BMJ Open

Non-pharmacological interventions to achieve blood pressure control in African patients: a systematic review

Monique Cernota,[1] Eric Sven Kroeber ,[1] Tamiru Demeke,[2] Thomas Frese,[1] Sefonias Getachew,[2] Eva Johanna Kantelhardt ,[3] Etienne Ngeh Ngeh,[4,5,6] Susanne Unverzagt [1,7]

To cite: Cernota M, Kroeber ES, Demeke T, *et al*. Non-pharmacological interventions to achieve blood pressure control in African patients: a systematic review. *BMJ Open* 2022;**12**:e048079. doi:10.1136/bmjopen-2020-048079

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2020-048079).

Received 04 January 2021
Accepted 26 January 2022

For numbered affiliations see end of article.

Correspondence to
Dr Eric Sven Kroeber;
eric.kroeber@posteo.de

ABSTRACT

Objectives This systematic review aims to evaluate the evidence of non-pharmacological strategies to improve blood pressure (BP) control in patients with hypertension from African countries.

Design We performed a systematic review and searched Medline, Central, CINAHL and study registers until June 2020 for randomised studies on interventions to decrease BP of patients with hypertension in African countries. We assessed the study quality using the Cochrane risk of bias tool and narratively synthesised studies on non-pharmacological hypertension interventions.

Setting We included studies conducted in African countries.

Participants Adult African patients with a hypertension diagnosis.

Interventions Studies on non-pharmacological interventions aiming to improve BP control and treatment adherence.

Outcomes Main outcomes were BP and treatment adherence.

Results We identified 5564 references, included 23 with altogether 18 153 participants from six African countries. The studies investigated educational strategies to improve adherence (11 studies) and treatment by healthcare professionals (5 studies), individualised treatment strategies (2 studies), strategies on lifestyle including physical activity (4 studies) and modified nutrition (1 study). Nearly all studies on educational strategies stated improved adherence, but only three studies showed a clinically relevant improvement of BP control. All studies on individualised strategies and lifestyle changes resulted in clinically relevant effects on BP. Due to the type of interventions studied, risk of bias in domain blinding of staff/participants was frequent (83%). Though incomplete outcome data in 61% of the studies are critical, the general study quality was reasonable.

Conclusions The identified studies offer diverse low-cost interventions including educative and task-shifting strategies, individualised treatment and lifestyle modifications to improve BP control. Especially trialled physical activity interventions show clinically relevant BP changes. All strategies were trialled in African countries and may be used for recommendations in evidence-based guidelines on hypertension in African settings.

PROSPERO registration number CRD42018075062.

Strengths and limitations of this study

- This systematic review summarises evidence on a wide range of different non-pharmacological interventions, adding a comprehensive overview to the literature that can support physicians and healthcare policymakers in the African setting.
- Most of the included studies were conducted in urban areas of few Western and Southern African countries leading to a lack of generalisability to other African regions and showing a need of future research in rural areas.
- A main limitation of this systematic review occurs through deviations from the protocol. Due to the amount of search results for the initially planned more general scope on cardiovascular diseases, we decided to focus on hypertension.
- Nevertheless, this review was limited to studies with the highest level of evidence to investigate the benefits and harms of non-pharmacological interventions on blood pressure control in African patients with hypertension.
- This review adds to the scope of a recently published systematic review on the efficacy of common pharmacological treatment for patients with hypertension in sub-Saharan Africa.

BACKGROUND

Hypertension is a major public health problem and affects the lives of about 1.13 billion people.[1] The highest blood pressure (BP) levels shifted from high to low-income countries in South Asia and sub-Saharan Africa (SSA)[2] with a prevalence of 57% in older adults in African countries.[3 4] The estimated number of adults with raised BP in SSA rose from 30 million in 1975 to over 100 million in 2016 due to population growth, ageing and westernisation of lifestyle.[2] Hypertension is a leading risk factor of cardiovascular disease (CVD), chronic kidney disease and diabetes.[1] Studies show that black people suffer from more severe forms of hypertension associated with more frequent treatment failure

and more severe and earlier target organ damage, all resulting in higher morbidity and mortality.[5 6] Hypertension is a major contributor to devastating health events like stroke or heart failure,[7–9] which can be catastrophic to both individuals and healthcare systems in which resources are scarce.

Tackling and reducing the burden of premature mortality due to non-communicable diseases (NCDs) through prevention and treatment has been a designated goal within the United Nations (UN) 2030 Agenda.[10] The Pan-African Society of Cardiology developed an algorithm including recommendations on screening, diagnosis and treatment to achieve 25% hypertension control in Africa by 2025 with a treatment target value of less than 140/90 mm Hg. Screening programmes are proposed to be carried out in healthcare facilities as well as public places like markets and churches. The treatment starts with lifestyle modifications, is intensified through a monotherapy and a subsequent combination of two or three medications in higher stages and resistant forms of hypertension. In some cases, the assessment of secondary causes by specialists is recommended.[9]

However, the awareness of hypertension remains relatively low in many parts of Africa, hindering adequate screening, treatment and control to lower the long-term risks.[11–13] Extensive counselling and education of patients and healthcare providers on the importance of adherence to medications and lifestyle modifications is necessary in order to improve hypertension control.[14 15] Especially patients with multiple medications benefit from the support of their healthcare providers to understand the treatment's purpose.[16]

Evidence is needed detailing regional differences in hypertension incidences, risk factors, and, as subject of this review, treatment strategies in different, transitioning populations on the African continent. Seeley *et al* recently published a systematic review on the efficacy of common pharmacological treatment for patients with hypertension in SSA.[17] These interventions do not include treatment strategies like lifestyle modifications (eg, nutritional modifications, physical activity) or educational strategies, which can be summarised as non-pharmacological interventions.[18] The main aim of this systematic review is to summarise the best available evidence on the effectiveness of non-pharmacological strategies on BP control in African patients with hypertension.

METHODS

A protocol of this systematic review was prospectively registered on PROSPERO (CRD42018075062) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline[19] . We initially planned to include randomised controlled trials (RCTs) on all CVDs. Due to the high number and heterogeneity of eligible studies, we decided to focus this review on patients with hypertension as one of the main risk factors for other CVDs. We aim to describe all non-pharmacological hypertension interventions in detail in order to broaden the scope of the existing evidence.

Table 1 Inclusion and exclusion criteria

Design	RCTs conducted in African countries, in international studies with at least 50% African countries
Population	African adult patients in secondary and tertiary prevention, diagnosis and treatment of hypertension Exclusion of patients with gestational diabetes, pre-eclampsia or eclampsia
Intervention	All non-pharmacological strategies to improve adequate diagnoses, prevention and treatment of hypertension
Control	► No intervention ► Standard care ► Another intervention
Outcome	Blood pressure (SBP, DBP, MAP) and adherence to recommendations (medications and lifestyle changes) within longest follow-up
Publication	Full-text publications according to CONSORT in English or German

CONSORT, Consolidated Standards of Reporting Trials; DBP, diastolic blood pressure; MAP, mean arterial pressure; RCTs, randomised controlled trials; SBP, systolic blood pressure.

Patient and public involvement

The conception of this systematic review was discussed in detail with members and students at the Addis Ababa School of Public Health in order to consider the priorities in the African context. Consensus was to gather evidence on hypertension treatment as a measure of tackling the burden of NCDs which is part of the UN 2030 Agenda.[10] No patients were involved.

Inclusion and exclusion criteria

We included full-text publications on RCTs[20] including cross-over RCTs and cluster RCTs on non-pharmacological interventions with adult patients with hypertension in African countries and reported results on BP. The study aims were improvement of prevention, diagnoses and treatment of hypertension in African countries. Studies on primary prevention were excluded due to the high variety of possible participants and interventions. International multicentre studies were included if more than 50% of centres were set in African countries. For detailed inclusion criteria, see table 1.

Literature search and study selection

Two electronic databases (Medline Ovid, Central) and registers of ongoing and completed studies (International Clinical Trials Registry Platform) were searched to identify all relevant studies (see online supplemental file 1). We added a search in CINAHL to cover nursing interventions. The main keywords of the search strategy included hypertension, high blood pressure, blood

pressure control, Africa, a list of all African countries and randomized controlled trials. The first searches in 2017 included all CVDs, while updated strategies were limited to hypertension. The last search was conducted in June 2020. All searches were done without time frame constrictions. The study selection process was described in a flow chart according to the PRISMA statement.[19] We exported articles retrieved from the literature search into a reference manager software (EndNote[21]). Duplicate references were identified in case of congruence of authors, title, year, and journal and deleted.

Titles, abstracts and full texts of potentially eligible articles were independently screened by three authors (MC, ESK and SU). Disagreements were resolved through consensus.

Interventions

This systematic review compares non-pharmacological interventions to improve adequate diagnoses, prevention and treatment of patients with hypertension with standard care, no intervention or another, less intensive or frequent intervention (table 1). Non-pharmacological interventions are considered non-medication treatment strategies such as educational programmes for patients or health professionals, individualised treatment, physical activity or nutrition-modification strategies.[18]

Outcomes

The main goal of non-pharmacological interventions for patients with hypertension is to improve BP control through the implementation of recommended lifestyle changes, attendance to follow-up visits and interventions promoting adherence to take hypertensive medications. We therefore report results on BP and adherence (table 1).

Data extraction and management

One author (MC or SU) extracted and a second author (SU or ESK) checked all information on study design and setting, participants, interventions and main results by using an assessment form in Excel. The form was especially designed for this systematic review and piloted for the first five studies.

We extracted information on the publication (study name consisting of the name of first author and year of the first publication of final results, registration and additional publications), study characteristics (design, country and region in which the study was conducted, duration, preplanned outcomes), participants (with inclusion/exclusion criteria, randomised sample size, prevention level, grade of hypertension, mean age, baseline BP), a short description of the intervention and control groups, and the main results on BP and adherence within the longest follow-up periods. The grade of hypertension was described as mild (grade 1, 140–159/90–99 mm Hg), moderate (grade 2, 160–179/100–109 mm Hg) or severe (grade 3, ≥180/≥110 mm Hg).[15] If BP was reported in standing and supine position, we extracted results for supine position.

All effect sizes were reported with their corresponding CIs. They were calculated either on the basis of mean and SD for metric outcomes or by comparing the frequencies of better adherence or BP control. Positive mean differences (MDs) describe a positive treatment effect on BP with lower mean values or higher decrease in the intervention group. Relative risks (RRs), HRs and ORs compare the frequency of good adherence or BP control. Effect measures greater than 1 describe a better adherence or BP control in the intervention group.

Quality assessment and risk of bias

Risk of bias was evaluated for all studies based on the Cochrane risk of bias tool.[22] Two investigators (MC or ESK and SU) independently assessed the risk of bias in seven domains (sequence generation, allocation concealment, blinding of personal and participants, blinding of outcome assessors, incomplete outcome data, selective outcome reporting and other sources of bias). Risk of bias due to selective outcome reporting was judged as low, when the study protocol was available and results on all preplanned outcomes were reported. Incomplete outcome data were judged as high, when more than 10% of randomised participants dropped out. Other sources of bias were reported to be high in cases of missing sample size calculation, no definition of the primary endpoint or no reporting of baseline values.

