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### Interventions addressing risk factors of ischaemic heart disease in sub-Saharan Africa

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# BMJ Open Interventions addressing risk factors of ischaemic heart disease in sub-Saharan Africa: a systematic review

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## ABSTRACT

**Background:** Ischaemic heart disease (IHD) is currently ranked eighth among the leading causes of deaths in sub-Saharan Africa (sSA). Yet, effective population-wide preventive measures targeting risks in the region are still largely unavailable. We aimed to review population-wide and individual-level interventions addressing risk factors of IHD among adults in sSA.

**Methods:** A systematic search of MEDLINE, EMBASE, Global Health and AJOL was conducted to identify studies focusing on population-wide and individual-level interventions targeting risks of IHD among adults in sSA. We conducted a detailed synthesis of basic findings of selected studies.

**Results:** A total of 2311 studies were identified, with only 9 studies meeting our selection criteria. 3 broad interventions were identified: dietary modifications, physical activity and community-based health promotion measures on tobacco and alcohol cessation. 3 studies reported significant reduction in blood pressure (BP), and another study reported statistically significant reduction in mean total cholesterol. Other outcome measures observed ranged from mild to no reduction in BP, blood glucose, body mass index and total cholesterol, respectively.

**Conclusions:** We cannot specify with all certainty contextually feasible interventions that can be effective in modifying IHD risk factors in population groups across sSA. We recommend more research on IHD, particularly on the understanding of the burden, geared towards developing and/or strengthening preventive and treatment interventions for the disease in sSA.

## INTRODUCTION

The burden of cardiovascular diseases (CVDs) has consistently increased across many world regions over the last three decades.<sup>1 2</sup> Between 1990 and 2013, the Institute for Health Metrics and Evaluation reported a median percentage change of CVDs at 40.8% and 89.2% for global deaths and years lived with disabilities, respectively.<sup>3 4</sup> Increasing cases and deaths from CVDs, especially Ischaemic Heart Disease (IHD), have

## Strengths and limitations of this study

- This study provides an insight into interventions targeting known risks of ischaemic heart disease (IHD) in selected African population groups.
- This study identifies substantive gaps in research and evidence for informed policy decisions on IHD in sub-Saharan Africa.
- Dietary modification, physical activity, health education and health promotion measures have been effective IHD preventive strategies in specific African population groups.
- We still cannot generalise and recommend identified IHD interventions to many African settings, especially due to varying degrees of heterogeneity within and across several African population groups.

also been reported among young and active adults globally.<sup>5</sup> Global estimates suggest the figures to be about 93 million cases and 8.1 million deaths from IHD in 2013.<sup>3 4</sup> In Africa, IHD accounted for 361 000 deaths in 2005, and is currently ranked eighth among the top causes of deaths in the region.<sup>6</sup> In sub-Saharan Africa (sSA) alone, it has been estimated that mortality from IHD may rise from the current rates by about 70% and 74% among African men and women, respectively, by 2030.<sup>7</sup> Increasing sedentary lifestyles, tobacco smoking, alcohol consumption, unhealthy diets and the fast rate of urbanisation and epidemiological transition across many African settings have been strongly indicated.<sup>5 8</sup>

The 2011 United Nations high-level meeting on non-communicable diseases (NCDs) focused on developing a comprehensive policy framework for the prevention and control of NCDs globally, especially across Africa and many low-income and middle-income countries, where the burden is fast increasing.<sup>9</sup> Current reports from Africa show that public health response, access to health services, and availability of effective interventions and treatment options



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for NCDs, including IHD, are relatively poor.<sup>10 11</sup> Cost-effective interventions have been described in many high-income settings.<sup>12 13</sup> Health education, improving access to screening and detection of IHD, deploying inexpensive technologies to arrive at diagnosis and providing affordable medications for prevention and treatment of heart attacks, have all been practised in many developed countries with success.<sup>12 14</sup> In sSA, substantive gaps exist in terms of implementation of many of these interventions due to weak primary healthcare and health systems, and poor political will.<sup>6 15</sup> Moreover, only a few studies, reviews and randomised controlled trials (RCTs) have examined the effectiveness of some of these interventions.<sup>6</sup> Therefore, little evidence is available for informed policy decisions in this African sub-region.<sup>7</sup> A comprehensive synthesis and appraisal of the studies on interventions for IHD in sSA may be necessary towards informing better response and strengthening existing interventions. We systematically reviewed available literature on IHD in sSA to identify, synthesise and appraise population-wide and individual-level interventions addressing risk factors of IHD among adults, towards better public health policy and practise in the region.

