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Interventions addressing risk factors of Ischemic Heart Disease in sub-Saharan Africa: a systematic review

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ABSTRACT

Background: Ischemic Heart Disease (IHD) is currently ranked 8th 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 Ischemic Heart Disease among adults in sSA.

Methods: A systematic search of Medline, EMBASE and Global Health was conducted to identify studies focusing on population-wide and individual-level interventions targeting risks of Ischemic Heart Disease among adults in sSA. A synthesis of basic findings of selected studies was conducted.

Results: A total of 1448 studies were identified, with only seven studies meeting our selection criteria. Three broad interventions were identified- dietary modifications, physical activity, and community-based health promotion measures on tobacco and alcohol cessation. Two studies reported significant reduction in blood pressure, and another study reported statistically significant reduction in mean total cholesterol. Other outcome measures observed ranged from mild to no reduction in blood pressure, blood glucose, body mass index and total cholesterol, respectively

Conclusion: 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.

Article summary

Strengths

- This study provides an insight into interventions targeting known risks of Ischemic 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 (SSA).
- Dietary modification, physical activity, health education and health promotion measures have been effective IHD preventive strategies in specific African population groups.

Limitations

- We still cannot generalize and recommend identified IHD interventions to many African settings, especially due varying degrees of heterogeneities within and between several African population groups.

INTRODUCTION

The burden of cardiovascular diseases (CVDs) has consistently increased across many world regions over the last three decades.[1 2] Between 1990 and 2013, the Institute for Health Metrics and Evaluation (IHME) reported a median percentage change of CVDs at 40.8% and 89.2% for global deaths and years lived with disabilities (YLDs), respectively.[3 4] Increasing cases and deaths from CVDs, especially Ischemic Heart Disease (IHD), have also been reported among young and active adults globally.[5] Global estimates suggest about 93 million cases and 8.1 million deaths from IHD in 2013.[3 4] In Africa, IHD accounted for 361,000 deaths in 2005, and is currently ranked 8th among the top causes of deaths in the region.[6] 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.[7] Increasing sedentary lifestyles, tobacco smoking, alcohol consumption, and unhealthy diets, and the fast rate of urbanization and epidemiological transition across many African settings have been strongly indicated.[5 8]

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- and middle-income countries (LMICs), where the burden is fast increasing.[9] Current reports from Africa show that public health response, access to health services, and availability of effective interventions and treatment options for NCDs, including IHD, are relatively poor.[10 11] Cost-effective interventions have been described in many high-income settings.[12 13] 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 practiced in many developed countries with successes.[12 14] In sSA, substantive gaps exist in terms of implementation of many of these interventions due to weak primary health care and health systems, and poor political will.[6 15] Moreover, only a few studies, reviews and randomized controlled trials (RCTs) have examined the effectiveness of some of these interventions.[6] Therefore, little evidence is available for informed policy decisions in this African sub-region.[7] 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, synthesize and appraise population-wide and individual-level interventions addressing risk factors of IHD among adults, towards better public health policy and practice in the region.

METHODS

Search strategy

A systematic search of Medline, EMBASE and Global Health was conducted to identify relevant studies on Ischemic Heart Disease in sub-Saharan Africa, with search date set from 1980 to 2015 (**Table 1**).

Table 1. Search terms

#	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	risk/ or risk factors/
6	lifestyle intervention*.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]
7	population wide intervention*.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]
8	individual level intervention*.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]
9	"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 burundi/ or djibouti/ or eritrea/ or ethiopia/ or kenya/ or rwanda/ or somalia/ or sudan/ or tanzania/ or uganda/ or africa, southern/ or angola/ or botswana/ or lesotho/ or malawi/ or mozambique/ or namibia/ 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/
10	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]
11	1 or 2 or 3 or 4
12	5 or 6 or 7 or 8
13	9 or 10
14	11 and 12 and 13

Further searches were conducted on Google Scholar, and the reference lists of selected studies were further hand-searched for relevant articles. Countries in sub-Saharan Africa were as provided in the World Bank list of countries, regions and economies.[16]

Selection criteria

We included original studies (RCTs, cohort studies, and quasi-experimental 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, 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.

Case definitions

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

Quality assessment

The quality of selected studies were assessed using an adaptation of Consolidated Standards of Reporting Trials (CONSORT) and Transparent Reporting of Non-randomised Designs (TREND) checklists, respectively.[20 21] Each of the studies was assessed using the appropriate quality appraisal checklist. Criteria used to assess the validity of the article included randomization, similarity between intervention and control groups, blinding, homogeneity, and follow-up after the study. Studies were graded as [++], [+] or [-], with [++] having the highest grade and [-] the lowest grade (**Supplementary file**). Generally, all studies assessed as [-] were not selected for the review.

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 and evidence appraisal based on relevant information obtained from selected studies was conducted (**Supplementary file**). A PRISMA checklist was used to assess the completeness of all stages of our review.

RESULTS

Our search returned 1448 records. Only 7 studies met our inclusion criteria and were retained for qualitative synthesis. The reasons for the excluded studies are as

highlighted in **Figure 1**. Individual study characteristics are shown in **Table 2**.

Table 2. Summary of results

Studies	Country, Location (Setting)	Study design	Type of Intervention	Results
Cappuccio *et al*. 2006 [22]	Ghana, Ejisu-Juabeng and Kumasi districts (rural & semi-urban)	Cluster Randomised Trial	Dietary modification and health promotion	Positive reduction in systolic and diastolic blood pressure, non-significant changes observed in 24 hour urinary sodium excretion
Dowse *et al*. [23]	Mauritius (semi-urban)	Cross-Sectional Survey	Health education and health promotion	Reduction in blood pressure, increased physical activity, but no effect observed on BMI. There was unusual increase in blood sugar
Forrester *et al*. [24]	Nigeria, Igbo-Ora and Idere (rural)	Randomised Control Trial	Dietary modification	No significant association observed between changes in salt and blood pressure
Grace *et al*. [25]	South Africa, Mpumalanga and Gauteng (rural)	Non-Randomised Trial	Physical activity and health promotion	Small reductions observed in BMI and blood pressure. No reduction observed in total serum cholesterol
Mendis *et al*. [26]	Nigeria (semi-urban)	Cluster Randomised Trial	Health education and health promotion	Positive and significant results observed in blood pressure levels
Rossouw *et al*. [27]	South Africa, Riversdale, Swellendam and Robertson (rural)	Quasi Experimental Design	Health education and health promotion	Reduction in blood pressure, slight reduction in BMI for only females
Uusitalo *et al*. [28]	Mauritius (semi-urban)	Cross Sectional Survey	Dietary modification	Positive reduction observed in total serum cholesterol.

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 hypercholesterolemia (**Table 2** & **Supplementary file**).

Dietary Modification

Three of the retained studies employed dietary modification in addressing hypertension and hypercholesterolemia associated with IHD.[22 24 28] Two studies focused on salt intake and its relationship with blood pressure,[22 24] while the third study focused on modifying the content of a commonly used cooking oil targeted at reducing total cholesterol concentration.[28]

Cappuccio *et al.* examined the effects of not adding salt to cooking foods and limiting the consumption of preserved salted foods on urinary sodium and blood pressure among 1,013 adult participants in both rural and semi-urban settings in Ghana.[22] Although not very pronounced, 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 BP reduction is associated with reduced salt intake in West Africa sub-region.

In a Nigerian study involving 58 participants from 2 rural communities, Forrester *et al.* also examined the effect of sodium or salt reduction on blood pressure.[24] In this study, outcome measures showed that the mean change in systolic and diastolic blood pressure for both the low salt and high salt phase differed by 4.8mm Hg and 3.2mm Hg, respectively. No significant association was observed between measured changes in salt and systolic or diastolic blood pressure (p=0.08).

In Mauritius, Uusitalo *et al.* examined the effect of modifying commonly used cooking oil (ration oil) on mean serum cholesterol concentration among 1,926 participants.[28] The main composition of the ration oil was mostly palm oil which was high in saturated and monounsaturated fatty acid. The palm oil in ration oil was

modified to entirely soya bean oil. At baseline, 86% of participants used ration oil which was still composed of mostly palm oil. During the 5 year follow-up, 53% of participants used the modified ration oil. The mean cholesterol concentration at baseline was 5.5mmol/l, and after the five years intervention programme, the mean cholesterol concentration reduced to 4.7mmol/l. There was about 0.8mmol/l reduction observed in all ethnic groups. This reduction was statistically significant for both males and females ($p<0.001$).

Physical activity

Only one study examined the effect of physical activity on some selected health indicators such as blood pressure, body mass index (BMI) and plasma cholesterol concentration.[25] The study was conducted among 143 male South African colliery executives. Participants were recruited from five selected collieries which spread across two South African provinces- Mpumalanga and Gauteng. Participants were exposed to a physical fitness program in the control group and a physical fitness programme combined with a health promotion intervention programme in the experimental group for 32 weeks. At 16 weeks, an improvement in BMI in the control group was observed and statistically significant. At 32 weeks, there was a reduction in BMI in the experimental group, although, this reduction was not statistically significant ($p=0.067$). Additionally, the study observed an improvement in both the systolic and diastolic blood pressure of participants after 16 weeks, with only the control being statistically significant. Although no statistical significance was observed in the experimental group, the values at re-assessment were better than the baseline values.

Grace et al. also examined the effect of physical activity combined with health

promotion measures on total cholesterol concentration in participants. The duration of follow-up was for 32 weeks.[25] There were no changes observed during the 16 and 32 weeks re-assessment for the experimental group as the total cholesterol concentration remained the same. In fact, a slight increase was observed in the cholesterol concentration of the control group during the 16 week re-assessment. However, no statistical significances were reported in both groups.

Health Education and Health Promotion Measures

Three studies focused primarily on health education and health promotion activities targeted at tobacco smoking and alcohol consumption towards modifying hypertension, hypercholesterolemia, diabetes and obesity.[23 26 27] Other selected studies also had some forms of health education messages along with their targeted intervention, although these were non-specific.