Data synthesis

The main aim of this review is a narrative synthesis of studies with their participants, different types of interventions and resulting outcomes. We added a figure visualising the effect sizes on BP of different types of interventions in forest plots using RevMan.[23] Due to the high clinical heterogeneity between included studies with their different settings, interventions, control groups and lengths of follow-up, we did not pool any results.

Treatment effects were described as statistically significant or clinically relevant. Statistically significant results on BP with MD over 5 mm Hg were defined as clinically relevant.

RESULTS

We identified a total of 5564 references from electronic databases and 18 references from the International Clinical Trials Registry Platform. Three hundred forty articles were potentially eligible and full texts were assessed for the inclusion and exclusion criteria. Of those, 298 articles were excluded including 13 articles on studies to treat heart failure, 7 articles on coronary heart diseases and 76 articles on pharmacotherapy for hypertension (see list of excluded studies in the online supplemental material 1). Twenty-three studies (reported in 42 articles)[24–66] on non-pharmacological strategies to treat patients with hypertension matched the inclusion criteria and were

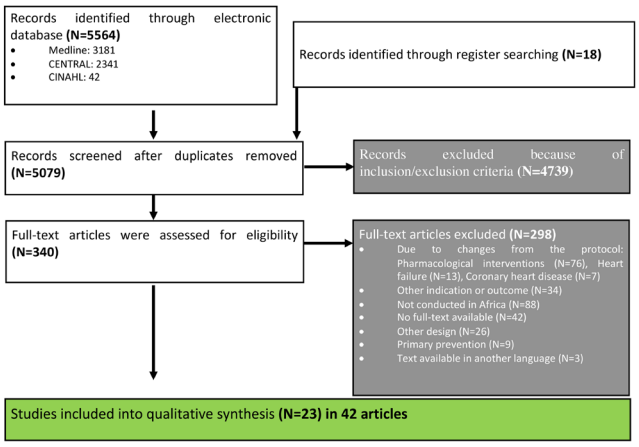

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart describing the process of study selection.

included in this systematic review (figure 1 and list of included studies in the online supplemental material 2). The characteristics and main results of these studies were summarised in table 2.

Study characteristics

We identified 15 studies with two or more independent parallel groups and individual randomisation of patients and eight cluster RCTs with randomisation of different observation units, such as independent villages, healthcare facilities or different geographical regions (table 2). Most of the included studies were conducted in Nigeria (11 studies) and South Africa (8 studies), others in Ghana, Kenya, Cameroon and Egypt. One of the studies[25 25] recruited patients in three countries (South Africa, Nigeria and Kenya). Nine studies (39%) were at least partly conducted in rurally located healthcare facilities (figure 2).[24 27 32 34–36 52 56 64] The included studies were published between 1991 and 2019. Only three of the studies, all conducted in South Africa, were published before 2010.[31 60 61]

Participants

The total sample size ranged from 30 to 4722 participants with a total number of 18 153 participants (table 2). Eighteen studies (78%) randomised more than 100 participants. The mean age was between 45 and 63 years. Most studies (n=19) included more women. Two studies to enhance physical activity included women (Khalid *et al*)[63] or men (Lamina)[37] only. Mean systolic BP (SBP) at baseline was between 128 and 175 mm Hg, mean diastolic BP (DBP) between 76 and 117 mm Hg. Most studies included patients in secondary prevention with mild to moderate hypertension. Three studies[56 58 66] included patients with hypertension post-stroke.

Intervention

Studies investigated educational strategies to improve adherence of patients and treatment by healthcare professionals (16 studies), to individualise treatment (2 studies), and to change lifestyle via enhanced physical activity (4 studies) or modified nutrition (1 study) (table 2).

Educational strategies to improve adherence

Sixteen studies (17 090 participants), with follow-up periods from 2 weeks in a short-term feasibility study (Wahab *et al*)[66] up to 18 months (Goudge *et al*),[34] were published between 1991 and 2019.

The main aim of 11 studies was the improvement of patients' knowledge on hypertension and adherence to self-monitoring of BP, recommendations on medication, lifestyle changes and regular attendance at healthcare facilities.[24 27–29 36 56 58 60 61 64 66] Five studies investigated strategies to improve adequate treatment of patients with hypertension by clinicians, nurses and healthcare workers.[32 34 35 52 62]

Eight studies[27 28 36 56 58 60 61 64] investigated the efficacy of adherence promotion via counselling and phone or letter-based interventions. Seven studies[24 29 32 34 35 52 66] investigated the efficacy of interventions on the basis of training measures with subsequent task-shifting to nurses or health workers for home visits and patient education. One study (Steyn *et al*)[62] tested a multifaced intervention to implement national South African guidelines into primary care of patients with hypertension or diabetes. Another two studies investigated the efficacy of financial incentives as an additional health insurance coverage (Gyamfi *et al*)[35] or free treatment (Labhardt *et al*),[36] respectively.

Nearly all studies stated improved medication adherence,[24 28 29 36 60 61] implementation of lifestyle recommendations (Ayodapo and Olukokun, Mendis *et al*),[27 52] linkage to care,[36 52 64] or knowledge and practical skills of healthcare professionals (Fairall *et al*, Gyamfi *et al*).[32 35] In only three studies,[27–29] these improvements resulted in modest benefits on BP (table 2 and figure 3A–C). In the study by Ayodapo and Olukokun,[27] counselling had a positive impact on lifestyle behaviour and resulted in a clinically relevant decrease of mean arterial BP (−9.8 mm Hg; 95% CI −11.5 to −8.1). Bobrow *et al*[28] assessed the effect of automated treatment adherence support delivered via mobile phone short messages. Bolarinwa *et al*[29] trialled home-based follow-up care with education and counselling of patients and modifications of environmental characteristics. Both studies achieved a 12% higher BP control with SBP <140 mm Hg and DBP <90 mm Hg in participants of the intervention compared with the control groups (RR: 1.12; 95% CI 1.01 to 1.23 and 1.12; 95% CI 1.00 to 1.25) (figure 3).

Individualised treatment strategies

Two studies (286 participants) with follow-up periods of 3 and 12 months were published in 2011 and 2017 (Akintunde *et al*, Okeahialam *et al*).[25 55] Both investigated strategies on the efficacy of an individualised therapy. Therapy individualisation based on the patients' renin/

Table 2 Study characteristics

Name (design)	Country	Participants n	Age (years)/ females	Hypertension; SBP/ DBP (mm Hg)	Intervention (IG) vs control (CG) group Description	Follow-up (months)	Results on adherence and BP IG vs CG; treatment effect (95% CI)
Educational strategies for patients (11 RCTs)							
Adeyemo *et al*[24] (RCT)	Nigeria (mixed)	668	62.7±10.0/66%	Mild to moderate 167.4±19.2/91.8±12.3	Home visits by nurses and clinic management (community based, nurse-led treatment programme with physician backup; facilitation of clinic visits and health education; use of diuretics and a beta blocker as needed) vs clinic management	6	Excellent adherence (missed ≤2 pills per month): worse in IG: 72.5% vs 79.0%; OR_a 0.524 (0.30 to 0.75) BP control: no difference 65.0% vs 66.3%; RR 0.98 (0.87 to 1.11)
Ayodapo and Olukokun[27] (RCT)	Nigeria (mixed)	322	60.9±10.0/51%	MAP: 106.4±8.3	Counselling on lifestyle behaviours (physical activity, fruit and vegetable consumption, alcohol consumption, smoking) over 30–45 min, reminders (telephone calls/SMS) vs usual care	3	Met recommendations on: physical activity: better in IG: 22.4% vs 6.2%; RR 3.60 (1.85 to 7.00) fruit and vegetable consumption: better in IG: 71.4% vs 66%; RR 1.74 (1.41 to 2.15) alcohol consumption: better in IG: 100% vs 87.6%; RR 1.14 (1.08 to 1.21) smoking: no difference: 83.9% vs 78.5%; RR 1.05 (0.95 to 1.17) BP: MAP: lower in IG: 94.6±8.1 vs 106.2±7.6 mm Hg; MD −9.8 (−11.5 to −8.1)
Bobrow *et al*[28] (PACTR2014 11000724141) (RCT)	South Africa (urban)	1372	54.3±11.5/72%	Mild to moderate 135.4±17.5/83.4±12.1	Mobile phone text messages on behaviour change techniques (IG2: interactive with information and possibility to response vs IG1: only information on hypertension, motivation to take medications and reminders) vs usual care	12	Adherence (days with medication ≥80%): higher with IG: 59.7% vs 62.8% vs 49.4%; RR 1.12 (1.01 to 1.23) IG2 vs CG: OR_a 1.86 (1.39 to 2.49) IG1 vs CG: OR_a 1.60 (1.20 to 2.16) BP: slightly lower with IG1 SBP: 132.7±17.5 vs 132.1±16.6 vs 134.3±17.3 mm Hg IG2 vs CG: MD_a −1.6 mm Hg (−3.7 to 0.6) IG1 vs CG: MD_a −2.2 mm Hg (−4.4 to −0.04) BP control: slightly better with IG: 65% vs 65% vs 58% IG1 vs CG: OR_a 1.42 (1.03 to 1.95) IG2 vs CG: OR_a 1.41 (1.02 to 1.95)
Bolarinwa *et al*[29] (PACTR2016 06001671335) (RCT)	Nigeria (urban)	299	61.1±10.8/77%	140.0±22.9/86.9±11.9	Task-shifting (driven by trained and professionally competent nurses) home-based follow-up care (BP and BMI monitoring, medical advice and counselling at home) vs usual care	12	Medical adherence: better with IG: low: 4% vs 16.6%, medium: 17.5% vs 34.7%, high: 78.5% vs 48.7% BP control: better with IG: 85.9% vs 76.7%; RR 1.12 (1.00 to 1.25)
Labhardt *et al*[36] (cluster RCT)	Cameroon (rural)	187	59.9±12.5/64%	Mild to moderate 175.8/100.7	Reminder letters in case of missing follow-up (IG2) vs financial incentive (1 month free treatment for regular attenders) (IG1) vs usual care in nurse-led facilities	12	Adherence: retention rate: 60% vs 65% vs 29%; lower risk of loss to follow-up from the programme and better adherence in IG IG2 vs CG: HR_a: 0.38 (0.24 to 0.61) IG1 vs CG: HR_a: 0.44 (0.27 to 0.72) Adherence (≥80%): 38% vs 35% vs 10% IG2 vs CG: MD_a: 28% (14% to 42%) IG1 vs CG: MD_a: 25% (13% to 37%) BP: no differences in SBP in retained patients Costs: In IG1: average monthly cost per patient for antihypertensive medication: €1.1±0.9, transport: €1.1±1.0

