Review Article

National prevalence of coronary heart disease and stroke in South Africa from 1990–2017: a systematic review and meta-analysis

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Abstract

Background: South Africa is experiencing an increasing burden of cardiovascular diseases, including coronary heart disease (CHD) and stroke. We aimed to obtain overall national prevalence estimates of CHD and stroke in South Africa.

Methods: Studies conducted in South Africa were systematically reviewed from PubMed, Scopus and Web of Science from January 1990 to July 2017. Random-effects meta-analyses were conducted on the selected studies to determine the overall prevalence of CHD and stroke.

Results: Out of 2 466 studies, only 12 covering 75 140 participants reported the national prevalence of CHD and stroke. All 12 studies estimated the national prevalence of both diseases based on self-reported disease status. The overall national prevalence was 1.29 (95% CI = 0.83; 1.75) and 4.29 (95% CI = 3.13; 5.45) for CHD and stroke, respectively. Only one study reported incidence rates so we did not perform any meta-analysis of incidence rates.

Conclusions: There are very few studies on national prevalence of CHD and stroke in South Africa. Well-structured registries for CHD and stroke are required to accurately identify the disease burden and enable adequate resources to be allocated for the implementation of appropriate prevention and management programmes.

Keywords: coronary heart disease, stroke, meta-analysis, South Africa

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Submitted 16/10/19, accepted 2/10/20
Published online 26/3/21
Cardiovasc J Afr 2021; **32**: 156–160 www.cvja.co.za

DOI: 10.5830/CVJA-2020-045

Cardiovascular diseases (CVDs) account for 31% of global deaths annually, with more than 80% due to coronary heart disease (CHD) and stroke;[1] this amounts to 15 million deaths.[2] The CVD burden in low- and middle-income countries (LMICs), including those in sub-Saharan Africa (SSA), is more severe and occurs at a younger age, that is, in the working population. This has serious economic and social consequences, not only for the individual but also for their families and the economy. The higher mortality burden in younger individuals in their prime in LMICs is likely attributable to inadequate prevention and management because prevention is not a priority, and effective treatments are not widely available.[3]

In order to address this gap in suboptimal prevention and management, it is vital to have accurate data on the incidence and prevalence of CHD and stroke to adequately manage these conditions. Given that risk factors for CVDs are known and can largely be modified and controlled, 80% of premature heart attacks and strokes could be preventable.[4] This is particularly important for SSA, where there was a 38% increase in CHD from 2000 to 2016, and stroke rose by 25% within the same period, with a projected increase of 21 and 82% by 2030 for CHD and stroke, respectively.[2] This places a great strain on a region that is already highly burdened with HIV and other infections, violent death, and perinatal and maternal diseases.[5]

This is especially true for South Africa where CHD and stroke are among the top 10 leading causes of mortality alongside the high mortality rate attributable to HIV and tuberculosis.[6,7] It is estimated that five and 10 people have a stroke and heart attack, respectively, every hour, 10 of which result in death. Although mortality data are available for CHD and stroke, evidence on the incidence and prevalence of these conditions nationally by gender, urban–rural residence and population group is lacking in South Africa.[9,10]

The available research that focuses on CHD and stroke in the country[11-15] has not been systematically evaluated and described in a manner that summarises the evidence thus far. Accurate and up-to-date information on the incidence and prevalence of these CVDs is crucial to enable appropriate and adequate allocation of healthcare resources for the prevention and management of CHD

and stroke. This requires the appropriate management of CVD risk factors such as hypertension, diabetes and dyslipidaemia, and optimal diagnosis and management of CHD and stroke by adequately trained healthcare professionals.

We are not aware of any nationwide study in South Africa that has assessed and pooled the available evidence on the burden of CHD and stroke. Therefore, this systematic review and meta-analysis aimed to estimate the pooled prevalence of CHD and stroke in South Africa over a period from 1990 to 2017. The findings of this systematic review and meta-analysis provide the depth and quality of evidence, which will support and inform policies and interventions regarding CHD and stroke in South Africa.

Methods

The systematic review of rationale and methods was specified in advance and documented in a protocol, which was published in the PROSPERO register (CRD42017068585). Ethical approval was not required for this study.