Dowse et al. in a study conducted in Mauritius and involving 5,162 participants, examined the effects of some health education and health promotion activities on the prevalence of IHD risk factors such as hypertension, hypercholesterolemia, diabetes and obesity over a period of five years (1987-1992).[23] 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 male and female participants ($p<0.001$), no positive effects were observed with their BMI. Additionally, no statistically significant effect was observed with diabetes status.[25] In another larger South African study involving 7,188 participants, Rossouw and colleagues observed a reduction also in blood pressure in both male and female participants

and a reduction in BMI only in the female participants after a four-year health education/promotion intervention programme.[27]

In Nigeria, Mendis *et al.* investigated the effectiveness of World Health Organization (WHO) cardiovascular disease risk management health promotion package in reducing blood pressure in primary care settings, and in improving adherence to lifestyle changes at the individual and cluster levels among 1,188 participants.[26] 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 blood pressure which was more pronounced 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 Ischemic Heart Disease in sSA. Our findings suggests there may be effective IHD preventive strategies specific for African population groups, with dietary modification, physical activity, health education and health 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 hypercholesterolemia.[22 24 28] However, not all studies reported 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 blood pressure after withdrawing antihypertensives. Hooper further noted that a comprehensive dietary and nutritional plan addressing salt and fat consumption may be very helpful at reducing the risk of cardiovascular diseases in a population.[29]

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.[25] 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.[30 31] In the study of 17,944 middle-aged male British civil servants, free of coronary heart disease (CHD), the age-standardized cumulative incidence of CHD was 3.1% among men observing vigorous physical activity, compared to 6.9% among those with no physical activity.[32] Although, this may not be directly compared to sSA due to several contextual differences.

From the included studies, we also noted that population-wide health education and health promotion measures can indirectly influence positive lifestyles and behavioural changes capable of reducing the risks of IHD.[23 26 27] Ford *et al*. employed a health promotion model that can relatively address common risk factors for cardiovascular diseases, with this accounting for population-wide improvements in blood pressure, cholesterol, smoking, and physical activity, and sufficient to influence a change from 44% to 76% of CHD mortality reduction.[33]

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 organization and sustainability of these interventions across many settings in sSA

may be difficult due to prevailing divergent cultural and individual characteristics. Policies that allow collaboration and regular interactions between experts, community leaders, relevant stakeholders and government leaders may be helpful in instituting some of these interventions effectively on a population-wide scale in many indigenous settings in sSA.[34]

Study limitations

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 sub-Saharan Africa population. Moreover, only four countries were represented in this review (Ghana, Mauritius, Nigeria and South Africa), 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 sub-Saharan African countries. We also understand there are several interventions that have been studied in many settings outside sub-Saharan Africa, 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, the WHO already provided comprehensive Package of Essential Noncommunicable (PEN) disease interventions for primary health care 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;[35] 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 sub-Saharan Africa, 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 is 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 promotions measures may have been suggestive of relative improvements in reducing the risk of IHD, yet we still cannot generalize and recommend this to many African settings, especially due varying degrees of heterogeneities within and between several African population groups. We recommend more research on IHD, particularly on the understanding of the burden, geared towards developing and/or strengthening preventive and treatment options required to address the disease across several settings in sSA.

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Data sharing statement: No additional data available.

Conflict of interest declaration: All authors have completed the Unified Competing Interest from at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author). The authors declare no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years, and no other relationships or activities that could appear to have influenced the submitted work.

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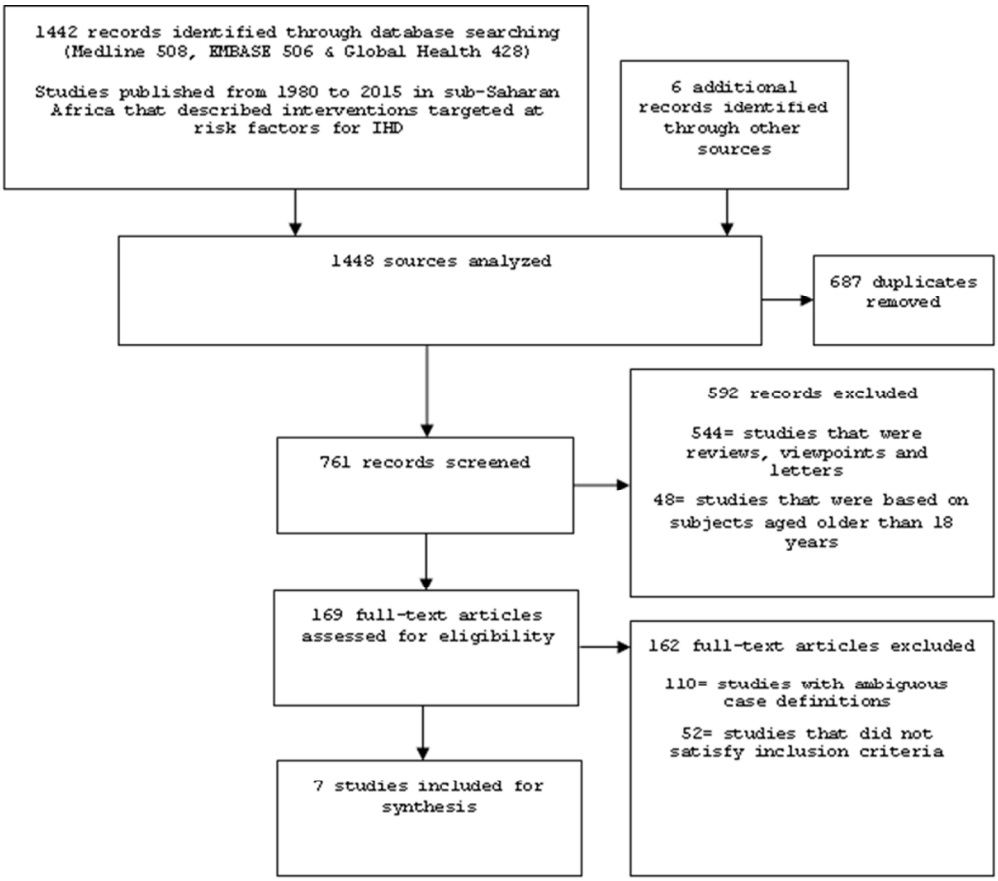
Legends to Figures

Figure 1. Flow chart of study selection



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SUPPLEMENTARY FILE

TABLE S1. EVIDENCE TABLE OF INCLUDED STUDIES

Study details	Population and setting	Description of intervention	Outcome measures and how they were analysed	Results relevant to this review	Limitations and source of funding
Authors: Cappuccio, F.P., Kerry, S, M., Micah, F.B., Plange-Rhule, J., and Eastwood, J.B. Year: 2006 Citation: : A community program to reduce salt intake and blood pressure in Ghana, BMC Public health, 6 (13), pp. 1-11. Aim of study: To establish the feasibility of reducing salt intake on blood pressure reduction without targeting other aspects of participant's diet in twelve communities in Ghana with a high rate of morbidity and mortality associated with stroke and heart failure. Study design: Cluster	Population: Adults 18 years and above located in twelve communities in Ejisu-Juabeng and Kumasi districts in Ghana. Selected population: Adults between the ages of 40-75 years with no previous diagnosis of hypertension, stroke and heart failure. Setting: Twelve communities in Ejisu-Juabeng and Kumasi districts in Ghana. Six of these communities were rural and the other six semi-urban. Sample size: 1,013 participants	Participants were selected by stratified random sampling method from all the villages by age and sex from the census of all inhabitants in the villages. They were randomised in blocks of two to either intervention or control group. They were also blinded to the type of dietary intervention they were receiving. Intervention: The intervention was for 6 months and it involved additional advice given to participants not to add salt to food when cooking and to limit the amount of salts added to specific meals like koobi, momoni, kako, tilapia (salted fish), salted pigs'	Primary outcome: Changes in systolic and diastolic blood pressure were measured during follow-up periods and standardised time of measurement was 8am after adjusting for age, sex, locality and BMI. Changes in 24 hour urinary sodium excretion were measured at follow-up periods after adjusting for confounders such as age, sex, BMI. The method of analysis between BP and urinary sodium excretion was estimated by a random effect regression model.	Effect of the intervention on salt intake: It was observed that smaller villages with smaller samples showed greater reduction in urinary sodium excretion as compared to larger villages in both groups but the net intervention change was not statistically significant. Effect of intervention on BP: it was observed in the intervention group that there was a small reduction in systolic and diastolic BP which was more pronounced at six months and statistically significant for diastolic BP at six months. Follow-up rate in both	Limitations identified by authors: There was a delay of about 18 months between household survey and the starting of the intervention in some villages. Taking of blood samples from participants was a form of difficulty because there was spread of rumours in some villages that it was to be tested for HIV. The timing of data collection did not suit all participants as some of them left for work much earlier. The randomisation trial was not fully managed due to contamination of the two arms which may have been due to health workers giving information to control villages with the belief that all would improve the health of all the villagers.

randomised trial **Quality rating:** +		feet and salted beef and to soak them overnight in water before eating them. The control group received only health education messages on the awareness of diabetes and hypertension. Participants were re-examined at three months and six months. At follow-up periods, BP, pulse, weight, history of drug therapy and two 24-hour urine samples were measure and recorded. Blood sample was taken only during 6 month follow-up to measure factors related to CVDs. The study sample was divided into two groups: Intervention (522) and control (491).		males (80%) and females (79%) at 6 months was similar. The impact of participants who dropped out or had missing data on the study was not reported. Effect of intervention and 95%CI on BP reduction and urinary sodium excretion at 3 and 6 months: SBP(mmHg)=-0.48(-5.45 to -4.50) 6months= -2.54(-6.54 to -1.45) DBP(mmHg)= -1.02(-3.95 to 1.91) 6months= -3.95(-7.11to -0.78) Urinary sodium(mmol/24h)=-0.5(-12.3 to 11.3) 6months=6.0(-4.1 to 16.1)	Limitation identified by reviewer: Participants lost to follow up were different from those present during 6 months follow-up. Source of funding: The study was supported by the Wellcome Trust (9060415/Z/00/Z).
Authors: Dowse, G.K., Gareebo, H., Alberti, K.G., Zimmet, P., Tuomilehto, J., Purran, A., Fareed, D., Chitson, P., Collins, V.R., and Hemraj, F. Year: 1995 Citation: Changes in	Eligible population: All adults between ages 25-74 years living in ten randomly selected population clusters in Mauritius. Response rate of participants was 82.6%(5080/5892) Setting: Ten randomly	Intervention: Health education activity promoting healthy diet, increased physical activity, alcohol reduction and smoking cessation over a 5 year intervention period in the community, workplace and schools and extensive	The 2 hour 75g oral glucose test was measured using Yellow Spring Instruments (YSI) glucose analysers. Blood pressure was measured twice on the right arm of seated participants with sphygmomanometer. Physical activity was	The prevalence of hypertension decreased by 19.3% in males and 12.1% in females and these changes were significant after adjusting for age and ethnic group. 95% CI for males=-2.9(-4.7 to -1.1). Females=-1.5(-3.0	Limitations identified by authors: 1)It is not clear to what extent the changes observed represent the true intervention as it was not feasible to have a reference area in the small island of Mauritius. Limitation identified by

