
The heterogeneity in diagnostic criteria, study dates, age of study participants and population groups may limit comparison across studies.

The prevalence of diabetes is rapidly increasing in South Africa. In 2009, approximately 2 million (9%) people aged 30 years and older had diabetes, increasing almost twofold since 2000 when Bradshaw et al reported a prevalence of 5.5%. Several factors such as the ageing population, economic transition and urbanisation associated with nutrition transition and obesity have contributed to the increased diabetes prevalence. In 2000, it was estimated that 87% of diabetes cases in South Africa were attributed to excess body weight. This is concerning since in 2013 ~38% of men and ~69% of women in South Africa were considered overweight or obese. In 2015, the global burden of disease study estimated that high body mass index and hyperglycaemia, ranked as the second and third leading risk factors, respectively, after unsafe sex, for early death and disability in South Africa.

Diabetes, due to its association with several microvascular and macrovascular complications, places a significant burden on the South African health system. In 2009, it was estimated that diabetes caused about 8000 new cases of blindness and 2000 new cases of amputations annually. A national
burden of disease study in 2000 reported that diabetes accounted for approximately 14% of cases of ischaemic heart disease, 10% of stroke, 12% of hypertensive disease and 12% of renal disease. Furthermore, the indirect costs of diabetes are high. Diabetes in Africa affects mainly working-aged people between 40 and 60 years of age, placing an added burden on the economy due to work absenteeism and decreased productivity. South Africa is battling a quadruple burden of disease due to high rates of infectious diseases, non-communicable disease, maternal and child mortality, and injury-related disorders, thus have limited resources to meet the increased health and economic costs of diabetes.13

Rationale
Urgent action is required to halt the burgeoning diabetes epidemic in South Africa. The feasibility of population-level interventions, particularly those aimed at prevention is widely reported.14 However, such initiatives are hampered by the lack of epidemiological data, a challenge faced by all countries in Africa.15 Several studies have measured the prevalence of diabetes in South Africa,16–26 although they were conducted in different geographical areas (urban vs rural), among different population groups and are generally too small to individually give generalisable prevalence data. Pooling of existing data is considered an effective strategy to generate representative and robust prevalence figures.8 Bertram et al calculated the national prevalence of diabetes in 2009; however, their estimate included only four studies measuring the diabetes prevalence in black South Africans in two rural, one urban and one metro urban population.21–24 The study did not account for population variation in diabetes prevalence in South Africa,16 19 20 23 and focused on estimating the disability burden of diabetes rather than characterising the different levels of hyperglycaemia in these populations. This review explores availability and quality of diabetes prevalence data for South Africa.

Objective
The purpose of this systematic review is to identify, collate and synthesise all studies reporting the prevalence of diabetes in South Africa. A secondary aim is to report the prevalence of impaired glucose tolerance and impaired fasting glucose, conditions which are associated with an increased risk of progression to overt diabetes, and the prevalence of undiagnosed diabetes. These findings will be used to inform the Second National Burden of Disease study which can guide health and policy planning.

METHODS
Study selection
Published population-based surveys, cross-sectional studies and prospective or retrospective cohort studies that report the prevalence of diabetes in South Africa.

Inclusion criteria
Studies will be included if they were published between January 1997 and February 2018, include more than 100 participants regardless of age, gender, ethnicity, socioeconomic and educational background and study setting, and report the primary outcome using a case definition according to the 2006 WHO diagnostic criteria,27 where type 2 diabetes is diagnosed either by a physician, fasting blood glucose concentrations ≥7.0 mmol/L, 2-hour oral glucose tolerance test values ≥11.1 mmol/L, or self-reported use of oral diabetes drugs. In addition, glycated haemoglobin ≥6.5% (48 mmol/mol) will also be used for case definition.28 Due to limitations that hamper the differentiation between type 1 diabetes and type 2 diabetes, diabetes in individuals older than 25 years of age will be classified as type 2 diabetes. Impaired glucose tolerance will be defined by fasting blood glucose concentrations <7.0 mmol/L and 2-hour oral glucose tolerance values ≥7.8 mmol/L, but <11.1 mmol/L. Impaired fasting glucose will be defined as fasting blood glucose concentrations between 6.1 mmol/L and 6.9 mmol/L, and, if available, 2-hour oral glucose tolerance values <7.8 mmol/L.27

Exclusion criteria
Studies will be excluded if they were not conducted in South Africa, do not report the primary outcome, have no clear description of the case definition and contain data for refugees in camps since they may not be representative of the South African population.