## METHODS

### Research question

IHD is a largely preventable NCD, with deaths estimated to rise in sSA by over 70% by the year 2030.<sup>7</sup> In line with

the aim, this study seeks to address the question: are there evidence-based interventional measures currently available to address known risk factors for this preventable disease in the African subregion?

### Search strategy

A systematic search of MEDLINE, EMBASE, Global Health and African Journals Online (AJOL) was conducted in May 2016 to identify relevant studies on IHD in sSA, with search date set from 1980 to 2015 (table 1).

Further searches were conducted on Google Scholar, and the reference lists of selected studies were further hand searched for relevant articles. Countries in sSA were as provided in the World Bank list of countries, regions and economies.<sup>16</sup>

### Selection criteria

We included original studies (RCTs, cross-sectional or cohort studies and quasiexperimental studies) that described basic interventions used in modifying risk factors associated with IHD across different countries in sSA. The outcome measures assessed were changes in blood pressure (BP), blood glucose, total cholesterol and body mass index (BMI). We ensured participants in selected studies were adults aged 18 years and above. We excluded studies that focused on interventions in children. Reviews, commentaries, viewpoints and letters were also excluded. There were no English Language restrictions, and no attempt was made to contact authors of articles that were not selected.

**Table 1** Search terms on MEDLINE

Number	Searches
1	cardiovascular diseases/ or myocardial ischemia/ or angina pectoris/ or coronary disease/ or coronary artery disease/ or myocardial infarction/
2	ischemic heart disease*.mp. (mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier)
3	coronary heart disease*.mp. (mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier)
4	ischaemic heart disease*.mp. (mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier)
5	"africa south of the sahara"/ or africa, central/ or cameroon/ or central african republic/ or chad/ or congo/ or "democratic republic of the congo"/ or equatorial guinea/ or gabon/ or africa, eastern/ or comoros/ or burundi/ or djibouti/ or eritrea/ or ethiopia/ or kenya/ or rwanda/ or seychelles/ or somalia/ or south sudan/ or sudan/ or tanzania/ or uganda/ or africa, southern/ or angola/ or botswana/ or lesotho/ or madagascar/ or malawi/ or mauritius/ or mozambique/ or namibia/ or sao tome and principe/ or south africa/ or swaziland/ or zambia/ or zimbabwe/ or africa, western/ or benin/ or burkina faso/ or cape verde/ or cote d'ivoire/ or gambia/ or ghana/ or guinea/ or guinea-bissau/ or liberia/ or mali/ or mauritania/ or niger/ or nigeria/ or senegal/ or sierra leone/ or togo/ or subsaharan africa.mp. (mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier)
6	1 or 2 or 3 or 4
7	5 or 6
8	7 and 8
9	7 and 8

Searches on EMBASE, Global Health and AJOL were slightly modified.

## Case definitions

We mainly considered studies that focused on interventions addressing known risk factors IHD, including high BP, diabetes mellitus, hypercholesterolaemia, overweight and obesity and tobacco smoking.<sup>17</sup> IHD was defined as a group of heart and vascular events characterised by narrowing of arteries with reduced blood and oxygen supply to the heart muscle.<sup>18</sup> Diagnosis, when described, may be based on ECG findings, echocardiogram or relevant imaging findings, cardiac enzymes and/or tissue-specific cardiac biomarkers.<sup>18 19</sup> IHD is also often referred to as 'coronary artery disease' or 'coronary heart disease' (CHD); in such cases, we generally checked for any reported evidence of intervention targeting risk of ischaemic myocardial necrosis to satisfy inclusion in our review.