population cholesterol concentration and other cardiovascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius, BMJ, 311: PP.1255-1259. Objective of study: To study changes in prevalence of risk factors such as diabetes, obesity, hypertension and hypercholesterolemia associated with CVDs after a 5 year intervention that involved promoting healthy lifestyle. Study design: Cross sectional cluster survey **Quality rating: +**	selected population clusters plus an eleventh area purposely selected for its geographic concentration of the minority Chinese population, Mauritius. Sample size: 5,162 participants.	use of mass media. Follow-up was performed in April and May, 1992. A 2 hour 75g oral glucose tolerance test was performed on participants except diabetic patients. BP measurements, BMI and administration of a short lifestyle questionnaire.	graded on a scale of 1- 4 with 1 been the lowest grade and 4 the highest grade. Method of analysis: Data were analysed using the Statistical Package for Social Sciences (SPSS).	to 0.0). There were small non-significant increases in the prevalence of diabetes in both sexes. 95% CI for males= 1.8 (0.0 to 3.6) and females= 0.9(-0.7 to 2.5). There was an increase in moderate or heavy physical activity in males from 16.9% to 22.1% but a very low increase in females from 1.3% to 2.7%. 95% CI for males=5.2(2.9 to 7.5) and females= 1.4(0.6 to 2.2).	reviewer: Follow up frequency was done just once during the 5 year intervention program. The authors did not report if all participants were present during follow-up period. Source of funding: National Institute of Diabetes and Digestive and Kidney Diseases, grant DK-25446
Authors: Forrester, T., Adeyemo, A., Soarres-Wynter, S., Sargent, L., Bennett, F., Wilks, R., Luke, A., Prewitt, W., Kramer, H., and Cooper, R.S. Year: 2005 Citation: A randomised trial on sodium reduction in two developing	Eligible population: Normotensive adults between the ages of 25-55 years who were able to give informed consent. Selected population: Normotensive adults between ages 25-55yrs who were not pregnant, not breastfeeding and had no history of atherosclerotic vascular	Participants were enrolled in a 4 week run-in phase trial on a dietary sodium restriction to test their compliance. After this phase, participants were randomised to either a high salt or low salt diet for 3 weeks, followed by a washout period for 2weeks and a crossover phase for an additional 3	Primary outcome: A 24-hour urine sodium excretion. This was measured by flame photometry in the laboratory. Blood pressure of participants was measured three times each with the stand mercury manometer and the Omron automatic device and the average	The mean net change for urinary sodium excretion during the low salt and high salt phases after controlling for age, sex and period effects in participants was 72.2mEq/day. The average systolic blood pressure for the low salt phase was 109.5mmHg while the	Limitations identified by authors: Due to the short period of the crossover design, the study could not determine the sustainability or acceptability of a 70mmol reduction in sodium intake daily. Limitation identified by reviewer: The small number of participants and volunteer

countries, Journal of human hypertension, 19: pp.55-60. Aim: To evaluate the effect of low salt or high salt diet over the crossover trial intervention period in order to estimate the mean blood pressure response. Study design: Randomised cross-over trial. **Quality rating: +**	disease, diabetes, kidney disease and a BMI>40kg/m². Setting: Two rural communities Igbo-Ora and Idere in south west Nigeria. Sample size: 58 participants	weeks. They were also counselled and given information on diets high in salts and behavioural skills that helps in reducing salt intake.	calculated. Participants were seated for 5mins before BP measurements were taken and asked to avoid eating, drinking anything other than water and avoid strenuous exercise for at least 30mins before measurements. Method of Analysis: continuous variables were compared using Wilcoxon rank sum test and Wald x^2test for categorical variables.	high salt phase was 114mmHg. 95% CI=1.6, 7.3 The average diastolic blood pressure for low and high salt phase was 72mmHg and 74.7mmHg respectively. 95%CI=0.9, 4.5	nature of recruitments limit the study's generalizability. The 24 hour urine sample collection by participants may not be accurate because they were asked to record the start and end time. Source of funding: N/A
Authors: Mendis, S., Johnston, S.C., Fan, W., Oladapo, O., Cameron, A., and Faramawi, M.F. Year: 2010 Citation: Cardiovascular risk management and its impact on hypertension control in primary care in low-resource settings: a cluster-randomised trial, Bull World Health Organ, 88: pp.412-419. Objective of study: To assess the effectiveness	Eligible population: Adults above 18 years of age who were registered in ten pairs of randomly selected primary health care facilities in Nigeria and who were ready to provide necessary information when asked. Selected population: Adults between the ages of 30-70 years with systolic blood pressure between 140-179mmHg who were not on treatment for hypertension and no	Participants in the intervention group were counselled on the control of risk factors such as diet, physical activity and tobacco cessation by staff that were give a training workshop on the intervention before participants were enrolled. Participants were also given follow-up cards that contained BP measurements, future visit dates and the back of the card contained	Primary outcome: It was absolute reduction of systolic blood pressure at 12 month follow-up with respect to baseline measurements. BP was measured using a validated automatic BP monitor. Two readings were taken with a 5mins interval. Secondary outcome: Rates of smoking cessation and change in BMI compared to baseline. Method of analysis: unvaried comparisons were performed with t-tests for	There was a reduction in mean change of systolic BP in both groups but it was greater in the intervention group which was -11.01 mmHg and control -6.61mmHg with a p-value of 0.0002 which was statistically significant. The mean changes in BMI -0.22kg/m² for the intervention group and 0.92kg/m² for the control. P <0.0001.	Limitations identified by authors: Randomisation was done at the regional level which could bring about differences in the baseline characteristics of the intervention and control groups. Facilities were chosen from only two geographical areas and they may not have been representative of all primary health care facilities in the country. Limitations identified by reviewer: 1) The information on

of the WHO CVD risk management package in reducing blood pressure in primary care settings and improving adherence to lifestyle change interventions at both individual and cluster levels. Study design: Cluster-randomised trial **Quality rating:** ++	previous history of heart attack, stroke, transient ischaemic attack or diabetes. Setting: Ten pairs of matched randomly selected primary care facilities in two regions in Nigeria. Sample size: 1188 participants.	summary of the counselling on diet, physical activity and tobacco cessation. This was to encourage participants' adherence.	continuous variables and Fisher's exact test for dichotomous variables.		smoking cessation was based on self-report and they could have reported higher rates of smoking cessation. Future research: Future studies should get more information and use objective evidence on tobacco cessation to ensure data quality Source of funding: N/A
Authors: Rossouw, J.E., Jooste, P.J., Chalton, D.O., Jordaan, E.R., Langenhoven, M.L., Jordaan, P.C.J., Steyn, M., Swanepoel, A.S.P., and Rossouw, L.J. Year: 1993 Citation: Community-Based Intervention: The Coronary Risk Factor Study (CORIS), International Journal of Epidemiology, 22 (3): pp. 428-438. Aim of study: To examine the feasibility and effectiveness of a community intervention	Eligible population: All white males and females between the ages of 15-64years in three rural towns in South Africa. Setting: Three rural towns, Riversdale, Swellendam and Robertson in South Africa with similar age, language, population size and accessibility from cape town. Sample size: 7,188 participants	The intervention areas were divided into low intervention (LII) and high intervention (HII). Both group received a structured health education programme on lowering BP, reducing blood cholesterol and increasing physical activity and managing stress. In addition to this, the HII received a 5-day smoking cessation seminar, public health meetings addressed by experts on each of the risk factors and series of 2-hour diet instruction sessions under the guidance of dieticians.	Both systolic and diastolic BP was assessed using a stethoscope and two sets of ear pieces. The quantity of tobacco consumed was assessed for all groups in g/day. BMI was also calculated in kg/m². Method of Analysis: An unpaired t-test was used with a covariance adjustment for age.	Blood pressure measurements to a greater extent in the intervention areas and it was statistically significant with $p<0.01$.The mean net change for SBP observed in males for LII was -2.3±0.8, HII=-2.7±0.9. Females, LII=-2.4±0.8, HII=-3.6±0.9. DBP for males, LII= -3.4±0.5, HII=-3.7±0.5 Females, LII=-2.5±0.5, HII=-3.0±0.5. There was no significant reduction for BMI in both intervention groups for both males and	Limitations identified by author: The participation rate was between 56-70% which was lower than 80% needed to assure a representative sample. There could possibly have been cross-contamination between control and intervention areas because of some positive effects observed in the control areas. Limitation identified by reviewer: 1) There could be a form of sampling bias as recruitment of participants was not randomised. 2) Allocation of participants to either intervention or

in reducing coronary risk factors such as high BP, high cholesterol concentration and smoking rates in three communities. Study design: Quasi-experimental design **Quality rating:** +				females. LII=-0.1±0.1, HII=-0.0±0.1 for males. Females, LII=-0.1±0.1, HII=-0.2±0.1	control group was not randomised. This could lead to selection bias Source of funding: N/A.
Authors: Uusitalo, U., Feskens, E.J.M., Tuomilehto, J., Dowse, G., Haw, U., Fareed, D., Hemraj, F., Gareebo, K., Alberti, G.M.M., and Zimmet, P. Year: 1996 Citation: Fall in cholesterol over five years in association with changes in fatty acid composition of cooking oil in Mauritius: cross sectional survey, BMJ, 313(7064):PP. 1044-1046. Objective: To determine the extent to which reduction in saturated fatty acid composition of commonly used cooking	Eligible population: A randomly selected subsample of 2059 adults was selected from a large cohort of 5162 participants. Selected population: Adults between the ages of 30-64 years stratified by age, sex and ethnic groups. Setting: Mauritius in the Indian Ocean Sample size: 1926 participants	It was a dietary intervention which involved modification of palm oil in a commonly used cooking oil (ration oil) which is high in saturated fatty acid to soya bean oil. The follow up survey was done 5 years later to determine whether the changes in the content of ration oil to soya bean oil has influenced the cholesterol concentration in participants.	Primary outcome: The outcome measure assessed was a reduction in the mean cholesterol concentration of participants after 5 years compared with baseline by changes in fatty acid composition in stored serum (blood) samples in the laboratory. Method of analysis: Data analysis was done using the SPSS.	The measured serum cholesterol concentration after the 5 year intervention programme for males was 4.78mmol/l and the change observed was -0.79mmol/,l 95% CI= -18.9 (-21.0 to -16.8) while for females, the concentration was 4.65mmol/l and the change observed from baseline= - 0.82mmol/l, 95% CI= -17.5 (-19.2 to -15.8). There was a 14-15% reduction observed in mean cholesterol concentration in adults during the intervention programme.	Limitation identified by reviewer: 1) Only 53% of participants were available during the 5 year follow-up period. The other 47% were lost to follow –up which would probably have affected the final results and conclusions drawn by the authors. Sources of funding: National Institute of Diabetes and Digestive and Kidney Diseases, grant DK-25446.