Continued

Table 2 Continued

		Participants			Intervention (IG) vs control (CG) group		Results on adherence and BP
Name (design)	Country	n	Age (years)/ females	Hypertension; SBP/ DBP (mm Hg)	Description	Follow-up (months)	IG vs CG; treatment effect (95% CI)
Owolabi *et al*[56] (NCT01900756) (RCT)	Nigeria (mixed)	400*	57.2±11.7/37%	All stroke (n=400); 138.3±23.6/83.0±15.2 stroke and uncontrolled hypertension (SBP/DBP >140/90 mm Hg) (n=168) 158.7±21.7/92.5±15.6	Chronic care model components of delivery system redesign (increased follow-up visits, pre-appointment phone texts), self-management support (patient report card, post-clinic follow-up phone texts, waiting room educational video) and clinical information systems (patient report card as part of medical chart, hospital registry) vs standardised usual care (risk factor identification and control) and phone contact information	12	BP: No difference for all patients after stroke: SBP: 136.5±22.3 vs 136.2±21.2 mm Hg Patients with uncontrolled hypertension: SBP: 145.1±22.6 vs 148.5±22.8 mm Hg
Sarfo *et al*[58] (NCT02568137) (cluster RCT)	Ghana (urban)	60*	55±13/35%	Stroke and uncontrolled hypertension; 143.8±26.7/90.5±15.7	Nurse-led, multilevel approach with m-Health technology for monitoring and reporting BP measurement and tailored motivational text messages vs usual care	9	Adherence: modified MMA score: no difference: 13±1.5 vs 13±1.7 BP: BP control: no difference: 47% vs 40%; OR_a: 1.24 (0.83 to 1.84) SBP <140 mm Hg: better in IG: 73% vs 43% DBP <90 mm Hg: better in CG: 47% vs 77%
Saunders *et al*[60] (RCT)	South Africa (urban)	224	65% between 40 and 50/73%	Mild to moderate; n.r. 116.6	Reminder letters and home visits by fieldworkers and patient-retained records for self-monitoring of medication compliance and BP control vs usual care (appointment system and health education)	6	Adherence (treatment received) over 6 months: higher for newly treated (135.5±48.9 vs 95.0±60.0 days) and infrequent attenders (168.4±16.4 vs 116.7±56.9 days) of 180 days >80% of treatment: better for newly treated (59% vs 29%; p<0.001) and infrequent attenders (87% vs 42%; p<0.001) BP: DBP: lower for newly treated patients (93.4 vs 100.5 mm Hg; MD: 7.1 mm Hg (0.5 to 13.7), no difference for infrequent attenders: 97.5 vs 94.7 mm Hg; MD: –2.8 mm Hg (–6.9 to 1.3))
Stewart *et al*[61] (RCT)	South Africa (urban)	83	Late middle-aged/n.r.	All hypertensives; 146.4±18.5/93.5±11.1	Telephonic intervention (educational and home-based exercise programme+support of a healthcare practitioner and a family member) vs control group (educational and home-based exercise programme only)	6	Adherence: better with IG: 62.8%±34.5% vs 39.3±42.8%; p=0.007 BP: no difference: SBP: 142±16 vs 144±20 mm Hg; MD: –2 mm Hg (–10.3 to 6.3) DBP: 92±12 vs 91±10 mm Hg, change: MD: 1 mm Hg (–4.0 to 6.0)
Vedanthan *et al*[64] (NCT01844596) (cluster RCT)	Kenya (rural)	1460	54.2±16.4/58%	All hypertensives; 159.4±19.5/89.7±12	Tailored behavioural communication (smartphone (IG2) or paper-based (IG1)) vs usual care	12	Adherence (linkage to care): best results with IG2, worse with IG1: IG2 vs CG: OR_a: 1.21 (0.70 to 2.01) IG1 vs CG: OR_a: 0.64 (0.43 to 0.91) IG2 vs IG1: OR_a: 1.95 (1.23 to 3.01) BP: no difference SBP: 149.4±20.8 vs 150.2±21.6 vs 150.0±22.9 mm Hg, change: –13.1±20.5 vs –8.4±24.0 vs –9.7±25.1 mm Hg IG2 vs CG: MD_a: –2.13 mm Hg (–4.89 to 0.42) IG1 vs CG: MD_a: –0.06 mm Hg (–3.61 to 3.20) IG2 vs IG1: MD_a: –2.07 mm Hg (–5.14 to 1.12) DBP: no difference: 91.3±12.7 vs 91.0±14.1 vs 90.1±13.7 mm Hg, change: 1.5±12.7 vs 0.4±15.2 vs 0.1±14.7 mm Hg BP control: no difference: IG2 vs CG: OR_a: 0.95 (0.61 to 1.38) IG1 vs CG: OR_a: 0.97 (0.63 to 1.42) IG2 vs IG1: OR_a: 1.00 (0.69 to 1.40)

Continued

Table 2 Continued

		Participants			Intervention (IG) vs control (CG) group		Results on adherence and BP
Name (design)	**Country**	**n**	**Age (years)/ females**	**Hypertension; SBP/ DBP (mm Hg)**	**Description**	**Follow-up (months)**	**IG vs CG; treatment effect (95% CI)**
Wahab *et al*[66] (RCT)	Nigeria (urban)	35*	58.1±10.5/34%	All patients with stroke; 138.3±24.2/85.0±12.4	Feasibility of a nurse-led Intervention (education and skill building, BP monitor with review, phone calls) vs usual care	0.5	Adherence: no difference, but improvement in both groups: MMA score: 7.32±0.93 vs 7.03±1.36 BP: no difference SBP: 137.5±23.0 vs 133.1±18.2 mm Hg; MD: 4.40 mm Hg (–9.4 to 18.2) DBP: 84.1±9.7 vs 84.2±13.1 mm Hg; MD –0.1 mm Hg (–7.7 to 7.5)
Educational strategies for healthcare professionals (5 RCTs)							
Fairall *et al*[32] (ISRCTN20283604) (cluster RCT)	South Africa (rural)	4393	52 (IQR 43–62)/73%	Mild to moderate 139±23.6 90±13.2	Education of nurses on NCD care (nurse training in educational outreach sessions with a primary care programme to expand their role in NCD care, authorisation to prescribe an expanded range of drugs on NCDs) vs usual training	14	Adherence: no difference BP: BP controlled: no difference: 33% vs 32%; RR 1.01 (0.2 to 1.8)
Goudge *et al*[34] (ISRCTN12128227) (cluster RCT)	South Africa (rural)	4722	56.6±19.4/56%	Hypertension: 46.6%, of them: 53.4%, on treatment and controlled: 8.6%, on treatment and uncontrolled: 9%, not on treatment: 29%	Support of nurses by health workers (eg, assistance with booking appointments, retrieve and fill patient files, health education, measurements in the vital signs queue, prepacking of medications, reminders to appointment for patients) to provide chronic disease care vs usual care	18	No hypertension: 50.9% vs 52.9% Adherence and BP: no difference on treatment and controlled: 11.3% vs 11.2% on treatment and uncontrolled: 13.0% vs 13.2% not on treatment: 24.9% vs 22.7% undiagnosed: 24.1% vs 22.2% taking medication: 24.3% vs 24.4%
Gyamfi *et al*[35] (NCT01802372) (cluster RCT)	Ghana (mixed)	757	58.0±12.4/60%	Mild to moderate 155.9±12.1/89.6±10.8	Training of nurses in task-shifting for hypertension control+health insurance coverage vs health coverage	12	BP: improvement in both groups, but no difference between groups: SBP: 137.1±27.5 vs 138.4±27.3 mm Hg; change: –19.5±18.0 vs –16.6±17.9 mm Hg; MD: –2.9 mm Hg (–6.9 to 1.0) DBP: 79.8±22.9 vs 81.8±22.8 mm Hg; change –9,3±11.5 vs 8.7±18.7 mm Hg; MD –0.6 mm Hg (–2.9 to 1.7) BP control: 55.2% vs 49.9% (MD 5.2% (–1.8% to 12.4%))
Mendis *et al*[52] (cluster RCT)	Nigeria (mixed)	1188	55±4.7/58%	Mild to moderate 153.2±12.4/94±9.7	Education of healthcare workers and patients with a simple cardiovascular risk management package vs usual care	12	Adherence: higher with IG Attended visits: 90.1% vs 74.5% quit smoking: 100% vs 74.4% (p=0.023) Increased fruit consumption: 93.4% vs 18.8% (p<0.0001) Increased vegetable consumption: 14.2% vs 7.0% (p=0.0002) BP: higher decrease in IG SBP: –11.0±15.4 vs –6.6±20.6 mm Hg; MD –4.4 mm Hg (–6.7 to –2.1) DBP: –5.4±10.0 vs –2.0±13.2 mm Hg; MD –3.4 mm Hg (–4.9 to –1.9)
Steyn *et al*[62] (PACTR2013 03000493351) (cluster RCT)	South Africa (urban)	920	60.3±11.1/79%	All hypertensives 151.2±26.7/87.1±12.4	Multifaced intervention to implement national guidelines (structured record of national guidelines and visits to train clinicians) vs usual care (passive dissemination) at primary care level	12	BP: no difference SBP: 161±28.9 vs 158.2±29.5 mm Hg; MD 2.8 mm Hg (–1.2 to 6.8) DBP: 88.1±13 vs 87.1±12.6 mm Hg; MD 1.00 mm Hg (–0.73 to 2.73) controlled BP: 23.1% vs 26%
Individualised treatment (3 RCTs)							