## Quality assessment

The quality of selected studies was assessed using the Jadad scale.<sup>20</sup> Studies were graded between 1 and 5, with 5 being the highest and 1 the lowest. Criteria employed were randomisation, blinding and accountability of all participants. Details of the grading of each study are in the online supplementary file.

## Data extraction and synthesis

Data were double extracted from each study and stored in Microsoft Excel file format. We extracted data on overall study characteristics including study period, country, location and setting, method of participant recruitment, number and mean age of participants,

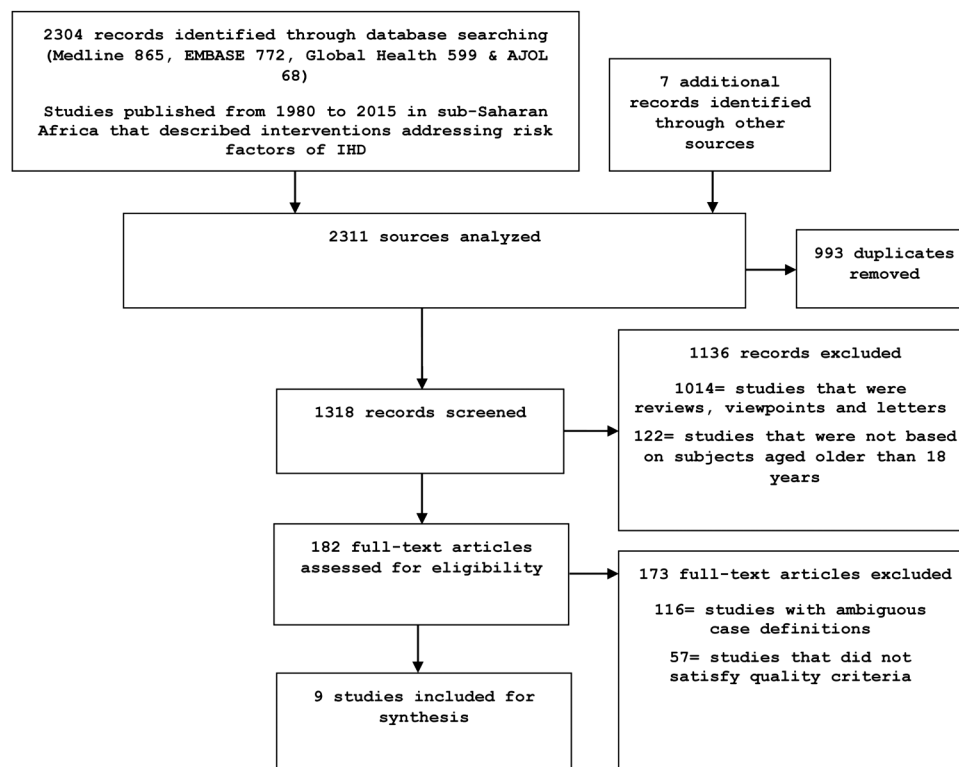
intervention implemented, follow-up period and assessment of outcome variables. We did not conduct any meta-analysis in this review due to varying heterogeneities observed within and between population groups in the selected studies. A qualitative synthesis, as well as evidence appraisal based on relevant information obtained from selected studies was conducted (see online supplementary file). A PRISMA checklist was used to assess the completeness of all stages of our review.

## RESULTS

Our search returned 2311 records. Only nine studies met our inclusion criteria and were retained for qualitative synthesis.<sup>21–29</sup> The reasons for the excluded studies are as highlighted in figure 1. Individual study characteristics are shown in table 2.

Our findings showed that population-wide and individual-level interventions conducted across selected studies included dietary modification, physical activity, health education and health promotion activities on tobacco and alcohol cessation. These interventions were primarily aimed at reducing metabolic risk factors for IHD, such as hypertension, diabetes, obesity and hypercholesterolaemia (table 2 and see online supplementary file).