oil influenced changes in cholesterol concentration in the population during a five year intervention programme. Study design: cross sectional survey **Quality rating:+**					
Grace, J.M., Wilders, C.J., and Strydom, G.L. Year: 2009 Citation: The effect of a physical and combined health promotion intervention programme on some selected health indicators on south African colliery executives, South African Journal for research in sports, physical education and recreation, 131 (1). Aim of study: To go beyond focussing on physical activity as an intervention programme but to also include other health promotion activities such as informative sessions on exercise, nutrition,	Selected population: White adult male executives between the ages of 26-58 years working in five different coal mines spread across two provinces, Mpumalanga and Gauteng. Setting: Five coalmines spread across two South African provinces, Mpumalanga and Gauteng in South Africa. Sample size: 143 participants	The intervention was conducted for 32 weeks and participants were randomly allocated to either an intervention or control group. The intervention group was exposed to a physical and health promotion program while the control group only received the physical part of the intervention program. The health promotion activity included informative session on exercise, nutrition, physical stress management and awareness on health activities that reduces lifestyle habits. The control group only received the exercise intervention programme.	Primary outcome: Outcome measures assessed were blood pressure which was measured with an aneroid sphygmomanometer. BMI was also measured at baseline, 16 and 32 weeks respectively. This was done by dividing the body mass (kg) by the height (m^2). Total cholesterol concentration was also measured using the Accutrend GC by taking a blood specimen from a finger prick. Method of Analysis: Statistical analysis of data was done using the ANOVA repetitive testing. The turkey post-hoc tests were used to determine if certain groups were statistically significant from each other.	The intervention group showed a statistical significance in DBP while the control group showed statistical significances in BMI and SBP. The mean DBP for was 75mmHg and 73mmHg for 16 and 32 weeks follow-up period respectively. SBP= There was a 7mmHg difference at follow up compared to baseline for control groups. BMI=-0.2kg/m^2 reduction for control and experimental group. The cholesterol concentration remained the same with baseline in experimental and control group.	Limitation identified by authors: The physical part of the intervention programme was not supervised. Limitations identified by reviewer: The sample may not be generalizable to all make workers in coal mines because only executives were asked to participate in the study. The coalmines were not randomly selected hence increasing the risk of bias. The method of selecting the collieries was not randomised thereby increasing the risk of selection bias. Source of funding: N/A

physical stress management and awareness on lifestyle habits. Study design: Non-randomised trial **Quality rating:** +		Follow up was done at 16 and 32 weeks.			

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4-7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	-
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5, 6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5, Table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6,7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6,7
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6,7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	-
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2 for each meta-analysis.	-

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6,7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	-
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7, Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7, 8, Table 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	-
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	7-12
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	-
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	-
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	-
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	12-14
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	14
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	-

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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Interventions addressing risk factors of Ischemic Heart Disease in sub-Saharan Africa: a systematic review

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Interventions addressing risk factors of Ischemic Heart Disease in sub-Saharan Africa: a systematic review

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Keywords: ischemic heart disease; myocardial infarction; systematic reviews; Africa

Word count: 3235

ABSTRACT

Background: Ischemic Heart Disease (IHD) is currently ranked 8th 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 Ischemic Heart Disease among adults in sSA.

Methods: A systematic search of Medline, EMBASE, Global Health, AJOL, and Google Scholar was conducted to identify studies focusing on population-wide and individual-level interventions targeting risks of Ischemic Heart Disease 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. Three broad interventions were identified— dietary modifications, physical activity, and community-based health promotion measures on tobacco and alcohol cessation. Three studies reported significant reduction in blood pressure, and another study reported statistically significant reduction in mean total cholesterol. Other outcome measures observed ranged from mild to no reduction in blood pressure, blood glucose, body mass index and total cholesterol, respectively

Conclusion: 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.

Article summary

Strengths

- This study provides an insight into interventions targeting known risks of Ischemic 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 (sSA).
- Dietary modification, physical activity, health education and health promotion measures have been effective IHD preventive strategies in specific African population groups.

Limitations

- We still cannot generalize and recommend identified IHD interventions to many African settings, especially due varying degrees of heterogeneity within and across several African population groups.

INTRODUCTION

The burden of cardiovascular diseases (CVDs) has consistently increased across many world regions over the last three decades.[1 2] Between 1990 and 2013, the Institute for Health Metrics and Evaluation (IHME) reported a median percentage change of CVDs at 40.8% and 89.2% for global deaths and years lived with disabilities (YLDs), respectively.[3 4] Increasing cases and deaths from CVDs, especially Ischemic Heart Disease (IHD), have also been reported among young and active adults globally.[5] Global estimates suggest about 93 million cases and 8.1 million deaths from IHD in 2013.[3 4] In Africa, IHD accounted for 361,000 deaths in 2005, and is currently ranked 8th among the top causes of deaths in the region.[6] 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.[7] Increasing sedentary lifestyles, tobacco smoking, alcohol consumption, and unhealthy diets, and the fast rate of urbanization and epidemiological transition across many African settings have been strongly indicated.[5 8]

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- and middle-income countries (LMICs), where the burden is fast increasing.[9] Current reports from Africa show that public health response, access to health services, and availability of effective interventions and treatment options for NCDs, including IHD, are relatively poor.[10 11] Cost-effective interventions have been described in many high-income settings.[12 13] 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 practiced in many developed countries with successes.[12 14] In sSA, substantive gaps exist in terms of implementation of many of these interventions due to weak primary health care and health systems, and poor political will.[6 15] Moreover, only a few studies, reviews and randomized controlled trials (RCTs) have examined the effectiveness of some of these interventions.[6] Therefore, little evidence is available for informed policy decisions in this African sub-region.[7] 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, synthesize and appraise population-wide and individual-level interventions addressing risk factors of IHD among adults, towards better public health policy and practice 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.[7] 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 sub-region?

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 Ischemic Heart Disease in sub-Saharan Africa, with search date set from 1980 to 2015

(**Table 1**).

Table 1. Search terms

#	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/
6	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]
7	1 or 2 or 3 or 4
8	5 or 6
9	7 and 8

Further searches were conducted on Google Scholar, and the reference lists of selected studies were further hand-searched for relevant articles. Countries in sub-Saharan Africa were as provided in the World Bank list of countries, regions and economies.[16]

Selection criteria

We included original studies (RCTs, cross-sectional or cohort studies, and quasi-experimental 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.

Case definitions

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

Quality assessment

The quality of selected studies was assessed using the Jadad scale.[20] Studies were graded between *1* and *5*, with *5* being the highest and *1* the lowest. Criteria employed were randomization, blinding, and accountability of all participants. Details of the grading of each study are in the **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 and evidence appraisal based on relevant information obtained from selected studies was conducted (**Supplementary file**). A PRISMA checklist was used to assess the completeness of all stages of our review.

RESULTS

Our search returned 2311 records. Only 9 studies met our inclusion criteria and were retained for qualitative synthesis.[21-29] The reasons for the excluded studies are as highlighted in **Figure 1**. Individual study characteristics are shown in **Table 2**.

Table 2. Summary of results

Studies	Country, Location (Setting)	Study design	Type of Intervention	Results
Adeyemo *et al*. [21]	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 *et al*. [22]	Ghana, Ejisu-Juabeng and Kumasi districts (rural & semi-urban)	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 *et al*. [23]	Mauritius (semi-urban)	Cross-Sectional Survey	Health education and health promotion	Reduction in blood pressure, increased physical activity, but no effect observed on BMI. There was unusual increase in blood sugar
Forrester *et al*. [24]	Nigeria, Igbo-Ora and Idere (rural)	Randomised Control Trial	Dietary modification	No significant association observed between changes in salt and blood pressure
Grace *et al*. [25]	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 *et al*. [26]	Nigeria (semi-urban)	Cluster Randomised Trial	Health education and health promotion	Significant reduction observed in blood pressure levels
Mtabaji *et al*. [27]	Tanzania (semi-urban)	Randomized 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 *et al*. [28]	South Africa, Riversdale, Swellendam and Robertson (rural)	Quasi Experimental Design	Health education and health promotion	Reduction in blood pressure, slight reduction in BMI for only females
Uusitalo *et al*. [29]	Mauritius (semi-urban)	Cross Sectional Survey	Dietary modification	Positive reduction observed in total serum cholesterol.

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 hypercholesterolemia (**Table 2** & **Supplementary file**).

Five of the retained studies employed dietary modification in addressing hypertension and hypercholesterolemia associated with IHD.[21 22 24 27 29] Four studies focused on salt intake and its relationship with blood pressure,[21 22 24 27] while the fifth study focused on modifying the content of a commonly used cooking oil targeted at reducing total cholesterol concentration.[29]

In the study by Adeyemo and colleagues,[21] 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 blood pressure reducing by 4.7 mm Hg and 7.0 mm Hg among men and women, respectively, after two weeks. A similar finding was reported in Tanzania by Mtabaji and colleagues,[27] with a significant reduction in arterial blood pressure 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.* also examined the effects of not adding salt while cooking and reducing the consumption of preserved salted foods on urinary sodium excretion and blood pressure among 1,013 adult participants in both rural and semi-urban settings.[22] Significant reduction in the systolic and diastolic BP, as well as urinary sodium, was observed in the intervention group compared with control, especially after six months of restriction of salt intake. The study concluded that a relative decrease in blood pressure may be observed with reduced salt intake in the West Africa sub-region. However, in a Nigerian study involving 58 participants from two rural communities, Forrester *et al.* reported that no significant association was observed between measured changes in dietary salt and systolic or diastolic blood pressure (p=0.08).[24] In this study, outcome measures showed that the mean change in systolic and diastolic blood pressure for both the low salt and high salt phase differed by 4.8mm Hg and 3.2mm Hg, respectively.[24]

In Mauritius, Uusitalo *et al.* examined the effect of modifying commonly used cooking

oil (ration oil) on mean serum cholesterol concentration among 1,926 participants.[29] The main composition of the ration oil was mostly palm oil which was high in saturated and monounsaturated fatty acid. 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 males and females ($p<0.001$).