Continued

Table 2 Continued

Name (design)	Country	Participants n	Age (years)/ females	Hypertension; SBP/ DBP (mm Hg)	Intervention (IG) vs control (CG) group Description	Follow-up (months)	Results on adherence and BP IG vs CG; treatment effect (95% CI)
Akintunde *et al*[25] (ISRCTN69440037) (RCT) {Akintunde, 2017 #4980} (ISRCTN69440037)	Nigeria, Kenya, South Africa (urban)	105	56.6±14.3/53%	Uncontrolled 170.9±19.2/85.6±21.8	Physiologically individualised care (guided by their physiological phenotype, based on plasma renin and aldosterone) vs usual care	12	BP: lower in IG SBP: 139.4±17.4 vs 152.6±12.3 mm Hg; MD −13.2 mm Hg (−19.4 to −7.0) DBP: 84.0±11.0 vs 89.6±7.0 mm Hg; MD −5.6 mm Hg (−9.4 to −1.8) BP control: 50.0% vs 11.1% (p=0.0001)
Okeahialam *et al*[55] (RCT)	Nigeria (urban)	181	49.7±14.2/61%	Mild to moderate 150.3±14.8/93.7±9.6	Chronotherapy: drug intake in the night (22:00) vs drug intake in the morning (10:00)	3	BP: higher decrease in IG SBP: −18.1±17.9 vs −14.1±14.7 mm Hg; MD −4.0 mm Hg (−9.0 to 1.0) DBP: −15.6±12.2 vs −8.7±10.2 mm Hg; MD −6.9 mm Hg (−10.4 to −3.4)
Physical activity (4 RCTs)							
Aweto *et al*[26] (RCT)	Nigeria (urban)	50	45±12.3/58%	Mild to moderate 138.7±10.9/79.9±9.3	Dance movement therapy (50 min) vs educational sessions, both 2×/week over 4 weeks	1	BP: lower in IG SBP: 119.9±8.3 vs 135.5±11.6 mm Hg; MD −15.6 mm Hg (−22.4 to −8.8) DBP: 70.9±7.2 vs 74.1±7.7 mm Hg; MD −3.2 mm Hg (−8.1 to 1.7)
Lamina[37] (RCT)	Nigeria (urban)	485	58.5±6.8/0%	Mild to moderate, stable 165.4±13.2/98.1±4.6	Training programmes on bicycle ergometer, 3×/week, 45–60 min: interval training (IG2) vs continuous training (IG1) vs usual care over 8 weeks	2	BP: lower in IG SBP: 150.4±16.7 vs 154.4±12.6 vs 163.5±14.9 mm Hg; MD −11.1 mm Hg (−14.8 to −7.4) DBP: 95±5 vs 94.4±8.8 vs 96.1±2.7 mm Hg; MD −1.4 mm Hg (−2.6 to −0.2)
Maruf *et al*[51] (ISRCTN81952488) (RCT)	Nigeria (urban)	120	52.8±8.4 (range 38–65)/71%	Mild to moderate, 155.7±11.4/93±10	Aerobic dance training (3×/week, 45 min) vs usual care over 12 weeks	3	BP: lower in IG SBP: 135.3±5.6 vs 142.4±4.7 mm Hg; MD: −7.1 mm Hg (−9.3 to −4.9) DBP: 82.2±3.4 vs 83.9±2.8 mm Hg; MD: −1.7 mm Hg (−3.0 to −0.4)
Khalid *et al*[63] (RCT)	Egypt (urban)	30	52.8±2.4, 40–50/100%	Postmenopausal hypertensives 151±6.2/94.5±4.2	Moderate aerobic exercise training (40 min, 3×/week) by walking on a treadmill vs usual care over 8 weeks	2	BP: lower in IG SBP: 124±5.6 vs 145±6.7 mm Hg; MD: −21.0 mm Hg (−25.8 to −16.2) DBP: 85±5.4 vs 95±3.7 mm Hg; MD: −10.0 mm Hg (−13.7 to −6.3)
Modified nutrition (1 RCT)							
Charlton *et al*[31] (RCT)	South Africa (urban)	92	61.1±7/84%	Mild to moderate 134.6±15.7/81.1±8.1	Food-based dietary strategy (modified food, salt replacement, +500 mL of maas (fermented milk) vs control (same quantities of the targeted foods of standard commercial composition, 500 mL/day artificially sweetened cool drink)	2	BP: lower in IG SBP: 132.5±15.8 vs 127.5±15.8 mm Hg; MD_a: −6.2 mm Hg (−11.4 to −0.9) DBP: 82.2±9.5 vs 79.2±11.4 mm Hg; MD_a: −0.6 mm Hg (−3.0 to 1.8)

*Tertiary prevention.
BMI, body mass index; BP, blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; MD, mean difference; MD_a, adjusted mean difference; MMA, Morisky medication adherence; n, number of randomised participants; NCD, non-communicable disease; n.r, not reported; OR_a, adjusted OR; RCT, randomised controlled trial; RR, relative risk; SBP, systolic blood pressure; SMS, short message service.

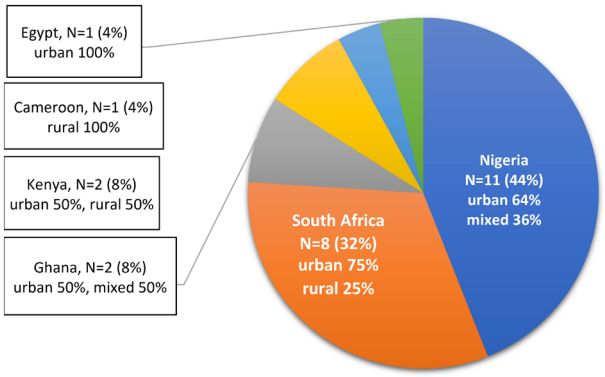

Figure 2 Spatial distribution of countries in which randomised studies were conducted.

aldosterone profile (Akintunde *et al*)[25] resulted in more appropriate prescriptions and a relevant decrease of SBP (MD: −13.2 mm Hg; 95% CI −19.4 to −7.0) and DBP (MD: −5.6; 95% CI −9.4 to −1.8) in patients with uncontrolled hypertension. The second study (Okeahialam *et al*)[55] showed a higher reduction of DBP in patients using their anti-hypertensives at night compared with a morning intake (MD: −6.9 mm Hg; 95% CI −10.4 to −3.4) but stated no change in SBP (table 2).

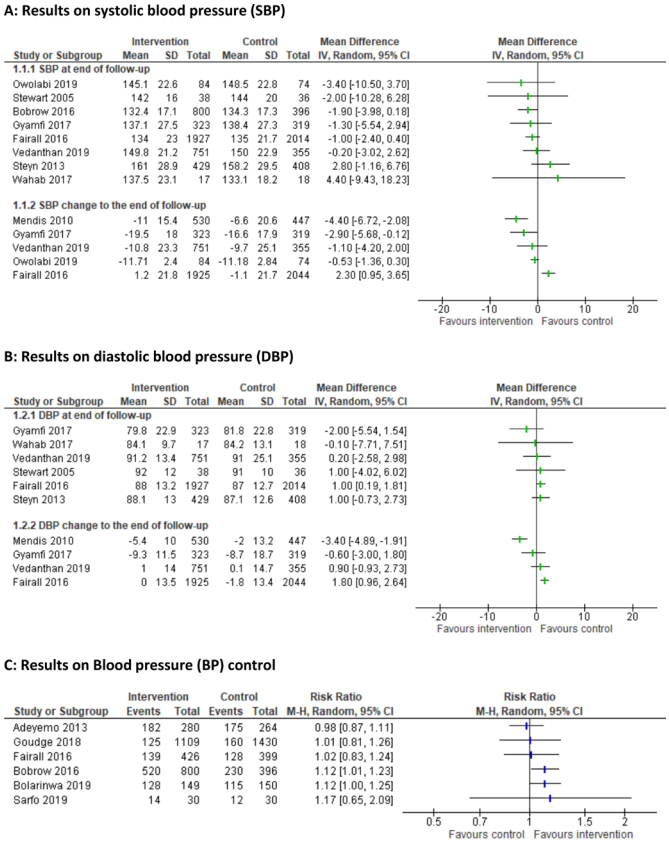

Figure 3 Results of educational strategies to improve adherence (3a Results on systolic blood pressure; 3b Results on diastolic blood pressure; 3c Results on blood pressure control)

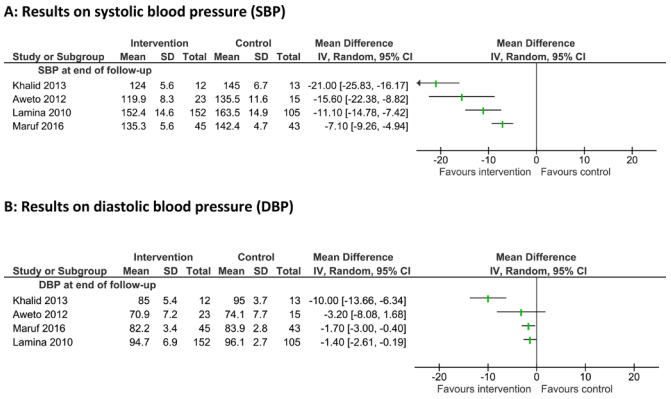

Figure 4 Results of strategies to enhance physical activity (4a Results on systolic blood pressure; 4b Results on diastolic blood pressure).

Strategies with physical activity

Four studies[26 37 51 63] (685 participants), published between 2010 and 2016, investigated the BP-lowering effect of different aerobic training strategies over 4–12 weeks. Enhanced physical activities were performed two or three times a week and included dance training (Aweto *et al*, Maruf *et al*)[26 51] and exercise training on an ergometer (Lamina)[37] or treadmill (Khalid *et al*).[63]

All studies stated a clinically relevant benefit with mean reductions of SBP between 21 and 7.1 mm Hg and DBP between 10 and 1.4 mm Hg (figure 4). The highest BP decrease was achieved in a study on the effect of moderate aerobic exercise training by walking on a treadmill in postmenopausal women with hypertension (Khalid *et al*)[63] (MD: −21 mm Hg; 95% CI −25.8 to −16.2).

Modified nutrition strategies

Charlton *et al*[31] tested a food-based dietary strategy (reduced salt consumption) in 92 patients with mild to moderate hypertension from a low socioeconomic background, stating a clinically relevant decrease in SBP after 2 months (MD: −6.2 mm Hg; 95% CI −11.4 to −0.9), but no effect on DBP (table 2).

Potential biases

The greatest restriction of study quality was a high risk of bias in the blinding of staff and study participants in 19 studies. Especially educational strategies were not examined in double-blinded studies, however three of these studies[34 56 58] reported a quality assurance against detection bias with blinded measurement of BP. Two studies on physical activity enhancement in comparison with usual care (Lamina, Maruf *et al*)[37 51] were described as double blinded without reporting further details. Only the study on modified nutrition (Charlton *et al*)[31] adequately reported detailed methods to ensure blinding of participants and fieldworkers. Another frequent problem was incomplete outcome data in 14 studies with loss to follow-up of over 10% of randomised participants or per-protocol analyses. Selective reporting was checked in all 13 studies with a published protocol. Of those, five studies[29 35 36 51 56] did not report all preplanned outcomes.

Problems concerning randomisation were identified in three studies with a non-random component in sequence generation or allocation concealment.[25 37 52] Other sources of bias include missing sample size calculations, reporting of intermediate results only and relevant differences at baseline in nine studies (table 3, figure 5).[24–26 29 51 55 63 64 66]

DISCUSSION

This systematic review describes interventions and treatment effects of 23 studies with a total of 18 153 participants with hypertension from six African countries. Most of the studies investigated successful low-cost concepts to improve BP control through improved adherence to medical treatment and lifestyle changes.