We included population-based surveys, modelling, prospective or retrospective cohort studies, case–control studies, and cross-sectional studies with crude or adjusted national prevalence and incidence estimates of CHD or stroke. Our interest was in participants with a diagnosis of CHD, namely acute myocardial infarction (MI), previous MI (ST-segment elevation MI and non-ST-segment elevation MI), unstable or stable angina, and those with a confirmed diagnosis of ischaemic and haemorrhagic stroke. Participants with a self-reported history of CHD or stroke were also included.

A search of the following electronic bibliographic databases was conducted: PubMed, Scopus, and Web of Science. An additional search was carried out on Google Scholar and reference lists of relevant studies were used to identify publications that could have been omitted in the database searches. The search strategy was edited to find epidemiological studies that focused on CHD and stroke. The search terms used are given in Table 1. The study setting was South Africa, and studies that had not been conducted in South Africa were excluded. Only English studies published between January 1990 and July 2017 were eligible for inclusion in the review.

Table 1. Search terms used to find CHD and stroke studies

Search	*Query*
Coronary heart disease	
#1	Search ('Coronary disease' OR 'Myocardial infarction' OR 'Coronary artery disease' OR 'Angina pectoris' OR 'Unstable angina' OR 'Cardiovascular disease' OR 'Coronary heart disease' OR 'Ischaemic heart disease' OR 'Heart attack' OR 'Ischaemic heart disease')
#2	Search (South Africa OR 'South Africa*' OR RSA OR Africa, Southern OR 'Southern Africa')
#3	Search (#1 AND #2)
#4	Search [#3 AND ('1990/01/01' : '2017/07/31') AND Humans]
Stroke	
#1	Search ('Brain infarction' OR 'Brain stem infarctions' OR 'Cerebral infarction' OR 'Lacunar infarction' OR 'Cerebrovascular disease' OR 'Cerebrovascular accident' OR 'Brain ischaemia' OR 'Cerebral haemorrhage' OR 'Cerebral ischaemia' OR 'infarct' OR 'Cerebral ischaemia' OR 'Brain ischaemia')
#2	Search (South Africa OR 'South Africa*' OR RSA OR Africa, Southern OR 'Southern Africa')
#3	Search (#1 AND #2)
#4	Search [#3 AND ('1990/01/01' : '2017/07/31') AND Humans]

Three reviewers (NA, NP and SOMM) independently evaluated the eligibility of the studies obtained from the literature searches. All articles yielded by the database search were initially screened by their titles and abstracts to obtain studies that met our inclusion criteria. In cases of discrepancies, an agreement was reached by discussion.

Data extraction was completed by one reviewer (NA) and comprised study title, author(s), year of study and publication; data source; population characteristics such as age, gender and study setting; and risk of bias criteria. Prevalence and incidence estimates were extracted for studies assessed to have a low or moderate risk of bias.

One reviewer (NA) assessed the risk of bias (ROB) for each study using a framework developed by Pillay-van Wyk *et al*.[16] The framework assesses the external and internal validity of each relevant study and was developed for observational studies. The overall quality score ranges from 1 to 20 (high risk of bias = 1 to 6; moderate risk = 7 to 13 and low risk = 14 to 20). This quality assessment can be evaluated as a source of heterogeneity or in the form of sensitivity analysis in which overall results can be compared with those obtained from studies with defined subsets of quality characteristics.[17] However, this was not done in this study and was only used to assess low- and moderate-risk studies to be included in the meta-analysis.

Statistical analysis

The main parameters of interest were the prevalence and incidence of CHD and stroke. Random-effects meta-analyses were used to pool the prevalence estimates for the two cardiovascular conditions, with 95% confidence intervals (CI) and *p*-values. Incidence estimates were only found in one study (for both CHD and stroke) and could not be pooled to provide an overall estimate. The random-effects model incorporates heterogeneity resulting from variation between studies and assigns greater variability to the estimate of the overall effect.[18,19]

Heterogeneity among study estimates was quantified using Higgins I^2, which computes the proportion of variance between studies due to heterogeneity rather than chance.[20] We considered an I^2 value greater than 50% as indicative of substantial heterogeneity and conducted sensitivity analyses to assess the robustness of the meta-analysis results in outlying effect sizes and studies that looked at subgroups of people. To evaluate possible causes of heterogeneity, subgroup analyses or stratified analyses are recommended; however, if the total number of studies is less than 10, it would not make sense to compare two or more subgroups.[21] Stata 15[22] was used for all analyses.