Only one study examined the effect of physical activity on some selected health measures such as blood pressure, body mass index (BMI) and plasma cholesterol concentration.[25] 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 program in the control group and a physical fitness programme combined with a health promotion intervention programme in the experimental group for 32 weeks. At 16 weeks, an improvement in BMI in the control group was observed and statistically significant. At 32 weeks, there was a reduction in BMI in the experimental group, although, this reduction was not statistically significant ($p=0.067$). The study also observed an improvement in both the systolic and diastolic blood pressure of participants after 16 weeks. Although no statistical significance was observed in the experimental group, the values at re-assessment were better than the baseline values. Moreover, effects of physical activity combined with health promotion measures on total cholesterol concentration in the participants was examined over the same 32-week period.[25] There were no changes in total cholesterol observed during the 16 and 32 weeks re-assessment in the experimental group. A moderate increase was observed in the

cholesterol concentration of the control group during the 16 week re-assessment.

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, hypercholesterolemia, diabetes and obesity.[23 26 28] 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.* examined the effects of some health education/promotion activities on the prevalence of IHD risk factors among 5,162 subjects over a five-year period (1987-1992).[23] 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 male and female participants ($p<0.001$), no positive effects were observed in BMI, and no statistically significant reduction was observed in mean fasting blood glucose.[25] In a larger South African study involving 7,188 participants, Rossouw and colleagues observed a reduction in blood pressure in both male and female participants, and a reduction in BMI only among the female participants after a four-year health education/promotion intervention programme.[28]

In Nigeria, Mendis *et al.* investigated the effectiveness of World Health Organization (WHO) cardiovascular disease risk management health promotion package in reducing blood pressure in primary care settings, and in improving adherence to lifestyle changes at the individual and cluster levels among 1,188 participants.[26]

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 blood pressure 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 Ischemic Heart Disease in sSA. Our findings suggests 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 hypercholesterolemia.[21 22 24 27 29] However, not all studies reported 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 blood pressure after withdrawing anti-hypertensives. Hooper further noted that a comprehensive dietary and nutritional plan addressing salt and fat consumption may be very helpful at reducing risks of cardiovascular diseases in a population.[30]

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.[25] 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.[31 32] In the study of 17,944 middle-aged male British civil servants, free of coronary heart disease (CHD), the age-standardized cumulative incidence of CHD was 3.1% among men observing vigorous physical activity, compared to 6.9% among those with no physical activity.[33] Although, this may not be directly compared to sSA, due to several contextual differences, it still possibly suggests such measures could lead to similar outcomes in the African sub-region.

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

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 organization 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.[35] Additionally, interventions targeting behavioral 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.[35] 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.[36] Such policy frameworks may need to be jointly developed by the various stakeholders to aid effective implementation, monitoring and evaluation across the sub-continent.

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 sub-Saharan African 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 heterogeneity 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 sub-Saharan African countries. We also understand there are several interventions that have been studied in many settings outside sub-Saharan Africa, 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, the WHO already provided comprehensive Package of Essential Non-communicable (PEN) disease interventions for primary health care 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;[37] 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 sub-Saharan Africa, 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 is 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 promotions measures may have been suggestive of relative improvements in reducing risks of IHD, yet we still cannot generalize 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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Data sharing statement: No additional data available.

Conflict of interest declaration: All authors have completed the Unified Competing Interest from at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author). The authors declare no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years, and no other relationships or activities that could appear to have influenced the submitted work.

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Legends to Figures

Figure 1. Flow chart of study selection

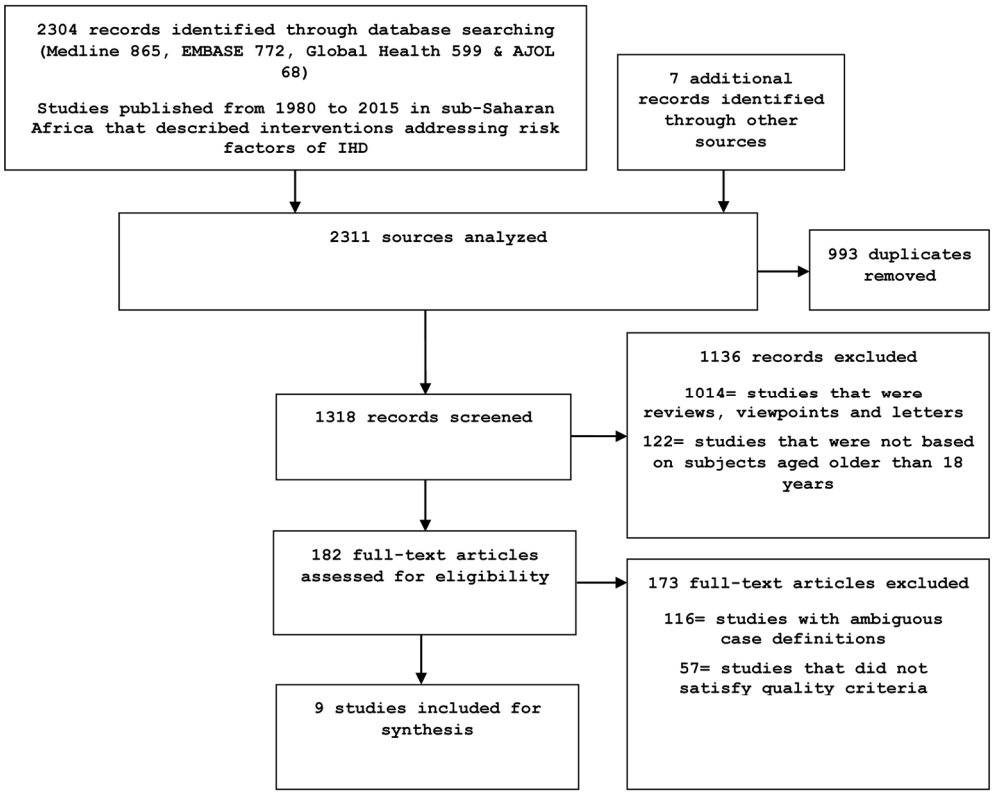

Figure 1. Flow chart of study selection
173x138mm (300 x 300 DPI)

Supplementary file: Evidence Table of Included Studies

Study details	Population and setting	Intervention	Outcome Measures	Results relevant to this review	Limitation and Sources of Funding
Authors: Adeyemo, A.A., Prewitt, T.E., Luke, A., Omotade, .O, Rotimi, C.N., Brieger, W.R., Cooper, R.S. Year:2002 Citation: The feasibility of implementing a dietary sodium reduction intervention among free-living normotensive individuals in south west Nigeria. Ethnicity & Disease, 12, pp 207-218. Design: Cross-sectional survey **Quality Rating: 2**	Adults aged above 25 years from a population register with no history of high BP, no concurrent illness and not on any medication. Involves two rural communities in Ibarapa district in south west Nigeria.	Cooking salt reduced by half, and stopping use of bouillon cubes and monosodium glutamate seasoning for 2 weeks.	Changes in 24 hour urinary sodium excretion were measured at follow-up. Changes in systolic and diastolic blood pressure were measured at follow-up after 30 minutes of rest.	67% of participants achieved 50mmol reduction in urinary sodium excretion over 24 hours. 25mmol reduction was observed in 84% of the participants. Changes were observed in the systolic and diastolic blood pressure.	It was a within subject comparison study and not a randomized trial. Funding: National Heart, Lung and blood Institute (HLB 455 08)
Authors: Cappuccio, F.P., Kerry, S, M., Micah, F.B., Plange-Rhule, J., and Eastwood, J.B. Year: 2006 Citation: : A community program to reduce salt intake and blood pressure in Ghana, BMC Public health, 6 (13), pp. 1-11. Design: Cluster randomised trial **Quality Rating: 3**	Adults aged 40-75 years with no history of hypertension, stroke and heart failure. Twelve communities in Ejisu-Juabeng and Kumasi districts in Ghana	Reducing the amount of salts added to specific meals for a period of 6 months	Changes in systolic and diastolic blood pressure were measured at follow-up. Changes in 24 hour urinary sodium excretion were also measured at follow-up.	Greater reduction in urinary sodium excretion in smaller villages compared to larger villages. There was a small reduction in systolic and diastolic BP which was more pronounced at six months and statistically significant for diastolic BP at six months.	Blood samples collection met barriers due to rumours that it was to be tested for HIV. The randomisation trial was not fully managed due to contamination of the two arms. The timing of data collection was not suitable for many participants due to work schedules. Funding: Wellcome Trust (9060415/Z/00/Z).