Primary outcome
Prevalence of type 2 diabetes.

Secondary outcome
Prevalence of impaired glucose tolerance, impaired fasting glucose and undiagnosed type 2 diabetes.

Search strategy
A search of articles written in English and indexed in PubMed, Scopus, Web of Science and African Index Medicus between January 1997 and February 2018 will be conducted. An experienced information scientist and disease content experts will be consulted to ensure that the search terms are relevant and optimally arranged, and will include keywords and medical subject headings. An example of the search strategy in PubMed is illustrated in table 1. The search will be modified to each database. References will be managed in EndNote.

Study selection
The titles and abstracts of articles from the electronic search outputs will be screened independently by two reviewers to identify eligible studies. Disagreements or uncertainties will be resolved by discussion and consensus between the two reviewers, or with a third reviewer if disagreement persists. Full-text copies of the eligible articles will be retrieved and reviewed by two independent reviewers for inclusion. Additional information will be
Table 1 PubMed search strategy

<table>
<thead>
<tr>
<th>Search</th>
<th>Query</th>
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<tbody>
<tr>
<td>#4</td>
<td>Search ((#3 NOT (animals[mh] NOT humans[mh]))) AND (‘1997/01/01’[Date-Publication]–’2018/02/28’[Date-Publication])</td>
</tr>
<tr>
<td>#3</td>
<td>Search (#1 AND #2)</td>
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Data extraction

After the final decision to include studies into the review, two authors will independently extract and record data using the Burden of Disease (BOD) Review Manager developed by the South African Medical Research Council.29 The following data will be extracted:

- Study details: date of publication, study title, study design, study period and study purpose.
- Study population: province/district of study, study setting (community or health facility based), setting (urban or rural) and sample size.
- Response rate.
- Case definition as reported in the study.
- Prevalence of type 2 diabetes, impaired glucose tolerance, impaired fasting glucose and undiagnosed type 2 diabetes.
- Characteristics of study population: age, sex, population group (ethnicity) and comorbid disease (tuberculosis (TB) or HIV status).

After completion, data will be compared and discrepancies will be resolved through consensus between the two reviewers, or in consultation with a third reviewer.

Risk of bias assessment

Two reviewers will independently appraise the study quality and risk of bias using a checklist for observational epidemiological studies that was adapted from the risk of bias tool for population-based studies30 and the Newcastle-Ottawa Scale for assessing the quality of non-randomised studies,31 32 and standardised in the BOD Review Manager.33 Parameters assessed will include: external validity (whether the target population is representative of South Africa, representativeness of sample, selection criteria and non-response bias) and internal validity (case definition, validity and reliability of test instruments, consistency of case measurement, appropriateness of time period and appropriateness of numerators and denominators in estimation). Disagreements between the reviewers over the risk of bias will be resolved by discussion with a third reviewer where necessary.

Data synthesis

A narrative description will be conducted for studies with a low or moderate risk of bias. Clinical heterogeneity will be investigated by looking at the characteristics of participants, method of diagnosis and case definitions in the study.

Subgroup analyses for study population (province/district, community or health facility based, urban or rural) and characteristics of cases (age, sex, population group and comorbid disease TB or HIV) will be done if sufficient data exists. If possible, a meta-regression to explore possible sources of variability in prevalence reported between studies will be conducted. Review findings will be displayed using tables and forest plots as appropriate.

Confidence in cumulative evidence

The strength of evidence will be assessed using the Grading of Recommendations Assessment, Development and Evaluation method33 which scores studies as very low, low, moderate or high based on methodological flaws within the included studies, consistency of results across diverse studies, precision of estimates and publication bias.

Patient and public involvement

Patients and public were not involved.

ETHICS AND DISSEMINATION

The systematic review does not require ethics clearance since published studies with non-identifiable data will be used. This review is the first to collate and synthesise all the available studies reporting the prevalence of diabetes in South Africa and will provide local epidemiological data to inform the Second National Burden of Disease study which can guide health and policy planning. Findings from the review will be disseminated in a peer-reviewed journal article and academic reports according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.34

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Contributors

CP, VP-vW, JDJ and DB conceived the idea and design of the study, and drafted the protocol. NL and MDN helped to draft the protocol. All authors wrote and approved the final manuscript.

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Competing interests

None declared.
REFERENCES