While lower-income and middle-income countries' CVD mortality remained unchanged over the last decades, high-income countries have reduced the CVD mortality by more than 50% since 1990,[67] largely by using country-specific guidelines, evidence-based policy interventions to reduce risk factor levels, strengthening the health system at the primary care level and improving acute care with attention to early initiation of treatment. However, policies to reduce population-wide risk factors of hypertension have not been widely adopted in low-income and middle-income countries.[68]

Pharmacotherapy with the well-established antihypertensive medications is the mainstay of hypertension management.[15 69] Nevertheless, treatment recommendations on adherence to medication and changed lifestyle habits are often only incompletely applied in practice.[70–72] Patients are frequently unwilling to take drugs due to possible side effects. They may benefit from adequate knowledge as well as a higher motivation to take their prescribed medications and to implement sustainable lifestyle changes.[73–75] Despite the frequent lack of acute symptoms, uncontrolled BP may result in severe long-term outcome and increased mortality. The risk increases in cases of inadequate treatment and low patient adherence as well as inconsistent follow-up on BP control.[7] Therefore, all strategies with the aim to increase knowledge, awareness and adherence are essential to lowering BP levels and improving the prognoses of patients.[69 76] Due to the short-term follow-up, no study reported long-term outcomes on mortality, and we interpreted available results on BP changes and treatment adherence.

Several strategies to improve health-related behaviour concerning hypertension with convincing results were examined. We identified eight studies that investigated the efficacy of phone or letter-based interventions (eg, via short message service) to improve knowledge on hypertension, with adherence support or reminder letters for follow-up.[27 28 36 56 58 60 61 64] All these studies showed strong effects of the intervention concerning self-reported behavioural changes, but only two of these studies showed improved BP during follow-up (Ayodapo and Olukokun, Bobrow *et al*).[27 28] Three studies[29 35 52] reported improved adherence and two of those a decreased BP level through nurse-led interventions (Bolarinwa *et al*, Mendis *et al*).[29 52] These studies demonstrated the efficacy of task-shifting interventions in a low-resource setting. Furthermore, low-cost interventions suited to the environment, including financial incentives for adherent patients with minimal additional resources, can significantly improve the adherence of patients (Labhardt *et al*)[36] and thus potentially influence BP control.

Even though cost-effective interventions are globally available, there are major gaps in their implementation, particularly in limited-resource settings.[68] Two large multilevel studies that combined phone or letter-based interventions with task-shifting to nurses or health workers were not successful in achieving a relevant improvement in adherence and BP control (Fairall *et al*, Goudge *et al*).[32 34] On the other hand, no harm was observed after the expansion of the nurses' roles (Fairall *et al*).[32] Thus, the intervention might be a practical and acceptable tool to expand the scope of non-physician clinicians into primary care of patients with common NCDs. There is a generally good access to essential medications in four countries where the included studies have been conducted (South Africa, Egypt, Kenya and Ghana). The access is not as widespread in Cameroon and Nigeria.[77] Nevertheless, one study conducted in rural parts of South Africa between 2014 and 2015 (Goudge *et al*)[34] reported insufficient or unavailable equipment and medication shortage. Moreover, increasing numbers of patients with NCD require an adequate number of nursing personnel as well as healthcare facilities. Similar factors contributed to the poor results of the implementation of national guidelines in resource-scarce primary healthcare settings in South Africa,[62] which did not show improved outcomes in patients with hypertension and diabetes. In studies with follow-up-periods of less than 1 year, the time frame might have been too short to reach a clinically relevant BP control through improved knowledge and awareness, since lifestyle changes are oftentimes challenging and should be applied over a long time.[24 61 66] Generally, the results of the systematic review are consistent with existing evidence on the importance of long-acting patient-centred interventions. Unfortunately, these interventions do not reach all patients and often, a full benefit of medical treatment on clinically important outcomes cannot be achieved.[78]

Most studies in this review included participants in secondary prevention with mild to moderate hypertension. In contrast, observational studies and conclusions from a systematic review on pharmacological treatment generally concerned participants with higher grades of hypertension.[5 7 79] Interventions for patients with severe or uncontrolled hypertension and potentially target-organ damage are under-represented. Interventions for high-risk patients are especially necessary due to the high frequency of late first diagnosis[7] and high prevalence of severe forms of hypertension at an early age in African patients.[6] A multicentre study on patients with uncontrolled hypertension in clinics in Nigeria, Kenya

Table 3 Risk of bias assessment

Study	Sequence generation	Allocation concealment	Blinding of Personnel/ participants	Blinding of Outcome assessors	Incomplete outcome data	Selective reporting	Other sources
Educational strategies							
Adeyemo *et al*[24]	😐	😐	☹	😐	☹	😐	☹
Ayodapo and Olukokun[27]	😐	☺	☹	☹	☺	😐	😐
Bobrow *et al*[28]	☺	☺	☹	😐	☹	☺	☺
Bolarinwa *et al*[29]	☺	☺	☹	☹	☹	☹	☹
Fairall *et al*[32]	☺	☺	☹	😐	☺	☺	☺
Goudge *et al*[34]	☺	☺	☹	☹	☹	☺	☺
Gyamfi *et al*[35]	☺	☺	☹	😐	☹	☹	☺
Labhardt *et al*[36]	☺	☺	☹	☹	☹	☹	☺
Mendis *et al*[52]	☹	☹	☹	☹	☹	😐	☺
Owolabi *et al*[56]	☺	😐	☹	☺	☺	☹	☺
Sarfo *et al*[58]	☺	☺	☹	☺	☺	☺	☺
Saunders *et al*[60]	😐	😐	☹	☹	☺	😐	☺
Stewart *et al*[61]	😐	😐	☹	☹	☹	😐	☺
Steyn *et al*[62]	☺	☺	☹	☹	☺	☺	☺
Vedanthan *et al*[64]	😐	☺	☹	☹	☹	☺	☹
Wahab *et al*[66]	☺	☺	☹	☹	☺	😐	☹
Standardised treatment							
Akintunde *et al*[25]	☹	😐	😐	😐	☹	☺	☹
Okeahialam *et al*[55]	☺	☺	☹	😐	☹	😐	☹
Physical activity							
Aweto *et al*[26]	😐	😐	☹	☹	☹	😐	☹
Lamina[37]	☹	😐	😐	☺	☹	😐	☺
Maruf *et al*[51]	☺	☺	😐	☺	☺	☹	☹
Khalid *et al*[63]	☺	☺	☹	☹	☹	😐	☹
Modified nutrition							
Charlton *et al*[31]	😐	😐	☺	☺	☺	😐	☺

☺: low; 😐: unclear; ☹: high risk of bias.

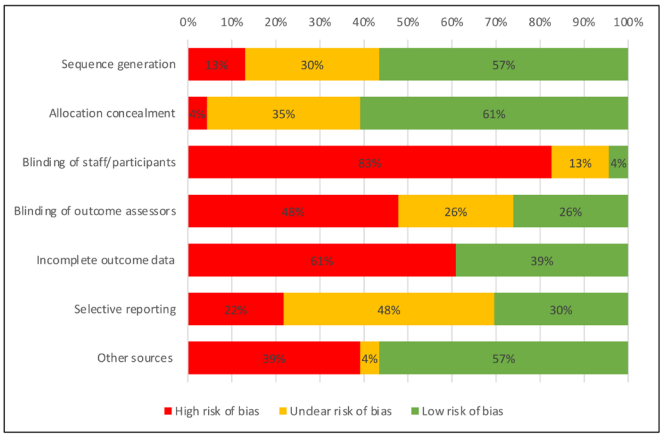

Figure 5 Summary of risk of bias.

and South Africa stated the efficacy of an individualised therapy based on phenotyping with plasma renin and aldosterone to improve BP control (Akintunde *et al*).[25] The researchers suggest testing this approach in African Americans and patients of any race with therapy-resistant hypertension. Three studies[56 58 66] investigated the implementation of multilevel approaches including educational, telephone-based, nurse-led, self-management supporting interventions, as well as BP monitoring for stroke survivors. These studies were not successful in sufficiently improving BP control, possibly due to short follow-up periods.

Regarding the different grades of hypertension, low-risk patients with grade 1 hypertension benefit from lifestyle modifications including regular physical activity, sodium restriction, weight reduction, smoking cessation, moderation of alcohol consumption and other dietary changes. These are recommended as initial strategies to reduce BP levels in order to prevent or delay the use of pharmacotherapy.[14 15] Nevertheless, even for patients with higher grades of hypertension, lifestyle modifications remain important in addition to pharmacotherapy.[14 15 69 80] The clinically accepted relevant BP-lowering effect of medium-intensity to high-intensity physical activity as a single or additive treatment for hypertension[81] was demonstrated in four of the included studies.[26 37 51 63] Only one study from South Africa investigated the effect of a modified nutrition strategy (reduction of salt intake) and stated a clinically relevant effect on SBP (Charlton *et al*).[31] To the authors' knowledge, no randomised study investigated the efficacy of other recommended lifestyle interventions, like smoking cessation or weight reduction, in patients with hypertension in an African country.

Strengths and limitations of this review

We were able to generate evidence on a wide range of different non-pharmacological interventions, adding a comprehensive overview to the literature that can support physicians and healthcare policymakers in the African setting.

A main limitation occurs through deviations from the protocol. We planned a comprehensive summary of all RCTs to prevent, diagnose and treat patients with CVDs in African countries. Due to a high number of eligible studies in the first systematic search, we decided to focus on published studies on hypertension. We therefore had to change the preplanned outcomes and instead focus on BP and additionally describe results on medication adherence and lifestyle changes. The preplanned outcomes mortality, New York Heart Association (NYHA) classification and hospital admission were dropped. Due to the recently published systematic review by Seeley *et al*,[17] this publication describes non-pharmacological strategies. The complete results, including pharmacological interventions, were summarised in a doctoral thesis paper.[82]

Nevertheless, this review was limited to studies with the highest level of evidence to investigate the benefits and harms of non-pharmacological interventions for hypertension. The randomised allocation ensures the comparability of participants across intervention groups. However, the unfeasibility of double blinding might restrict the internal validity of results.

The external validity might be limited by our restriction to studies published in the English language and the disproportionally high number of studies conducted in urban areas in some Western and Southern African countries. According to the UN, there are currently 54 African countries. RCTs have been conducted in only six of those countries. Inhabitants of these countries (approximately 480 million) represent only a fraction of the African population of about 1.34 billion.[83] Especially Central and Northern Africa were under-represented. There are high levels of diversity within and between African populations. Subpopulations with genetic variants are living in geographically distant areas with specific local lifestyle or environmental conditions, which may be associated with a susceptibility to specific NCDs.[84] Therefore, it is uncertain whether our results can be extrapolated to patients living in other areas than those studied. A significant amount of the African population lives in rural areas while the majority of studies were conducted in urban settings. However, it is crucial to make health service available as close as possible to the population in order to achieve the most comprehensive care. Thus, research on non-pharmacological interventions such as educational strategies to improve adherence and lifestyle modification should be expanded across all parts of Africa. Research must be conducted especially in rural areas to ensure a higher generalisability, quality of services and resulting improvement of the African people's health.

CONCLUSION

This systematic review shows that even though hypertension is a critical health problem, there are still few randomised studies on non-pharmacological treatment of hypertension conducted on the African continent. Available studies do not represent all Africans since they were conducted in only six countries, many in urban settings only. It is advisable to plan and implement studies on

patients with hypertension and healthcare professionals in rural areas as well as Northern and Central African countries.