Authors: Dowse, G.K., Gareebo, H., Alberti, K.G., Zimmet, P., Tuomilehto, J., Purran, A., Fareed, D., Chitson, P., Collins, V.R., and Hemraj, F. Year: 1995 Citation: Changes in population cholesterol concentration and other cardiovascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius, BMJ, 311: pp.1255-1259. Design: Cross sectional cluster survey **Quality Rating: 2**	Adults between ages 25-74 years in ten randomly selected population clusters plus an eleventh area purposely selected for its geographic concentration of the minority Chinese population.	Health education activity promoting healthy diet, increased physical activity, alcohol reduction and smoking cessation over a 5 year intervention period.	The 2 hour 75g oral glucose test was measured using Yellow Spring Instruments (YSI) glucose analysers. Blood pressure was measured twice with sphygmomanometer. Physical activity was graded on a scale of 1- 4 with 1 been the lowest grade and 4 the highest grade.	Significant decrease in the prevalence of hypertension after adjusting for age and ethnic group. Small non-significant increases in the prevalence of diabetes in both sexes. Increase in moderate or heavy physical activity in males but a very low increase in females.	It is not clear to what extent the changes observed represent the true intervention as it was not feasible to have a reference area in the small island of Mauritius The authors did not report if all participants were present during follow-up period. Funding: National Institute of Diabetes and Digestive and Kidney Diseases, grant DK-25446
Authors: Forrester, T., Adeyemo, A., Soarres-Wynter, S., Sargent, L., Bennett, F., Wilks, R., Luke, A., Prewitt, W., Kramer, H., and Cooper, R.S. Year: 2005 Citation: A randomised trial on sodium reduction in two developing countries, Journal of human hypertension, 19: pp.55-60. Design: Randomised cross-over trial.	Normotensive adults aged 25-55 years who were not pregnant, not breastfeeding and had no history of atherosclerotic vascular disease, diabetes, kidney disease and a BMI>40kg/m². Two rural communities Igbo-Ora and Idere in south west Nigeria.	4 week run-in phase trial on a dietary sodium restriction. After phase 1, participants were randomised to either a high salt or low salt diet for 3 weeks. 2 weeks wash out period and a crossover phase for an additional 3 weeks.	24-hour urine sodium excretion measured by flame photometry. Blood pressure of participants was measured thrice each with the stand mercury manometer	Urinary sodium excretion during the low salt and high salt phases after controlling for age, sex and period effects was 72.2mEq/day. The average systolic BP for the low salt phase was 109.5mmHg while the high salt phase was 114mmHg. The average diastolic BP for low and high salt phase was 72mmHg and 74.7mmHg.	The study could not determine the sustainability or acceptability of a 70mmol reduction in sodium intake daily because of the short cross over phase. Funding: N/A

Quality Rating: 4					
Grace, J.M., Wilders, C.J., and Strydom, G.L. Year: 2009 Citation: The effect of a physical and combined health promotion intervention programme on some selected health indicators on south African colliery executives, South African Journal for research in sports, physical education and recreation, 131 (1). Design: Non-randomised trial. **Quality Rating: 1**	White adult male executives between the ages of 26-58 years working in five different coal mines. Two provinces, Mpumalanga and Gauteng in South Africa	Physical and health promotion program conducted for a period of 32 weeks.	BP was measured with an aneroid sphygmomanometer. BMI was also measured at baseline, 16 and 32 weeks respectively. Total cholesterol concentration was also measured using the Accutrend GC.	The intervention group showed a statistical significance in DBP, while the control group showed statistical significances in BMI and SBP. Slight reduction in the experimental and control group. No changes observed in the total cholesterol of participants.	The physical part of the intervention programme was not supervised. Funding: N/A
Authors: Mendis, S., Johnston, S.C., Fan, W., Oladapo, O., Cameron, A., and Faramawi, M.F. Year: 2010 Citation: Cardiovascular risk management and its impact on hypertension control in primary care in low-resource settings: a cluster-randomised trial, Bull World Health Organ, 88: pp.412-419. Design: Cluster-randomised trial. **Quality Rating: 3**	Adults between 30-70 years with systolic blood pressure between 140-179mmHg who were not on treatment for hypertension and no previous history of heart attack, stroke, transient ischaemic attack or diabetes. Ten pairs of matched randomly selected primary care facilities in two regions in Nigeria	Health Education on the control of risk factors of CVD such as diet, physical activity and tobacco cessation.	Absolute reduction of SBP at 12 month follow-up with respect to baseline measurements. Rates of smoking cessation and change in BMI compared to baseline.	Reduction in mean change of SBP in both groups but it was greater in the intervention group. The mean changes in BMI was "-0.22kg/m²" for the intervention group and 0.92kg/m² for the control.	Randomisation was done at the regional level which could bring about differences in the baseline characteristics of both groups. Facilities were chosen from only two geographical areas and they may not be a representative of all primary health care facilities in the country. Funding: N/A

Authors: Mtabaji, J.P., Nara, Y., Yamori, Y. Year: 1990 Citation: The cardiac study in Tanzania: salt intake in the causation and treatment of hypertension. J Hum Hypertens. 1990 Apr;4(2):80-1 Study design: Randomized control trial **Quality rating: 1**	Normotensive male adults aged above 20 years	Participants were randomised to either a high salt or low salt diet. Daily diet were maintained on 100 g protein, 85 g fat, and 2700 kcal per day	Differences in 24 hour urinary sodium excretion were measured at follow-up between subjects on high and low salt diet. Differences in arterial blood pressure were measured at follow-up between subjects on high and low salt diet.	A significant reduction in arterial blood pressure among male normotensives placed on low salt diet compared to those on high salt diet. Subjects on low salt diet had a urinary sodium excretion of 52mmol/day relative to a 320mmol/day observed among those on high salt diet	Randomization not clearly explained. Funding: N/A
Authors: Rossouw, J.E., Jooste, P.J., Chalton, D.O., Jordaan, E.R., Langenhoven, M.L., Jordaan, P.C.J., Steyn, M., Swanepoel, A.S.P., and Rossouw, L.J. Year: 1993 Citation: Community-Based Intervention: The Coronary Risk Factor Study (CORIS), International Journal of Epidemiology, 22 (3): pp. 428-438. Study design: Quasi-experimental design. **Quality Rating: 1**	All white males and females between the ages of 15-64years. Three rural towns, Riversdale, Swellendam and Robertson in South Africa	Health Education on reducing BP, cholesterol, managing stress and increases physical activity for both Low intervention (LII) and high intervention (HII) groups. In addition, HII received a 5-day smoking cessation seminar, public health meetings on each of the risk factors and series of 2-hour diet instruction sessions.	BP was assessed using a stethoscope and two sets of ear pieces. The quantity of tobacco consumed was assessed for all groups in g/day. BMI was also calculated in kg/m².	Statistical significant changes observed in BP measurements of both groups. No significant reduction for BMI in both intervention groups.	The participation rate was between 56-70% which was lower than 80% needed to assure a representative sample. There could possibly have been cross-contamination between control and intervention areas because of some positive effects observed in the control areas. Funding: N/A
Authors: Uusitalo, U., Feskens, E.J.M., Tuomilehto, J., Dowse, G., Haw, U., Fareed, D., Hemraj, F., Gareebo, K.,	Adults between 30-64 years stratified by age, sex and ethnic groups. Mauritius in the Indian Ocean.	Dietary intervention which involved modification of palm oil in a commonly used cooking oil (ration oil) which is high in	Reduction in the mean cholesterol concentration of participants after 5 years compared with baseline by changes in fatty acid	There was a 14-15% reduction observed in mean cholesterol concentration in adults during the intervention programme.	Only 53% of participants were available during the 5 year follow-up period. The other 47% were lost to follow-up which would probably have affected the final results.

Alberti, G.M.M., and Zimmet, P. Year: 1996 Citation: Fall in cholesterol over five years in association with changes in fatty acid composition of cooking oil in Mauritius: cross sectional survey, BMJ, 313(7064):PP. 1044-1046. Study design: cross sectional survey **Quality Rating: 2**		saturated fatty acid to soya bean oil.	composition in stored serum (blood) samples in the laboratory.		Funding: National Institute of Diabetes and Digestive and Kidney Diseases, grant DK-25446

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4-7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	-
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5, 6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5, Table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6,7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6,7
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6,7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	-
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2 for each meta-analysis.	-

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6,7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	-
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7, Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7, 8, Table 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	-
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	7-12
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	-
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	-
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	-
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	12-14
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	14
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	-

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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Interventions addressing risk factors of Ischemic Heart Disease in sub-Saharan Africa: a systematic review

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Interventions addressing risk factors of Ischemic Heart Disease in sub-Saharan Africa: a systematic review

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Keywords: ischemic heart disease; myocardial infarction; systematic reviews; Africa

Word count: 3218

ABSTRACT

Background: Ischemic Heart Disease (IHD) is currently ranked 8th 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 Ischemic Heart Disease 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 Ischemic Heart Disease 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. Three broad interventions were identified— dietary modifications, physical activity, and community-based health promotion measures on tobacco and alcohol cessation. Three studies reported significant reduction in blood pressure, and another study reported statistically significant reduction in mean total cholesterol. Other outcome measures observed ranged from mild to no reduction in blood pressure, blood glucose, body mass index and total cholesterol, respectively

Conclusion: 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.

Article summary

Strengths

- This study provides an insight into interventions targeting known risks of Ischemic 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 (sSA).
- Dietary modification, physical activity, health education and health promotion measures have been effective IHD preventive strategies in specific African population groups.

Limitations

- We still cannot generalize and recommend identified IHD interventions to many African settings, especially due to varying degrees of heterogeneity within and across several African population groups.

INTRODUCTION

The burden of cardiovascular diseases (CVDs) has consistently increased across many world regions over the last three decades.[1 2] Between 1990 and 2013, the Institute for Health Metrics and Evaluation (IHME) reported a median percentage change of CVDs at 40.8% and 89.2% for global deaths and years lived with disabilities (YLDs), respectively.[3 4] Increasing cases and deaths from CVDs, especially Ischemic Heart Disease (IHD), have also been reported among young and active adults globally.[5] Global estimates suggest about 93 million cases and 8.1 million deaths from IHD in 2013.[3 4] In Africa, IHD accounted for 361,000 deaths in 2005, and is currently ranked 8th among the top causes of deaths in the region.[6] 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.[7] Increasing sedentary lifestyles, tobacco smoking, alcohol consumption, and unhealthy diets, and the fast rate of urbanization and epidemiological transition across many African settings have been strongly indicated.[5 8]

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- and middle-income countries (LMICs), where the burden is fast increasing.[9] Current reports from Africa show that public health response, access to health services, and availability of effective interventions and treatment options for NCDs, including IHD, are relatively poor.[10 11] Cost-effective interventions have been described in many high-income settings.[12 13] 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 practiced in many developed countries with successes.[12 14] In sSA, substantive gaps exist in terms of implementation of many of these interventions due to weak primary health care and health systems, and poor political will.[6 15] Moreover, only a few studies, reviews and randomized controlled trials (RCTs) have examined the effectiveness of some of these interventions.[6] Therefore, little evidence is available for informed policy decisions in this African sub-region.[7] 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, synthesize and appraise population-wide and individual-level interventions addressing risk factors of IHD among adults, towards better public health policy and practice 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.[7] 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 sub-region?

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 Ischemic

Heart Disease in sub-Saharan Africa, with search date set from 1980 to 2015 (**Table 1**).