Results

The PRISMA flow diagram displays the process of selecting the studies[23] (Fig. 1). The literature search returned 2 959 publications (2 705 for CHD and 254 for stroke) from PubMed, Scopus and Web of Science. After removing duplicates, 2 466 publications remained. After the screening of titles and abstracts, 2 343 publications were excluded, giving a total of 123 full-text articles that were assessed. A total of 12 studies were retained for the final review (five for CHD and seven for stroke).

The 12 studies retained provided population-level prevalence and only one study provided incidence estimates of CHD and

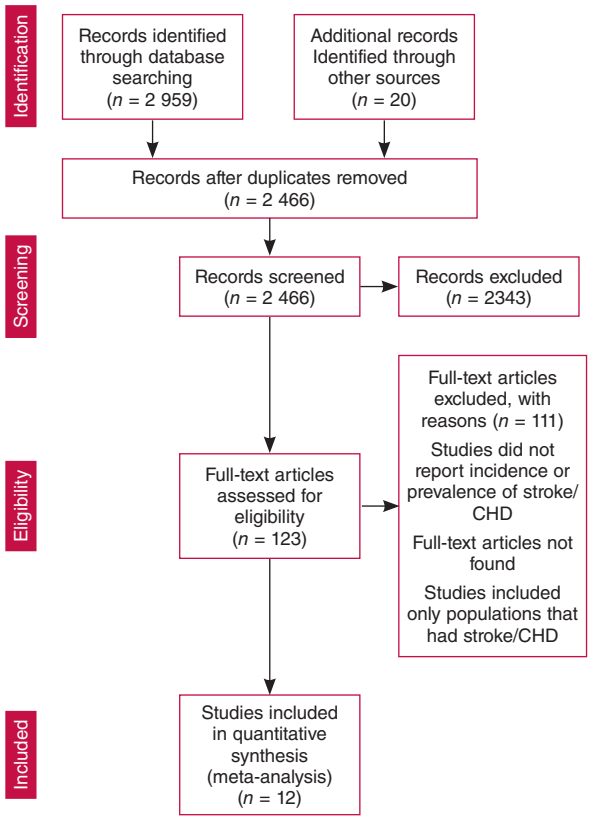

Fig. 1. Study-selection process using the PRISMA flow diagram.

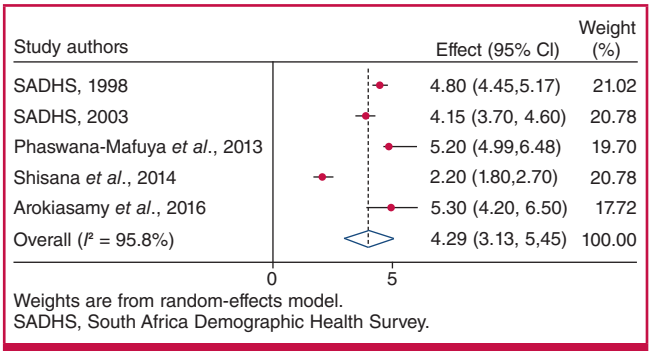

Fig. 2. Pooled prevalence rates of CHD.

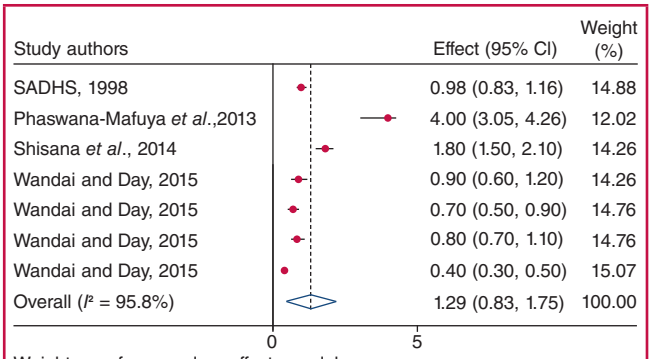

Fig. 3. Pooled prevalence rates of stroke.

stroke (Table 2). All the estimates were self-reported conditions. The total sample size of the studies that were included was 75 140 (41 168 for CHD and 33 972 for stroke).