Five of the retained studies employed dietary modification in addressing hypertension and hypercholesterolaemia associated with IHD.<sup>21 22 24 27 29</sup> Four studies focused on salt intake and its relationship with BP,<sup>21 22 24 27</sup> while the fifth study focused on modifying



**Figure 1** Flow chart of study selection.

**Table 2** Characteristics of included studies

Studies	Country, location (setting)	Study design	Type of intervention	Results
Adeyemo <i>et al</i> <sup>21</sup>	Nigeria, Igbo-Ora and Idere (rural)	Feasibility study	Dietary modification	Reduction observed in 24-hour urinary sodium excretion, and in systolic and diastolic blood pressure
Cappuccio <i>et al</i> <sup>22</sup>	Ghana, Ejisu-Juabeng and Kumasi districts (rural and semiurban)	Cluster randomised trial	Dietary modification and health promotion	Significant reduction in systolic and diastolic blood pressure, and changes observed in 24-hour urinary sodium excretion
Dowse <i>et al</i> <sup>23</sup>	Mauritius (semiurban)	Cross-sectional survey	Health education and health promotion	Reduction in blood pressure, increased physical activity, but no effect observed on BMI. There was an unusual increase in blood sugar
Forrester <i>et al</i> <sup>24</sup>	Nigeria, Igbo-Ora and Idere (rural)	Randomised control trial	Dietary modification	No significant association observed between changes in salt and blood pressure
Grace <i>et al</i> <sup>25</sup>	South Africa, Mpumalanga and Gauteng (rural)	Non-randomised trial	Physical activity and health promotion	Minimal reductions observed in BMI and blood pressure. No reduction observed in total serum cholesterol
Mendis <i>et al</i> <sup>26</sup>	Nigeria (semiurban)	Cluster randomised trial	Health education and health promotion	Significant reduction observed in blood pressure levels
Mtabaji <i>et al</i> <sup>27</sup>	Tanzania (semiurban)	Randomised control trial	Dietary modification	A significant reduction in arterial blood pressure among male normotensives placed on low salt diet compared to those on high salt diet
Rossouw <i>et al</i> <sup>28</sup>	South Africa, South-Western Cape (rural)	Quasi-experimental design	Health education and health promotion	Reduction in blood pressure in both sexes, and minimal reduction in BMI among females
Uusitalo <i>et al</i> <sup>29</sup>	Mauritius (semiurban)	Cross-sectional survey	Dietary modification	Positive reduction observed in total serum cholesterol

BMI, body mass index.



the content of a commonly used cooking oil targeted at reducing total cholesterol concentration.<sup>29</sup>

In the study by Adeyemo *et al*,<sup>21</sup> the effects of reducing cooking salt among free-living normotensive individuals in two rural communities in south-western Nigeria were examined. There was at least 50 mmol reduction in 24-hour urinary sodium in 67% of the participants, and 25 mmol reduction in 84% of the participants. Reductions were also observed in the systolic and diastolic BP of participants, with the mean systolic BP reducing by 4.7 and 7.0 mm Hg among men and women, respectively, after 2 weeks. A similar finding was reported in Tanzania by Mtabaji *et al*,<sup>27</sup> with a significant reduction in arterial BP among male normotensives placed on low salt diet compared to those on high salt diet. The study further reported that those on low salt diet had a urinary sodium excretion of 52 mmol/day relative to a 320 mmol/day observed among those on high salt diet. In Ghana, Cappuccio *et al*<sup>22</sup> also examined the effects of not adding salt while cooking, and reducing the consumption of preserved salted foods on urinary sodium excretion and BP among 1013 adult participants in both rural and semiurban settings. Significant reduction in the systolic and diastolic BP, as well as urinary sodium, was observed in the intervention group compared with control, especially after 6 months of restriction of salt intake. The study concluded that a relative decrease in BP may be observed with reduced salt intake in the West Africa subregion. However, in a Nigerian study involving 58 participants from two rural communities, Forrester *et al*<sup>24</sup> reported that no significant association was observed between measured changes in dietary salt and systolic or diastolic BP ( $p=0.08$ ). In this study, outcome measures showed that the mean change in systolic and diastolic BP for both the low salt and high salt phases differed by 4.8 and 3.2 mm Hg, respectively.<sup>24</sup>

In Mauritius, Usitalo *et al*<sup>29</sup> examined the effect of modifying commonly used cooking oil (ration oil) on mean serum cholesterol concentration among 1926 participants. The main composition of the ration oil was mostly palm oil which was high in saturated and monounsaturated fatty acids. The ration oil was modified to entirely soya bean oil. At baseline, 86% of participants used ration oil. During the 5-year follow-up, 53% of participants used the modified ration oil. The mean cholesterol concentration at baseline was 5.5 mmol/L, with this reducing to 4.7 mmol/L at follow-up. This reduction was statistically significant for both men and women ( $p<0.001$ ).