An improvement in the prognosis of patients with high BP in Africa requires the implementation of practical and effective solutions to diagnose, treat and control hypertension in specific settings.[9] The identified studies describe diverse approaches tested in African countries that may be used to generate local African evidence-based guidelines on hypertension treatment. Especially trialled physical activity interventions and individualised treatment strategies show clinically relevant BP changes. Educational strategies for patients and medical personnel show mixed results and offer a comprehensive insight into trialled approaches as well as a basis for future research opportunities. This review summarises miscellaneous low-cost interventions including task-shifting, education individualised treatment and lifestyle modifications to improve BP control.

Author affiliations
[1]Institute of General Practice and Family Medicine, Center of Health Sciences, Martin-Luther-Universität Halle-Wittenberg Medizinische Fakultät, Halle, Germany
[2]School of Public Health, Addis Ababa University, Addis Ababa, Ethiopia
[3]Institute for Medical Epidemiology, Biostatistics and Informatics, Center of Health Sciences, Martin-Luther-Universität Halle-Wittenberg Medizinische Fakultät, Halle, Germany
[4]Physiotherapy Department, Regional Hospital Bamenda, Bamenda, Cameroon
[5]Research Organization for Health Education and Rehabilitation-Cameroon(ROHER-CAM), St. Louis University Bamenda, Bamenda, Cameroon
[6]African Regional Community, Guidelines International Network (G-I-N), Bamenda, Cameroon
[7]Department of Primary Care, Universität Leipzig Medizinische Fakultät, Leipzig, Germany

Contributors MC was involved in all steps to plan this systematic review including the protocol; wrote the draft of this manuscript; screened titles, abstracts, and full texts; and did data extraction and quality assessment. ESK wrote the draft of this manuscript; screened titles, abstracts and full texts; did data extraction and quality assessment of the last update; and submitted the manuscript. TD was involved in all steps to plan this systematic review including the protocol; provided expertise and discussed the results in the African context; and commented on the manuscript. TF provided expertise on primary care aspects of hypertension treatment, discussed the results and commented on the manuscript. SG provided expertise on CVD epidemiology and public health, discussed the results in the African context and commented on the manuscript. EJK was involved in all steps to plan this systematic review including the protocol; provided expertise on the needs of evidence in the African context; and commented on the manuscript. EN provided expertise on public health and African guideline work, discussed the results in the African context, commented on the manuscript, provided expertise and discussed the reviewer comments and supported the draft of the revised manuscript. SU is responsible for the overall content as the guarantor and was involved in all steps to plan this systematic review including the protocol; wrote the draft of this manuscript; made systematic search; screened titles, abstracts and full texts; did data extraction and quality assessment; and submitted the manuscript.

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

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval No ethics approval and consent to participate was necessary.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplemental information.

ORCID iDs
Eric Sven Kroeber http://orcid.org/0000-0002-7201-6023
Eva Johanna Kantelhardt http://orcid.org/0000-0001-7935-719X
Susanne Unverzagt http://orcid.org/0000-0002-0108-0415

REFERENCES

1 Global Burden of Metabolic Risk Factors for Chronic Diseases Collaboration. Cardiovascular disease, chronic kidney disease, and diabetes mortality burden of cardiometabolic risk factors from 1980 to 2010: a comparative risk assessment. *Lancet Diabetes Endocrinol* 2014;2:634–47.
2 NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19·1 million participants. *Lancet* 2017;389:37–55.
3 Kaze AD, Schutte AE, Erqou S, *et al*. Prevalence of hypertension in older people in Africa: a systematic review and meta-analysis. *J Hypertens* 2017;35:1345–52.
4 Bosu WK, Reilly ST, Aheto JMK, *et al*. Hypertension in older adults in Africa: a systematic review and meta-analysis. *PLoS One* 2019;14:e0214934.
5 Brewster LM, Seedat YK. Why do hypertensive patients of African ancestry respond better to calcium blockers and diuretics than to ACE inhibitors and β-adrenergic blockers? A systematic review. *BMC Med* 2013;11:141.
6 Brewster LM, van Montfrans GA, Oehlers GP, *et al*. Systematic review: antihypertensive drug therapy in patients of African and South Asian ethnicity. *Intern Emerg Med* 2016;11:355–74.
7 Oladapo OO, Salako L, Sadiq L, *et al*. Target-organ damage and cardiovascular complications in hypertensive Nigerian Yoruba adults: a cross-sectional study. *Cardiovasc J Afr* 2012;23:379–84.
8 Nelissen HE, Hendriks ME, Wit FWNM, *et al*. Target organ damage among hypertensive adults in rural Nigeria: a cross-sectional study. *J Hypertens* 2014;32:487–94.
9 Dzudie A, Rayner B, Ojji D, *et al*. Roadmap to achieve 25% hypertension control in Africa by 2025. *Cardiovasc J Afr* 2017;28:262–72.
10 United Nations. Sustainable development goals. Goal 3: ensure healthy living and promote well-being for all at all ages, 2019. Available: https://www.un.org/sustainabledevelopment/health/
11 Gómez-Olivé FX, Ali SA, Made F, *et al*. Regional and sex differences in the prevalence and awareness of hypertension: an H3Africa AWI-Gen study across 6 sites in sub-Saharan Africa. *Glob Heart* 2017;12:81–90.
12 Lloyd-Sherlock P, Beard J, Minicuci N, *et al*. Hypertension among older adults in low- and middle-income countries: prevalence, awareness and control. *Int J Epidemiol* 2014;43:116–28.
13 Guwatudde D, Nankya-Mutyoba J, Kalyesubula R, *et al*. The burden of hypertension in sub-Saharan Africa: a four-country cross sectional study. *BMC Public Health* 2015;15:1211.
14 Whelton PK, Carey RM, Aronow WS, *et al*. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: Executive summary: a report of the American College of Cardiology/American heart association Task force on clinical practice guidelines. *Hypertension* 2018;71:1269–324.
15 Williams B, Mancia G, Spiering W, *et al*. 2018 ESC/ESH guidelines for the management of arterial hypertension. *Eur Heart J* 2018;39:3021–104.