Only a pooled estimate for prevalence was calculated, since there were insufficient studies found that reported incidence rates. The pooled overall prevalence for stroke was 1.29% (95% CI = 0.83; 1.75, I^2 = 97.2%, p-value = 0.000), and for CHD it was 4.29% (95% CI = 3.13; 5.45, I^2 = 95.8%, p-value = 0.000). The I^2 statistic showed high between-study heterogeneity, greater than 90% for both CHD and stroke (Figs 2, 3).

As a sensitivity analysis, outlying studies were excluded to assess whether the effect estimate was greatly influenced (Table 3). For stroke, Phaswana-Mufaya *et al.*[26] and Shisana *et al.*[27] were individually removed, and then both were removed at the same time. The overall effect estimate was reduced from 1.29 to 0.92 when Phaswana-Mufaya *et al.* was excluded, and went down slightly to 1.20 when Shisana *et al.* was excluded. The heterogeneity was smallest (I^2 = 90.7%), although still quite large, when both studies were removed and therefore had the most profound influence on the overall prevalence effect estimate.

Table 2. Final CHD and stroke studies included in the meta-analysis

Author, year	*Study period*	*Case definition*
Coronary heart disease		
South African Demographic Health Survey, 1998[24]	1998	Self-reported CHD
South African Demographic Health Survey, 2003[25]	2003	Self-reported CHD
Phaswana-Mafuya *et al.*, 2013[26]	2008	Self-reported angina
Shisana *et al.*, 2014[27]	2012	Self-reported heart disease (heart attack, angina or chest pain)
Arokiasamy *et al.*, 2016[28]	2007–2010	Self-reported angina
Stroke		
South African Demographic Health Survey, 1998[24]	1998	Self-reported stroke
Phaswana-Mafuya *et al.*, 2013[26]	2008	Self-reported stroke
Shisana *et al.*, 2014[27]	2012	Self-reported stroke
Wandai and Day, 2015[29]	2008	Self-reported stroke
Wandai and Day, 2015[29]	2010	Self-reported stroke
Wandai and Day, 2015[29]	2012	Self-reported stroke
Wandai and Day, 2015[29]	2013	Self-reported stroke

Table 3. Sensitivity analysis with outlying studies and those with gender breakdowns excluded

Condition	*Meta-analysis*	*Number of studies*	*Esti-mate*	*95% CI*		*Higgins I^2 (%)*
Without outlying studies						
CHD	All studies	5	4.29	3.13	5.45	95.8
	Excluding Shisana *et al.*[26]	4	4.75	4.25	5.25	65.6
Stroke	All studies	7	1.29	0.83	1.75	97.2
	Excluding Phaswana-Mufa-ya *et al.*[26]	6	0.92	0.58	1.26	95.0
	Excluding Shisana *et al.*[27]	6	1.20	0.74	1.65	96.9
	Excluding both	5	0.75	0.49	1.01	90.7
Without those with gender breakdowns						
CHD	All studies	5	4.29	3.13	5.45	95.8
	Excluding Arokiasamy *et al.*;[29] SADHS;[24] Shisana *et al.*[27]	2	4.63	3.61	5.66	82.1
Stroke	All studies	7	1.29	0.83	1.75	97.2
	Excluding SADHS;[24] Shisa-na *et al.*[27]	5	1.26	0.70	1.83	97.3

For CHD, the exclusion of Shisana *et al*. from the meta-analysis resulted in a slightly higher effect estimate, from 4.3 to 4.8. Removing Shisana *et al.* also resulted in a significant reduction in the level of heterogeneity, from 96 to 66%, which is a moderate level of heterogeneity.

To assess whether excluding studies that assessed gender-specific prevalence affected the overall prevalence effect estimate, the South African Demographic Health Survey (SADHS)[24] and Shisana *et al*.[27] were excluded for stroke, and Arokiasamy *et al*.,[28] SADHS[24] and Shisana *et al*.[27] were excluded for CHD. The overall prevalence effect estimate went down slightly for stroke from 1.29 to 1.26, and went up for CHD, from 4.29 to 4.63. The heterogeneity improved to 82% for CHD by removing those studies. For stroke, heterogeneity did not change much, indicating that the inclusion of these two studies did not make a significant difference.

