment, Development and Evaluation approach, by two reviewers, with possible disagreement arbitrated by a third reviewer.[12] The approach involves assessing the evidence based on study limitations, directness, consistency, precision and reporting bias. The evidence will be determined as very low, low, moderate or high quality.

### Ethics and dissemination

Ethical approval is not required for this literature review. The results will be disseminated through a peer-reviewed publication and conference presentations. The results of the study will inform the design of a community pharmacy intervention.

### Patient and public involvement

Patients and the public were not involved in the design, conduct, or reporting and dissemination plans of this study

## DISCUSSION

A robust and precise POC infrastructure has the possibility of removing known barriers to testing and encouraging engagement in health-seeking behaviours and self-management of chronic disease. This systematic review will contribute a summary of the progress made in deploying the POC technology and demonstrating the changes in patient outcomes that may be attributed to its use.

We will use a rigorous methodology in accordance with the Cochrane Handbook and results will be reported in accordance with the PRISMA reporting statement.

**Twitter** Andrew Radley @AndrRadl

**Contributors** AG: Conceptualisation, methodology, data curation, data validation, formal analysis, final approval of manuscript. Agreement to be accountable for content. CS: Conceptualisation, methodology, writing—review and editing, supervision, final approval of manuscript. Agreement to be accountable for content. AR: Conceptualisation, methodology, data validation, formal analysis, writing preparation of first draft, writing – review and editing, final approval of manuscript. Agreement to be accountable for content.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Provenance and peer review** Not commissioned; externally peer reviewed.



**ORCID iD**

Andrew Radley http://orcid.org/0000-0003-4772-2388

## REFERENCES

1 Khan MAB, Hashim MJ, King JK, *et al*. Epidemiology of type 2 diabetes – global burden of disease and forecasted trends. *JEGH* 2020;10:107.
2 Diabetes UK. Type two diabetes. Available: https://www.diabetes.org.uk/diabetes-the-basics/types-of-diabetes/type-2 [Accessed 2 2023].
3 Zhou B, Lu Y, Hajifathalian K, *et al*. Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4·4 million participants. *The Lancet* 2016;387:1513–30.

4 Scottish Government. Diet and healthy weight: monitoring report. *Scottish Government, Edinburgh* 2022. Available: https://www.gov.scot/publications/diet-healthy-weight-monitoring-report-2020/pages/5/
5 International Diabetes Federation. *IDF Diabetes Atlas 10th ed*. Brussels, Belgium: International Diabetes Federation, 2021.
6 Sobolesky PM, Smith BE, Saenger AK, *et al*. Multicenter assessment of a hemoglobin A1c point-of-care device for diagnosis of diabetes mellitus. *Clin Biochem* 2018;61:18–22.
7 Sattar N, Rawshani A, Franzén S, *et al*. Age at diagnosis of type 2 diabetes mellitus and associations with cardiovascular and mortality risks. *Circulation* 2019;139:2228–37.
8 NHS England. Nhs diabetes prevention programme (DPP). Available: https://www.england.nhs.uk/diabetes/diabetes-prevention/ [Accessed 2 2023].
9 Equator Network. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Available: https://www.equator-network.org/reporting-guidelines/prisma/ [Accessed 2 2023].
10 Higgins JS, Page MJ, Elbers RG, *et al*. Cochrane Handbook for systematic reviews of interventions version 63. 2022. Available: www.training.cochrane.org/handbook
11 National Institutes of Health. Quality assessment tool for observational cohort and cross-sectional studies. 2014. Available: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools
12 Berkman ND, Lohr KN, Ansari MT, *et al*. Grading the strength of a body of evidence when assessing health care interventions: an EPC update. *J Clin Epidemiol* 2015;68:1312–24.

# Supplementary material

## Search strategy

1. HbA1c
2. Glycated haemoglobin
3. Glycated hemoglobin
4. Haemoglobin A1c
5. Hemoglobin A1c
6. Glycosylated hemoglobin
7. Glycosylated haemoglobin
8. Hemoglobin test
9. HbA1c test
10. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11. POC
12. POC device
13. Point of care
14. POC machine
15. 11 or 12 or 13 or 14
16. Healthcentre
17. Health centre
18. Community
19. Pharmacy
20. Pharmacies
21. GP
22. GPs
23. Primary
24. Health center
25. Healthcenter
26. Communities
27. 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26
28. 10 and 15 and 27