16 Fredericksen RJ, Gibbons L, Brown S, *et al*. Medication understanding among patients living with multiple chronic conditions: implications for patient-reported measures of adherence. *Res Social Adm Pharm* 2018;14:540–4.
17 Seeley A, Prynn J, Perera R, *et al*. Pharmacotherapy for hypertension in sub-Saharan Africa: a systematic review and network meta-analysis. *BMC Med* 2020;18:1–11.
18 Mahmood S, Shah KU, Khan TM, *et al*. Non-pharmacological management of hypertension: in the light of current research. *Ir J Med Sci* 2019;188:437–52.
19 Moher D, Liberati A, Tetzlaff J, *et al*. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009;6:e1000097.
20 Boutron I, Altman DG, Moher D, *et al*. Consort statement for randomized trials of nonpharmacologic treatments: a 2017 update and a consort extension for nonpharmacologic trial Abstracts. *Ann Intern Med* 2017;167:40–7.
21 Team TE. *EndNote. EndNote X9 ed*. Philadelphia, PA: Clarivate, 2013.
22 Higgins JPT, Altman DG, Gøtzsche PC, *et al*. The Cochrane collaboration's tool for assessing risk of bias in randomised trials. *BMJ* 2011;343:d5928.
23 Collaboration Copenhagen TC. *Review Manager (RevMan) [Computer program].Version 5.3*, 2014.
24 Adeyemo A, Tayo BO, Luke A, *et al*. The Nigerian antihypertensive adherence trial: a community-based randomized trial. *J Hypertens* 2013;31:201–7.
25 Akintunde A, Nondi J, Gogo K, *et al*. Physiological phenotyping for personalized therapy of uncontrolled hypertension in Africa. *Am J Hypertens* 2017;30:923–30.
26 Aweto HA, Owoeye OBA, Akinbo SRA, *et al*. Effects of dance movement therapy on selected cardiovascular parameters and estimated maximum oxygen consumption in hypertensive patients. *Nig Q J Hosp Med* 2012;22:125–9.
27 Ayodapo AO, Olukokun TAV. Lifestyle counselling and behavioural change: role among adult hypertensives in a rural tertiary institution. *South African Family Practice* 2019;61:91–6.
28 Bobrow K, Farmer AJ, Springer D, *et al*. Mobile Phone Text Messages to Support Treatment Adherence in Adults With High Blood Pressure (SMS-Text Adherence Support [StAR]): A Single-Blind, Randomized Trial. *Circulation* 2016;133:592–600.
29 Bolarinwa OA, Juni MH, Nor Afiah MZ, *et al*. Mid-term impact of home-based follow-up care on health-related quality of life of hypertensive patients at a teaching hospital in Ilorin, Nigeria. *Niger J Clin Pract* 2019;22:69–78.
30 Cappuccio FP, Kerry SM, Micah FB, *et al*. A community programme to reduce salt intake and blood pressure in Ghana [ISRCTN88789643]. *BMC Public Health* 2006;6:13.
31 Charlton KE, Steyn K, Levitt NS, *et al*. A food-based dietary strategy lowers blood pressure in a low socio-economic setting: a randomised study in South Africa. *Public Health Nutr* 2008;11:1397–406. [Erratum appears in Public Health Nutr 2009;12:284].
32 Fairall LR, Folb N, Timmerman V, *et al*. Educational outreach with an integrated clinical tool for nurse-led non-communicable chronic disease management in primary care in South Africa: a pragmatic cluster randomised controlled trial. *PLoS Med* 2016;13:e1002178.
33 Folb N, Timmerman V, Levitt NS, *et al*. Multimorbidity, control and treatment of noncommunicable diseases among primary healthcare attenders in the Western Cape, South Africa. *S Afr Med J* 2015;105:642–7.
34 Goudge J, Chirwa T, Eldridge S, *et al*. Can lay health workers support the management of hypertension? Findings of a cluster randomised trial in South Africa. *BMJ Glob Health* 2018;3:e000577.
35 Gyamfi J, Plange-Rhule J, Iwelunmor J, *et al*. Training nurses in task-shifting strategies for the management and control of hypertension in Ghana: a mixed-methods study. *BMC Health Serv Res* 2017;17:104.
36 Labhardt ND, Balo J-R, Ndam M, *et al*. Improved retention rates with low-cost interventions in hypertension and diabetes management in a rural African environment of nurse-led care: a cluster-randomised trial. *Trop Med Int Health* 2011;16:1276–84.
37 Lamina S. Effects of continuous and interval training programs in the management of hypertension: a randomized controlled trial. *J Clin Hypertens* 2010;12:841–9.
38 Lamina S. Comparative effect of interval and continuous training programs on serum uric acid in management of hypertension: a randomized controlled trial. *J Strength Cond Res* 2011;25:719–26.
39 Lamina S, Okoye CG. Effect of low intensity continuous training programme on serum uric acid in the non pharmacological management of hypertension: a randomized controlled trial. *Niger J Med* 2010;19:77–86.
40 Lamina S, Okoye CG. Uricaemia as a cardiovascular events risk factor in hypertension: the role of interval training programme in its downregulation. *J Assoc Physicians India* 2011;59:23–8.
41 Lamina S, Okoye CG. Effect of interval training program on white blood cell count in the management of hypertension: a randomized controlled study. *Niger Med J* 2011;52:271–7.
42 Lamina S, Okoye CG, Dagogo TT. Managing erectile dysfunction in hypertension: the effects of a continuous training programme on biomarker of inflammation. *BJU Int* 2009;103:1218-–21.
43 Lamina S, Okoye CG, Dagogo TT. Therapeutic effect of an interval exercise training program in the management of erectile dysfunction in hypertensive patients. *J Clin Hypertens* 2009;11:125–9.
44 Lamina S, Okoye CG, Hanif SM. Randomised controlled trial: effects of aerobic exercise training programme on indices of adiposity and metabolic markers in hypertension. *J Pak Med Assoc* 2013;63:680–7.
45 Lamina S, Okoye CG, Hanif SM. Effects of interval exercise training programme on the indices of adiposity and biomarker of inflammation in hypertension: a randomised controlled trial. *Niger Postgrad Med J* 2014;21:136–43.
46 Lamina S, Okoye G. Effects of aerobic exercise training on psychosocial status and serum uric acid in men with essential hypertension: a randomized controlled trial. *Ann Med Health Sci Res* 2012;2:161–8.
47 Lamina S, Okoye GC. Therapeutic effect of a moderate intensity interval training program on the lipid profile in men with hypertension: a randomized controlled trial. *Niger J Clin Pract* 2012;15:42–7.
48 Lamina S, Okoye GC. Effect of interval exercise training programme on C-reactive protein in the non-pharmacological management of hypertension: a randomized controlled trial. *Afr J Med Med Sci* 2012;41:379–86.
49 Leon N, Surender R, Bobrow K, *et al*. Improving treatment adherence for blood pressure lowering via mobile phone SMS-messages in South Africa: a qualitative evaluation of the SMS-text adherence support (StAR) trial. *BMC Fam Pract* 2015;16:80.
50 Maruf FA, Akinpelu AO, Salako BL. Self-reported quality of life before and after aerobic exercise training in individuals with hypertension: a randomised-controlled trial. *Appl Psychol Health Well Being* 2013;5:209–24.
51 Maruf FA, Akinpelu AO, Salako BL, *et al*. Effects of aerobic dance training on blood pressure in individuals with uncontrolled hypertension on two antihypertensive drugs: a randomized clinical trial. *J Am Soc Hypertens* 2016;10:336–45.
52 Mendis S, Johnston SC, Fan W, *et al*. Cardiovascular risk management and its impact on hypertension control in primary care in low-resource settings: a cluster-randomized trial. *Bull World Health Organ* 2010;88:412–9.
53 Ogedegbe G, Plange-Rhule J, Gyamfi J, *et al*. Health insurance coverage with or without a nurse-led task shifting strategy for hypertension control: a pragmatic cluster randomized trial in Ghana. *PLoS Med* 2018;15:e1002561.
54 Ogedegbe G, Plange-Rhule J, Gyamfi J, *et al*. A cluster-randomized trial of task shifting and blood pressure control in Ghana: study protocol. *Implement Sci* 2014;9:73.
55 Okeahialam B, Ohihoin E, Ajuluchukwu J. Chronotherapy in Nigerian hypertensives. *Ther Adv Cardiovasc Dis* 2011;5:113–8.
56 Owolabi MO, Gebregziabher M, Akinyemi RO, *et al*. Randomized trial of an intervention to improve blood pressure control in stroke survivors. *Circ Cardiovasc Qual Outcomes* 2019;12:e005904.
57 Sarfo FS, Ovbiagele B. Stroke minimization through additive anti-atherosclerotic agents in routine treatment (SMAART): a pilot trial concept for improving stroke outcomes in sub-Saharan Africa. *J Neurol Sci* 2017;377:167–73.
58 Sarfo FS, Treiber F, Gebregziabher M, *et al*. Phone-based intervention for blood pressure control among Ghanaian stroke survivors: a pilot randomized controlled trial. *Int J Stroke* 2019;14:630–8.
59 Sarfo FS, Treiber F, Jenkins C, *et al*. Phone-based intervention under nurse guidance after stroke (PINGS): study protocol for a randomized controlled trial. *Trials* 2016;17:436.
60 Saunders LD, Irwig LM, Gear JS, *et al*. A randomized controlled trial of compliance improving strategies in Soweto hypertensives. *Med Care* 1991;29:669–78.
61 Stewart A, Noakes T, Eales C, *et al*. Adherence to cardiovascular risk factor modification in patients with hypertension. *Cardiovasc J S Afr* 2005;16:102–7.
62 Steyn K, Lombard C, Gwebushe N, *et al*. Implementation of national guidelines, incorporated within structured diabetes and hypertension records at primary level care in Cape Town, South Africa: a randomised controlled trial. *Glob Health Action* 2013;6:20796.
63 Khalid T, Nesreen E, Ramadhan O. Effects of exercise training on postmenopausal hypertension: implications on nitric oxide levels. *Med J Malaysia* 2013;68:459–64.

64 Vedanthan R, Kamano JH, DeLong AK, *et al*. Community Health Workers Improve Linkage to Hypertension Care in Western Kenya. *J Am Coll Cardiol* 2019;74:1897–906.
65 Vedanthan R, Kamano JH, Naanyu V, *et al*. Optimizing linkage and retention to hypertension care in rural Kenya (LARK hypertension study): study protocol for a randomized controlled trial. *Trials* 2014;15:143.
66 Wahab KW, Owolabi M, Akinyemi R, *et al*. Short-term pilot feasibility study of a nurse-led intervention to improve blood pressure control after stroke in Nigeria. *J Neurol Sci* 2017;377:116–20.
67 Jagannathan R, Patel SA, Ali MK, *et al*. Global updates on cardiovascular disease mortality trends and attribution of traditional risk factors. *Curr Diab Rep* 2019;19:44.
68 Jeemon P, Gupta R, Onen C. In: Prabhakaran D, Anand S, Gaziano TA, eds. *Management of hypertension and dyslipidemia for primary prevention of cardiovascular diseases*. World Bank Publications, 2017: 444.
69 Noone C, Leahy J, Morrissey EC, *et al*. Comparative efficacy of exercise and anti-hypertensive pharmacological interventions in reducing blood pressure in people with hypertension: a network meta-analysis. *Eur J Prev Cardiol* 2020;27:247–55.
70 Burnier M. Drug adherence in hypertension. *Pharmacol Res* 2017;125:142–9.
71 GBD 2017 Causes of Death Collaborators. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the global burden of disease study 2017. *Lancet* 2018;392:1736–88.
72 Nielsen J Ø, Shrestha AD, Neupane D, *et al*. Non-adherence to anti-hypertensive medication in low- and middle-income countries: a systematic review and meta-analysis of 92443 subjects. *J Hum Hypertens* 2017;31:14–21.
73 Ajiboye RO, Okafor NA, Abiodun IO. Knowledge and practice of lifestyle modification among hypertensive patients in a general Hospital Lagos. *Indian J Commun Health* 2015;27:143–9.
74 Tedla YG, Bautista LE. Drug side effect symptoms and adherence to antihypertensive medication. *Am J Hypertens* 2016;29:772–9.
75 Goel MK. Non-adherence to anti-hypertensive treatment. *Indian J Commun Health* 2020;32:126–9.
76 Xu T, Yu X, Ou S, *et al*. Adherence to antihypertensive medications and stroke risk: a dose-response meta-analysis. *J Am Heart Assoc* 2017;6. doi:10.1161/JAHA.117.006371. [Epub ahead of print: 25 Jul 2017].
77 WHO. *Noncommunicable diseases country profiles*. Geneva: World Health Organization, 2018.
78 Nieuwlaat R, Wilczynski N, Navarro T, *et al*. Interventions for enhancing medication adherence. *Cochrane Database Syst Rev* 2014;11:CD000011.
79 Ayodele OE, Alebiosu CO, Akinwusi PO, *et al*. Target organ damage and associated clinical conditions in newly diagnosed hypertensives attending a tertiary health facility. *Niger J Clin Pract* 2007;10:319–25.
80 Hypertension guideline working group, Seedat YK, Rayner BL, *et al*. South African hypertension practice guideline 2014. *Cardiovasc J Afr* 2014;25:288–94.
81 Börjesson M, Onerup A, Lundqvist S, *et al*. Physical activity and exercise lower blood pressure in individuals with hypertension: narrative review of 27 RCTs. *Br J Sports Med* 2016;50:356–61.
82 Cernota MD. Randomized controlled trials on prevention, diagnosis and treatment of hypertension in Africa, a systematic review 2020.
83 United Nations. World population prospects, 2019. Department of economic and social Affairs, population division. Available: https://population.un.org/wpp/Download/Standard/Population/ [Accessed 21 Sep 2020].
84 Gomez F, Hirbo J, Tishkoff SA. Genetic variation and adaptation in Africa: implications for human evolution and disease. *Cold Spring Harb Perspect Biol* 2014;6:a008524.

Search strategies

Medline (Ovid): Search on CVDs

Nr.	Searches (24th July 2017)	Results
Indication		
1.	exp heart diseases/	
2.	exp vascular diseases/	
3.	cerebrovascular disorders/	
4.	exp brain ischemia/	
5.	exp carotid artery diseases/	
6.	exp dementia, vascular/	
7.	exp intracranial arterial diseases/	
8.	exp intracranial embolism/ and thrombosis/	
9.	exp intracranial hemorrhages/	
10.	exp stroke/	
11.	exp hyperlipidemias/	
12.	Exp hypercholesteremia/	
13.	exp Myocardial Ischemia/	
14.	angina.tw	
15.	(heart adj3 disease$).tw.	
16.	(coronary adj3 disease$).tw.	
17.	(peripheral adj3 disease$).tw.	
18.	(cerebrovascular disease).tw	
19.	Renal artery stenosis.tw	
20.	(Aortic aneurism or Aneurysm$).tw	
21.	myocardial infarct$.tw.	
22.	exp Myocardial Revascularization/	
23.	(coronary adj3 bypass$).tw.	
24.	(coronary adj3 angioplast$).tw.	
25.	(heart adj3 infarct$).tw.	
26.	postmyocardial infarct$.tw.	
27.	cardiovascular diseases/	
28.	Hypertens$.tw	
29.	(high adj2 blood pressure).tw	
30.	(blood pressure control).tw	
31.	Hypertensive heart disease.tw.	
32.	Cardiomyopath$.tw.	
33.	Heart failure.tw.	