Only one study examined the effect of physical activity on some selected health measures such as BP, body mass index (BMI) and plasma cholesterol concentration.<sup>25</sup> The study was conducted among 143 male South African colliery executives recruited across two South African provinces, Mpumalanga and Gauteng. The participants were exposed to a physical fitness programme in the control group and a physical fitness programme

combined with a health promotion intervention programme in the experimental group for 32 weeks. At 32 weeks, there was a reduction in BMI in the experimental group, although, this was not statistically significant ( $p=0.067$ ). The study also observed an improvement in both the systolic and diastolic BP of participants after 16 weeks. Although no statistical significance was observed in the experimental group, the values at reassessment were better than the baseline values. Moreover, effects of physical activity combined with health promotion measures on total cholesterol concentration in the participants were examined over the same 32-week period.<sup>25</sup> There were no changes in total cholesterol observed during the 16 and 32 weeks reassessment in the experimental group. A moderate increase was observed in the cholesterol concentration of the control group during the 16-week reassessment.

The third intervention identified was health education/promotion measures. Three studies were identified, and targeted essentially the effects of tobacco smoking cessation and alcohol consumption reduction on hypertension, hypercholesterolaemia, diabetes and obesity.<sup>23 26 28</sup> Other selected studies also had some forms of health education messages along with their targeted intervention, although these were non-specific.

In Mauritius, Dowse *et al*<sup>23</sup> examined the effects of some health education/promotion activities on the prevalence of IHD risk factors among 5162 participants over a 5-year period (1987–1992). The study employed the use of mass media campaigns, widespread community, school and workplace health education activities to promote increased physical activity, healthy diet, smoking cessation and reduction in alcohol consumption. While the interventions resulted in a significant reduction in the prevalence of hypertension in both men and women participants ( $p<0.001$ ), no positive effects were observed in BMI, and no statistically significant reduction was observed in mean fasting blood glucose.<sup>25</sup> In a larger South African study involving 7188 participants, Rossouw *et al*<sup>28</sup> observed a reduction in BP in both men and women participants, and a reduction in BMI only among the women participants after a 4-year health education/promotion intervention programme.

In Nigeria, Mendis *et al*<sup>26</sup> investigated the effectiveness of WHO CVD risk management health promotion package in reducing BP in primary care settings, and in improving adherence to lifestyle changes at the individual and cluster levels among 1188 participants. The intervention involved assessment and management of cardiovascular risk factors, and counselling on risk factors control such as physical activity, diet and tobacco cessation. There was a reduction in BP which was more in the intervention group than the control group. In the intervention group, all participants reported quitting smoking, while 74.4% reported quitting smoking in the control group ( $p=0.023$ ).

## DISCUSSION

This systematic review examined population-wide and individual-level interventions that focused on modification of risk factors associated with IHD in sSA. Our findings suggest there may be effective IHD-preventive strategies specific for African population groups, with dietary modification, physical activity, health education/promotion activities being the main measures reported.