Table 1. Search terms on Medline

#	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/
6	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]
7	1 or 2 or 3 or 4
8	5 or 6
9	7 and 8

Note: Searches on EMBASE, Global Health and AJOL were slightly modified

Further searches were conducted on Google Scholar, and the reference lists of selected studies were further hand-searched for relevant articles. Countries in sub-Saharan Africa were as provided in the World Bank list of countries, regions and economies.[16]

Selection criteria

We included original studies (RCTs, cross-sectional or cohort studies, and quasi-experimental 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.

Case definitions

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

Quality assessment

The quality of selected studies was assessed using the Jadad scale.[20] Studies were graded between *1* and *5*, with *5* being the highest and *1* the lowest. Criteria employed were randomization, blinding, and accountability of all participants. Details of the grading of each study are in the **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 (**Supplementary file**). A PRISMA checklist was used to assess the completeness of all stages of our review.

RESULTS

Our search returned 2311 records. Only 9 studies met our inclusion criteria and were retained for qualitative synthesis.[21-29] The reasons for the excluded studies are as highlighted in **Figure 1**. Individual study characteristics are shown in **Table 2**.

Table 2. Characteristics of included studies

Studies	Country, Location (Setting)	Study design	Type of Intervention	Results
Adeyemo *et al*. [21]	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 *et al*. [22]	Ghana, Ejisu-Juabeng and Kumasi districts (rural & semi-urban)	Cluster Randomised Trial	Dietary modification and health promotion	Significant reduction in systolic and diastolic blood pressure, and changes observed in 24 hour urinary sodium

Dowse *et al*. [23]	Mauritius (semi-urban)	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 *et al*. [24]	Nigeria, Igbo-Ora and Idere (rural)	Randomised Control Trial	Dietary modification	No significant association observed between changes in salt and blood pressure
Grace *et al*. [25]	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 *et al*. [26]	Nigeria (semi-urban)	Cluster Randomised Trial	Health education and health promotion	Significant reduction observed in blood pressure levels
Mtabaji *et al*. [27]	Tanzania (semi-urban)	Randomized Control Trial	Dietary Modification	A significant reduction in arterial blood pressure among male normotensives placed on low salt diet compared to those on
Rossouw *et al*. [28]	South Africa, Riversdale, Swellendam and	Quasi Experimental Design	Health education and health promotion	Reduction in blood pressure, slight reduction in BMI for
Uusitalo *et al*. [29]	Mauritius (semi-urban)	Cross Sectional Survey	Dietary modification	Positive reduction observed in total serum cholesterol.

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 hypercholesterolemia (**Table 2** & **Supplementary file**).

Five of the retained studies employed dietary modification in addressing hypertension and hypercholesterolemia associated with IHD.[21 22 24 27 29] Four studies focused on salt intake and its relationship with blood pressure,[21 22 24 27]

while the fifth study focused on modifying the content of a commonly used cooking oil targeted at reducing total cholesterol concentration.[29]

In the study by Adeyemo and colleagues,[21] 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 blood pressure reducing by 4.7 mm Hg and 7.0 mm Hg among men and women, respectively, after two weeks. A similar finding was reported in Tanzania by Mtabaji and colleagues,[27] with a significant reduction in arterial blood pressure 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.* also examined the effects of not adding salt while cooking and reducing the consumption of preserved salted foods on urinary sodium excretion and blood pressure among 1,013 adult participants in both rural and semi-urban settings.[22] Significant reduction in the systolic and diastolic BP, as well as urinary sodium, was observed in the intervention group compared with control, especially after six months of restriction of salt intake. The study concluded that a relative decrease in blood pressure may be observed with reduced salt intake in the West Africa sub-region. However, in a Nigerian study involving 58 participants from two rural communities, Forrester *et al.* reported that no significant association was observed between measured changes in dietary salt and systolic or diastolic blood pressure (p=0.08).[24] In this study, outcome measures showed that

the mean change in systolic and diastolic blood pressure for both the low salt and high salt phase differed by 4.8mm Hg and 3.2mm Hg, respectively.[24]

In Mauritius, Uusitalo *et al.* examined the effect of modifying commonly used cooking oil (ration oil) on mean serum cholesterol concentration among 1,926 participants.[29] The main composition of the ration oil was mostly palm oil which was high in saturated and monounsaturated fatty acid. 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 males and females ($p<0.001$).

Only one study examined the effect of physical activity on some selected health measures such as blood pressure, body mass index (BMI) and plasma cholesterol concentration.[25] 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 program 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 blood pressure of participants after 16 weeks. Although no statistical significance was observed in the experimental group, the values at re-assessment were better than the baseline values. Moreover, effects of physical activity combined with health promotion measures on total cholesterol concentration in the participants was examined over the same 32-week period.[25] There were no changes in total

cholesterol observed during the 16 and 32 weeks re-assessment in the experimental group. A moderate increase was observed in the cholesterol concentration of the control group during the 16 week re-assessment.

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, hypercholesterolemia, diabetes and obesity.[23 26 28] 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*. examined the effects of some health education/promotion activities on the prevalence of IHD risk factors among 5,162 subjects over a five-year period (1987-1992).[23] 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 male and female participants ($p<0.001$), no positive effects were observed in BMI, and no statistically significant reduction was observed in mean fasting blood glucose.[25] In a larger South African study involving 7,188 participants, Rossouw and colleagues observed a reduction in blood pressure in both male and female participants, and a reduction in BMI only among the female participants after a four-year health education/promotion intervention programme.[28]

In Nigeria, Mendis *et al.* investigated the effectiveness of World Health Organization (WHO) cardiovascular disease risk management health promotion package in

reducing blood pressure in primary care settings, and in improving adherence to lifestyle changes at the individual and cluster levels among 1,188 participants.[26] 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 blood pressure 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 Ischemic Heart Disease 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 hypercholesterolemia.[21 22 24 27 29] However, not all studies reported 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 blood pressure after withdrawing anti-hypertensives. Hooper further noted that a comprehensive dietary and nutritional plan addressing salt and fat consumption may be very helpful at reducing risks of cardiovascular diseases in a population.[30]

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.[25] 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.[31 32] In the study of 17,944 middle-aged male British civil servants, free of coronary heart disease (CHD), the age-standardized cumulative incidence of CHD was 3.1% among men observing vigorous physical activity, compared to 6.9% among those with no physical activity.[33] Although, this may not be directly compared to sSA, due to several contextual differences, it still possibly suggests such measures could lead to similar outcomes in the African sub-region.

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

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 organization 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.[35] Additionally, interventions targeting behavioral 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.[35] 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.[36] Such policy frameworks may need to be jointly developed by the various stakeholders to aid effective implementation, monitoring and evaluation across the sub-continent.

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 sub-Saharan African 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 heterogeneity 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 sub-Saharan Africa. We also understand there are several interventions that have been studied in many settings outside sub-Saharan Africa; 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, the WHO already provided comprehensive Package of Essential Non-communicable (PEN) disease interventions for primary health care 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;[37] 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 sub-Saharan Africa, 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 is 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 generalize 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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Data sharing statement: No additional data available.

Conflict of interest declaration: All authors have completed the Unified Competing Interest from at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author). The authors declare no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years, and no other relationships or activities that could appear to have influenced the submitted work.

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Legends to Figures

Figure 1. Flow chart of study selection

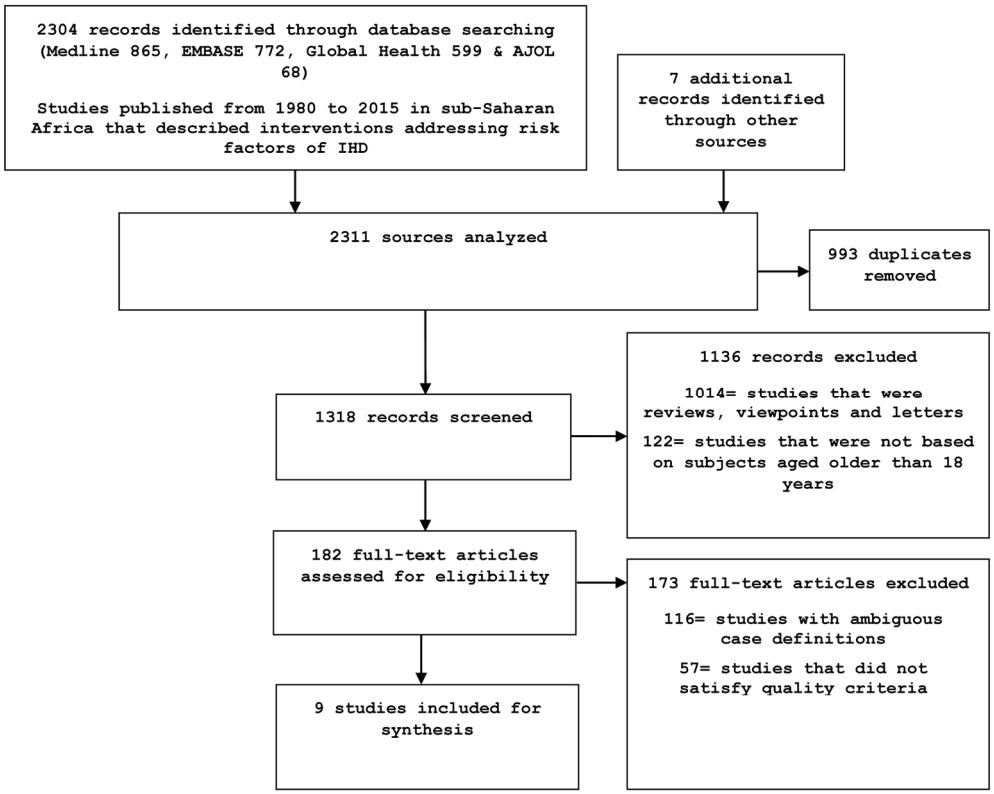

Figure 1. Flow chart of study selection
173x138mm (300 x 300 DPI)