Only SADHS 1998 reported a national incidence rate of CHD and stroke for men and women. For men, the incidence rates were 135 and 795 per 100 000 people for CHD and stroke respectively, and 234 and 1 744 for women. No other studies looked at incidence rates for either disease at a national level.

Discussion

The overall national prevalence of CHD and stroke in South Africa between 1990 and 2017, determined from five and seven studies, respectively, was low. This was also low compared to the crude prevalence rate of stroke of 387.93 per 100 000 in Africa.[30] The crude prevalence of stroke was 243 cases per 100 000 population in those aged 15 years or more, and 300 cases per 100 000 population in a rural community in north-east South Africa.[10] Another report estimated that 842 incident cases of stroke occurred in South Africa from 2007 to 2011.[10]

Our research has highlighted only one study on incidence and very few studies on the prevalence of CHD and stroke in South Africa. Given the high mortality burden, we would have expected a larger body of literature on these topics. Furthermore, there were insufficient data to estimate the prevalence of CHD or stroke by urban–rural residence.

Differential exposures to CVD risk factors by urban–rural residence, among other factors, is likely to influence the development of CHD and stroke. For example, poorer diets with higher caloric intake, greater sedentary behaviour and lower physical activity levels in urban compared with rural residents lead to higher rates of obesity, diabetes and hypertension in urban subjects. The uptake of these unhealthy lifestyle behaviours, together with the above cardiometabolic conditions, contribute to a greater risk for developing CHD and stroke in urban versus rural residents. Therefore, more epidemiological research needs to be conducted in both urban and rural areas, by gender and across population groups, because differential exposures to risk factors is likely to influence the burden of CHD and stroke.[31] Detailed and accurate information across these subgroups on the incidence and prevalence of CHD and stroke is essential for the prevention and management of CVDs.[32]

Although some studies have found that self-reported estimates were congruent with clinically measured estimates of disease,[33,34] others found that there were major differences between self-reported measures and actual clinical measurements.[35,36] There is also evidence that even though rates may seem low for CHD and stroke, this may be due to poor ascertainment or because it is under-diagnosed.[37,38] This could be a contributory factor to the low rates found in this study. There is, therefore, a need to determine prevalence estimates based on clinical assessments rather than relying on self-reported estimates, as this will likely provide a more accurate picture.

Although resting 12-lead electrocardiographs (ECGs) are available and inexpensive diagnostic tools for CHD, they have limited sensitivity and specificity for the diagnosis of acute coronary syndromes.[39] ECGs are inadequate screening tests in research settings where reproducibility is of paramount importance.[40] A standardised system, for example, the Minnesota coding system, is required when conducting epidemiological studies to ensure uniformity of interpretation. However, this has its disadvantages and may lead to over-reading.[40]

To determine the true burden of stroke, community-based studies that include brain imaging for accurate classification of stroke would be optimal, but such studies are expensive and challenging to conduct, particularly in low-resource settings.[31,41] A possible solution may be to establish well-structured CHD and stroke registries nationally. However, such an undertaking requires much effort and infrastructure costs to ensure good co-ordination and communication across centres.[42] Furthermore, there needs to be continuous monitoring and quality control to optimise data capturing.

The limitations of this review are that the 12 included studies were based on self-reported conditions and only one study was found that estimated incidence rates in CHD and stroke. Also, due to the small number of studies found, we were unable to conduct meaningful subgroup analyses. Only English language studies were included in this review. Grey literature, pre-prints and theses were also not included. The strength of this study was that we were able to provide pooled prevalence estimates of CHD and stroke in South Africa, which to date has not been done.

Conclusions

The findings of this review quantify the overall national prevalence of CHD and stroke, which was found to be low and may be due to the absence of the relevant evidence in the literature. This highlights the need for reliable and nationally representative data, as well as data by urban–rural residence, population group and gender, to identify high-risk, vulnerable communities. This can be achieved by the introduction of well-structured registries to correctly identify the burden of CHD and stroke in South Africa, which in turn could inform health policies and the delivery of appropriate healthcare services.

This study was funded by the South African Medical Research Council (SAMRC) with funds from the National Treasury under the SAMRC Computative Intramural Research Fund (SAMRC-RFA-IFF-02-2016).

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