The findings from studies on effects of dietary modifications indicate that meals low in fats and salts may reduce major IHD risks, including hypertension and hypercholesterolaemia.<sup>21 22 24 27 29</sup> However, not all studies reported a statistically significant relationship, suggesting there are still uncertainties on the role of dietary salts and fats in reducing risks of IHD. Hooper and colleagues, however, reported that evidence obtained from large and small trials revealed that low sodium diet may help in lowering BP after withdrawing antihypertensives. Hooper further noted that a comprehensive dietary and nutritional plan addressing salt and fat consumption may be very helpful at reducing risks of CVDs in a population.<sup>30</sup>

Physical activity, as a sole intervention for modifying risks of CVDs, was implemented in just one study, with the authors not clearly stating how physical activity can effectively modify risk factors associated with IHD among adults.<sup>25</sup> However, several studies have revealed that moderate physical activity and exercise most days of the week may be associated with significant reduction in the incidence and mortality from CVDs.<sup>31 32</sup> In the study of 17 944 middle-aged male British civil servants, free of CHD, the age-standardised cumulative incidence of CHD was 3.1% among men observing vigorous physical activity, compared with 6.9% among those with no physical activity.<sup>33</sup> Although, this may not be directly compared with sSA, due to several contextual differences, it still possibly suggests such measures could lead to similar outcomes in the African subregion.

From the included studies, we also noted that population-wide health education and health promotion measures can indirectly influence healthy lifestyles and behavioural changes.<sup>23 26 28</sup> Ford *et al.*<sup>34</sup> employed a health promotion model that can relatively address common risk factors for CVDs, with this accounting for population-wide improvements in BP, cholesterol, smoking and physical activity, and sufficient to influence a change from 44% to 76% in reduction of CHD mortality.

Most of the interventions reported in this review were community based, suggesting that they may only be feasible and acceptable within contextually similar settings. The organisation and sustainability of these interventions across many settings in sSA may be difficult due to prevailing divergent social, cultural and individual issues. Hence, underlying determinants of IHD, including income distribution and educational level specific to the various population subgroups in the region, need to be identified and addressed.<sup>35</sup> Additionally, interventions targeting behavioural risks in the general

population through a comprehensive risk assessment, and designing cost-effective management protocols for the high-risk categories may need to be undertaken towards ensuring improved cardiovascular health in sSA.<sup>35</sup> Advocacies and policies that allow collaboration and regular interactions among experts in the academia, researchers, clinicians, community leaders, government and non-governmental agencies, may be helpful in instituting some of these interventions effectively on a population-wide scale in many indigenous settings in the region.<sup>36</sup> Such policy frameworks may need to be jointly developed by the various stakeholders to aid effective implementation, monitoring and evaluation across the subcontinent.

Our study is not without limitations. Despite a rigorous search across several electronic databases, the number of studies retained was relatively small to fully reflect the entire sSA population. Moreover, only five countries were represented in this review (Ghana, Mauritius, Nigeria, South Africa and Tanzania), meaning that findings are more likely to reflect the conditions in these settings. There were obvious heterogeneities across the selected studies. As such, a meta-analysis, which could have provided a regional pooled estimate on the effectiveness of these interventions in sSA, was not conducted. We cannot, therefore, state with all certainty specific interventions for IHD that can be applied, modelled or replicated in sSA. We also understand there are several interventions that have been studied in many settings outside sSA; a contextual comparison of these to African countries would have been worthwhile, but discussing this would simply be beyond the aims of this study. Additionally, WHO already provided a comprehensive Package of Essential Non-communicable disease interventions for primary healthcare in less developed settings, with a focus on improving maternal nutrition, implementing tobacco prevention and cessation programmes, improving affordability of food, encouraging physical activity and providing access to effective prevention and care of risks and diseases,<sup>37</sup> our review would have been more detailed if assessments of these interventions were identified across selected studies. However, due to very low research output and a relative lack of understanding of the burden of IHD in sSA, we believe our report may contribute to relevant research and policy response on IHD risk factors and interventions across countries in the region.

## CONCLUSION

The rising burden of IHD in sSA without effective population-wide interventions remains a huge public health concern in the region. Hitherto, little has been known on the epidemiology, treatment options and overall public health response to IHD in Africa. Our findings on dietary modifications, physical activity and relevant health promotion measures may have been suggestive of relative improvements in reducing risks of

IHD, yet, we still cannot generalise and recommend this to many African settings, especially due to varying degrees of heterogeneity within and across population groups. We recommend more research and active collaboration on IHD, particularly on the understanding of its epidemiological distribution and overall burden in sSA, targeted towards developing and/or strengthening population-wide preventive and treatment options across several settings in the region.

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