Supplementary file: Evidence Table of Included Studies

Study details	Population and setting	Intervention	Outcome Measures	Results relevant to this review	Limitation and Sources of Funding
Authors: Adeyemo, A.A., Prewitt, T.E., Luke, A., Omotade, .O, Rotimi, C.N., Brieger, W.R., Cooper, R.S. Year:2002 Citation: The feasibility of implementing a dietary sodium reduction intervention among free-living normotensive individuals in south west Nigeria. Ethnicity & Disease, 12, pp 207-218. Design: Cross-sectional survey **Quality Rating: 2**	Adults aged above 25 years from a population register with no history of high BP, no concurrent illness and not on any medication. Involves two rural communities in Ibarapa district in south west Nigeria.	Cooking salt reduced by half, and stopping use of bouillon cubes and monosodium glutamate seasoning for 2 weeks.	Changes in 24 hour urinary sodium excretion were measured at follow-up. Changes in systolic and diastolic blood pressure were measured at follow-up after 30 minutes of rest.	67% of participants achieved 50mmol reduction in urinary sodium excretion over 24 hours. 25mmol reduction was observed in 84% of the participants. Changes were observed in the systolic and diastolic blood pressure.	It was a within subject comparison study and not a randomized trial. Funding: National Heart, Lung and blood Institute (HLB 455 08)
Authors: Cappuccio, F.P., Kerry, S, M., Micah, F.B., Plange-Rhule, J., and Eastwood, J.B. Year: 2006 Citation: : A community program to reduce salt intake and blood pressure in Ghana, BMC Public health, 6 (13), pp. 1-11. Design: Cluster randomised trial **Quality Rating: 3**	Adults aged 40-75 years with no history of hypertension, stroke and heart failure. Twelve communities in Ejisu-Juabeng and Kumasi districts in Ghana	Reducing the amount of salts added to specific meals for a period of 6 months	Changes in systolic and diastolic blood pressure were measured at follow-up. Changes in 24 hour urinary sodium excretion were also measured at follow-up.	Greater reduction in urinary sodium excretion in smaller villages compared to larger villages. There was a small reduction in systolic and diastolic BP which was more pronounced at six months and statistically significant for diastolic BP at six months.	Blood samples collection met barriers due to rumours that it was to be tested for HIV. The randomisation trial was not fully managed due to contamination of the two arms. The timing of data collection was not suitable for many participants due to work schedules. Funding: Wellcome Trust (9060415/Z/00/Z).

Authors: Dowse, G.K., Gareebo, H., Alberti, K.G., Zimmet, P., Tuomilehto, J., Purran, A., Fareed, D., Chitson, P., Collins, V.R., and Hemraj, F. Year: 1995 Citation: Changes in population cholesterol concentration and other cardiovascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius, BMJ, 311: pp.1255-1259. Design: Cross sectional cluster survey **Quality Rating: 2**	Adults between ages 25-74 years in ten randomly selected population clusters plus an eleventh area purposely selected for its geographic concentration of the minority Chinese population.	Health education activity promoting healthy diet, increased physical activity, alcohol reduction and smoking cessation over a 5 year intervention period.	The 2 hour 75g oral glucose test was measured using Yellow Spring Instruments (YSI) glucose analysers. Blood pressure was measured twice with sphygmomanometer. Physical activity was graded on a scale of 1- 4 with 1 been the lowest grade and 4 the highest grade.	Significant decrease in the prevalence of hypertension after adjusting for age and ethnic group. Small non-significant increases in the prevalence of diabetes in both sexes. Increase in moderate or heavy physical activity in males but a very low increase in females.	It is not clear to what extent the changes observed represent the true intervention as it was not feasible to have a reference area in the small island of Mauritius The authors did not report if all participants were present during follow-up period. Funding: National Institute of Diabetes and Digestive and Kidney Diseases, grant DK-25446
Authors: Forrester, T., Adeyemo, A., Soarres-Wynter, S., Sargent, L., Bennett, F., Wilks, R., Luke, A., Prewitt, W., Kramer, H., and Cooper, R.S. Year: 2005 Citation: A randomised trial on sodium reduction in two developing countries, Journal of human hypertension, 19: pp.55-60. Design: Randomised cross-over trial.	Normotensive adults aged 25-55 years who were not pregnant, not breastfeeding and had no history of atherosclerotic vascular disease, diabetes, kidney disease and a BMI>40kg/m². Two rural communities Igbo-Ora and Idere in south west Nigeria.	4 week run-in phase trial on a dietary sodium restriction. After phase 1, participants were randomised to either a high salt or low salt diet for 3 weeks. 2 weeks wash out period and a crossover phase for an additional 3 weeks.	24-hour urine sodium excretion measured by flame photometry. Blood pressure of participants was measured thrice each with the stand mercury manometer	Urinary sodium excretion during the low salt and high salt phases after controlling for age, sex and period effects was 72.2mEq/day. The average systolic BP for the low salt phase was 109.5mmHg while the high salt phase was 114mmHg. The average diastolic BP for low and high salt phase was 72mmHg and 74.7mmHg.	The study could not determine the sustainability or acceptability of a 70mmol reduction in sodium intake daily because of the short cross over phase. Funding: N/A

Quality Rating: 4					
Grace, J.M., Wilders, C.J., and Strydom, G.L. Year: 2009 Citation: The effect of a physical and combined health promotion intervention programme on some selected health indicators on south African colliery executives, South African Journal for research in sports, physical education and recreation, 131 (1). Design: Non-randomised trial. **Quality Rating: 1**	White adult male executives between the ages of 26-58 years working in five different coal mines. Two provinces, Mpumalanga and Gauteng in South Africa	Physical and health promotion program conducted for a period of 32 weeks.	BP was measured with an aneroid sphygmomanometer. BMI was also measured at baseline, 16 and 32 weeks respectively. Total cholesterol concentration was also measured using the Accutrend GC.	The intervention group showed a statistical significance in DBP, while the control group showed statistical significances in BMI and SBP. Slight reduction in the experimental and control group. No changes observed in the total cholesterol of participants.	The physical part of the intervention programme was not supervised. Funding: N/A
Authors: Mendis, S., Johnston, S.C., Fan, W., Oladapo, O., Cameron, A., and Faramawi, M.F. Year: 2010 Citation: Cardiovascular risk management and its impact on hypertension control in primary care in low-resource settings: a cluster-randomised trial, Bull World Health Organ, 88: pp.412-419. Design: Cluster-randomised trial. **Quality Rating: 3**	Adults between 30-70 years with systolic blood pressure between 140-179mmHg who were not on treatment for hypertension and no previous history of heart attack, stroke, transient ischaemic attack or diabetes. Ten pairs of matched randomly selected primary care facilities in two regions in Nigeria	Health Education on the control of risk factors of CVD such as diet, physical activity and tobacco cessation.	Absolute reduction of SBP at 12 month follow-up with respect to baseline measurements. Rates of smoking cessation and change in BMI compared to baseline.	Reduction in mean change of SBP in both groups but it was greater in the intervention group. The mean changes in BMI was "-0.22kg/m²" for the intervention group and 0.92kg/m² for the control.	Randomisation was done at the regional level which could bring about differences in the baseline characteristics of both groups. Facilities were chosen from only two geographical areas and they may not be a representative of all primary health care facilities in the country. Funding: N/A

Authors: Mtabaji, J.P., Nara, Y., Yamori, Y. Year: 1990 Citation: The cardiac study in Tanzania: salt intake in the causation and treatment of hypertension. J Hum Hypertens. 1990 Apr;4(2):80-1 Study design: Randomized control trial **Quality rating: 1**	Normotensive male adults aged above 20 years	Participants were randomised to either a high salt or low salt diet. Daily diet were maintained on 100 g protein, 85 g fat, and 2700 kcal per day	Differences in 24 hour urinary sodium excretion were measured at follow-up between subjects on high and low salt diet. Differences in arterial blood pressure were measured at follow-up between subjects on high and low salt diet.	A significant reduction in arterial blood pressure among male normotensives placed on low salt diet compared to those on high salt diet. Subjects on low salt diet had a urinary sodium excretion of 52mmol/day relative to a 320mmol/day observed among those on high salt diet	Randomization not clearly explained. Funding: N/A
Authors: Rossouw, J.E., Jooste, P.J., Chalton, D.O., Jordaan, E.R., Langenhoven, M.L., Jordaan, P.C.J., Steyn, M., Swanepoel, A.S.P., and Rossouw, L.J. Year: 1993 Citation: Community-Based Intervention: The Coronary Risk Factor Study (CORIS), International Journal of Epidemiology, 22 (3): pp. 428-438. Study design: Quasi-experimental design. **Quality Rating: 1**	All white males and females between the ages of 15-64years. Three rural towns, Riversdale, Swellendam and Robertson in South Africa	Health Education on reducing BP, cholesterol, managing stress and increases physical activity for both Low intervention (LII) and high intervention (HII) groups. In addition, HII received a 5-day smoking cessation seminar, public health meetings on each of the risk factors and series of 2-hour diet instruction sessions.	BP was assessed using a stethoscope and two sets of ear pieces. The quantity of tobacco consumed was assessed for all groups in g/day. BMI was also calculated in kg/m².	Statistical significant changes observed in BP measurements of both groups. No significant reduction for BMI in both intervention groups.	The participation rate was between 56-70% which was lower than 80% needed to assure a representative sample. There could possibly have been cross-contamination between control and intervention areas because of some positive effects observed in the control areas. Funding: N/A
Authors: Uusitalo, U., Feskens, E.J.M., Tuomilehto, J., Dowse, G., Haw, U., Fareed, D., Hemraj, F., Gareebo, K.,	Adults between 30-64 years stratified by age, sex and ethnic groups. Mauritius in the Indian Ocean.	Dietary intervention which involved modification of palm oil in a commonly used cooking oil (ration oil) which is high in	Reduction in the mean cholesterol concentration of participants after 5 years compared with baseline by changes in fatty acid	There was a 14-15% reduction observed in mean cholesterol concentration in adults during the intervention programme.	Only 53% of participants were available during the 5 year follow-up period. The other 47% were lost to follow-up which would probably have affected the final results.

Alberti, G.M.M., and Zimmet, P. Year: 1996 Citation: Fall in cholesterol over five years in association with changes in fatty acid composition of cooking oil in Mauritius: cross sectional survey, BMJ, 313(7064):PP. 1044-1046. Study design: cross sectional survey **Quality Rating: 2**		saturated fatty acid to soya bean oil.	composition in stored serum (blood) samples in the laboratory.		Funding: National Institute of Diabetes and Digestive and Kidney Diseases, grant DK-25446

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4-7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	-
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5, 6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5, Table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6,7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6,7
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6,7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	-
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2 for each meta-analysis.	-

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6,7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	-
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7, Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7, 8, Table 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	-
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	7-12
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	-
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	-
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	-
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	12-14
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	14
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	-

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