Nr.	Searches (24th July 2017)	Results
34.	(Pulmonary heart disease).tw	
35.	Cardiac dysrhythmia*.tw.	
36.	Inflammatory heart disease.tw.	
37.	Endocarditis.tw.	
38.	Cardiomegaly.tw	
39.	Valvular heart disease.tw.	
40.	Rheumatic heart disease.tw	
41.	Myocarditis.tw	
42.	Arrhythmi$.tw	
43.	Vasculitis.tw	
44.	**or/1-43**	**2 498 192**
Africa and African countries		
45.	Africa.tw	
46.	Exp Africa/	
47.	Algeria$.tw or exp Algeria/	
48.	Angol$.tw or exp Angola/	
49.	Benin$.tw or exp Benin/	
50.	Botswan$.tw or exp Botswana/	
51.	Burkina Faso.tw or exp Burkina Faso/	
52.	Burund$.tw or exp Burundi/	
53.	Cameroon$.tw or exp Cameroon/	
54.	Cape Verde.tw or exp Cape Verde/	
55.	Central African Republic$.tw or exp Central African Republic/	
56.	Chad$.tw or exp Chad/	
57.	Comoros$.tw or exp Comoros/	
58.	Cote d'Ivoire.tw or exp Cote d'Ivoire/	
59.	Democratic Republic of Congo.tw or exp Democratic Republic of Congo	
60.	Djibout$.tw or exp Djibouti/	
61.	Egypt$.tw or exp Egypt/	
62.	Equatorial Guinea$.tw or exp Equatorial Guinea/	
63.	Eritrea$.tw or exp Eritrea/	
64.	Ethiop$.tw or exp Ethiopia/	
65.	Gabon$.tw or exp Gabon/	
66.	Gambia$.tw or exp Gambia/	
67.	Ghana$.tw or exp Ghana/	
68.	Guinea$.tw or exp Guinea/	
69.	Guinea-Bissau.tw or exp Guinea-Bissau/	

Nr.	Searches (24th July 2017)	Results
70.	Kenya$.tw or exp Kenya/	
71.	Lesoth$.tw or exp Lesotho/	
72.	Liberia$.tw or exp Liberia/	
73.	Libya$.tw or exp Libya/	
74.	Madagascar$.tw or exp Madagascar/	
75.	Malawi$.tw or exp Malawi/	
76.	Mali.tw or exp Mali/	
77.	Mauritania$.tw or exp Mauritania/	
78.	Mauritius$.tw or exp Mauritius/	
79.	Morocc$.tw or exp Morocco/	
80.	Mozambique$.tw or exp Mozambique/	
81.	Namibia$.tw or exp Namibia/	
82.	Niger.tw or exp Niger/	
83.	Nigeria$.tw or exp Nigeria/	
84.	Rwanda$.tw or exp Rwanda/	
85.	(Sao Tome and Principe).tw	
86.	Senegal$.tw or exp Senegal/	
87.	Seychell$.tw	
88.	Sierra Leone.tw or exp Sierra Leone/	
89.	Somalia$.tw or exp Somalia/	
90.	South Africa$.tw or exp South Africa.de	
91.	South Sudan.tw or exp South Sudan/	
92.	Sudan$.tw or exp Sudan/	
93.	Swaziland$.tw or exp Swaziland/	
94.	Tanzania$.tw or exp Tanzania/	
95.	Togo$.tw or exp Togo/	
96.	Tunisia$.tw or exp Tunisia/	
97.	Uganda$.tw or exp Uganda/	
98.	Zambia$.tw or exp Zambia/	
99.	Zimbabwe$.tw or exp Zimbabwe/	
100.	Somaliland$.tw or exp Somaliland/	
101.	#1.tw	
102.	or/45-101	436 084
103.	44 and 102	19 017
Study design		
104.	randomized controlled trial.pt.	
105.	controlled clinical trial.pt.	

Nr.	Searches (24th July 2017)	Results
106.	randomized.ab.	
107.	placebo.ab.	
108.	randomly.ab.	
109.	trial.ab.	
110.	groups.ab.	
111.	or/104-110	2 535 560
112.	exp animals/ not humans.sh.	
113.	111 not 112	2 133 129
114.	103 and 113	**2643**

Medline (Ovid): Update on hypertension

Nr.	Searches (23th June 2020)	Results
Indication		
1.	Exp hypertension	
2.	Hypertens$.ti,ab	
3.	(high adj2 blood pressure).ti,ab	
4.	(blood pressure control).ti,ab	
5.	**or/1-4**	464 555
Africa and African countries		
6.	Africa.tw	
7.	Exp Africa/	
8.	Algeria$.tw or exp Algeria/	
9.	Angol$.tw or exp Angola/	
10.	Benin$.tw or exp Benin/	
11.	Botswan$.tw or exp Botswana/	
12.	Burkina Faso.tw or exp Burkina Faso/	
13.	Burund$.tw or exp Burundi/	
14.	Cameroon$.tw or exp Cameroon/	
15.	Cape Verde.tw or exp Cape Verde/	
16.	Central African Republic$.tw or exp Central African Republic/	
17.	Chad$.tw or exp Chad/	
18.	Comoros$.tw or exp Comoros/	
19.	Cote d'Ivoire.tw or exp Cote d'Ivoire/	
20.	Democratic Republic of Congo.tw or exp Democratic Republic of Congo	
21.	Djibout$.tw or exp Djibouti/	

Nr.	Searches (23th June 2020)	Results
22.	Egypt$.tw or exp Egypt/	
23.	Equatorial Guinea$.tw or exp Equatorial Guinea/	
24.	Eritrea$.tw or exp Eritrea/	
25.	Ethiop$.tw or exp Ethiopia/	
26.	Gabon$.tw or exp Gabon/	
27.	Gambia$.tw or exp Gambia/	
28.	Ghana$.tw or exp Ghana/	
29.	Guinea$.tw or exp Guinea/	
30.	Guinea-Bissau.tw or exp Guinea-Bissau/	
31.	Kenya$.tw or exp Kenya/	
32.	Lesoth$.tw or exp Lesotho/	
33.	Liberia$.tw or exp Liberia/	
34.	Libya$.tw or exp Libya/	
35.	Madagascar$.tw or exp Madagascar/	
36.	Malawi$.tw or exp Malawi/	
37.	Mali.tw or exp Mali/	
38.	Mauritania$.tw or exp Mauritania/	
39.	Mauritius$.tw or exp Mauritius/	
40.	Morocc$.tw or exp Morocco/	
41.	Mozambique$.tw or exp Mozambique/	
42.	Namibia$.tw or exp Namibia/	
43.	Niger.tw or exp Niger/	
44.	Nigeria$.tw or exp Nigeria/	
45.	Rwanda$.tw or exp Rwanda/	
46.	(Sao Tome and Principe).tw	
47.	Senegal$.tw or exp Senegal/	
48.	Seychell$.tw	
49.	Sierra Leone.tw or exp Sierra Leone/	
50.	Somalia$.tw or exp Somalia/	
51.	South Africa$.tw or exp South Africa.de	
52.	South Sudan.tw or exp South Sudan/	
53.	Sudan$.tw or exp Sudan/	
54.	Swaziland$.tw or exp Swaziland/	
55.	Tanzania$.tw or exp Tanzania/	
56.	Togo$.tw or exp Togo/	
57.	Tunisia$.tw or exp Tunisia/	
58.	Uganda$.tw or exp Uganda/	

Nr.	Searches (23th June 2020)	Results
59.	Zambia$.tw or exp Zambia/	
60.	Zimbabwe$.tw or exp Zimbabwe/	
61.	Somaliland$.tw or exp Somaliland/	
62.	Sahrawi Arab Democratic Republic.tw.	
63.	or/6-62	530 370
Study design		
64.	randomized controlled trial.pt.	
65.	controlled clinical trial.pt.	
66.	(randomized or randomised or randomly).ti,ab	
67.	placebo.ab.	
68.	trial.ab.	
69.	groups.ab.	
70.	or/64-69	2 757 989
71.	5 and 63 and 70	3036
72.	exp animals/ not humans.sh.	
73.	71 not 72	
74.	73 not (comment or editorial).pt	2964
75.	Limit 74 to yr= "2017-Current"	**538**

CENTRAL: Search on CVDs

Nr.	Searches (14th August 2017)	Results
1	Africa, explode all trees	
2	Algeria* or Angol* or Benin* or Botswan*	
3	(Burkina Faso) or Burund* or Cameroon* or (Cape Verde) or (Central African Republic)	
4	Chad* or Comoros* or Cote d'Ivoire or Congo*	
5	Djibout* or Egypt* or (Equatorial Guinea*) or Eritrea*	
6	Ethiop* or Gabon* or Gambia* or Ghana* or Guinea* or Guinea-Bissau	
7	Kenya* or Lesoth* or Liberia* or Libya* or Madagascar* or Malawi*	
8	Mali* or Mauritania* or Mauritius* or Morocc* or Mozambique* or Namibia* or Niger*	
9	Nigeria* or Rwanda* or (Sao Tome and Principe) or Senegal* or Seychell*	
10	Sierra Leone or Somalia* or (South Africa) or (South Sudan*) or Sudan* or Swasiland	
11	Tanzania* or Togo* or Tunisia* or Uganda* or Zambia* or Zimbabwe* or Somaliland or (Sahrawi Arab Democratic Republic)	
12	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11	39 610
13	MeSH descriptor Cardiovascular Diseases, this term only	
14	MeSH descriptor Heart Diseases explode all trees	
15	MeSH descriptor Vascular Diseases explode all trees	
16	MeSH descriptor Cerebrovascular Disorders, this term only	
17	MeSH descriptor Brain Ischemia explode all trees	
18	MeSH descriptor Carotid Artery Diseases explode all trees	
19	MeSH descriptor Dementia, Vascular explode all trees	
20	MeSH descriptor Intracranial Arterial Diseases explode all trees	
21	MeSH descriptor Intracranial Embolism and Thrombosis explode all trees	
22	MeSH descriptor Intracranial Hemorrhages explode all trees	
23	MeSH descriptor Stroke explode all trees	
24	MeSH descriptor Hyperlipidemias explode all trees (4197)	
25	(coronar* or heart or peripheral* or cerebrovascular* or myocardial) near 3 (disease or infarct*)	
26	myocardi* near 3 (infarct* or revascular* or ischaem* or ischem*)	
27	vascular* near 3 (peripheral* or disease* or complication*))	
28	hypertensi* or (high near 2 blood pressure)	
29	(heart near 2 failure) or stroke	
30	Endocarditis or myocarditis or Cardiomegaly or arrythmi*	
31	#13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30	101 472
32	#12 and #31	4139
32	Trials	**2008**

CENTRAL, Update on hypertension

Nr.	Searches (23th June 2020)	Results
1	Africa, explode all trees	
2	Algeria* or Angol* or Benin* or Botswan*	
3	(Burkina Faso) or Burund* or Cameroon* or (Cape Verde) or (Central African Republic)	
4	Chad* or Comoros* or Cote d'Ivoire or Congo*	
5	Djibout* or Egypt* or (Equatorial Guinea*) or Eritrea*	
6	Ethiop* or Gabon* or Gambia* or Ghana* or Guinea* or Guinea-Bissau	
7	Kenya* or Lesoth* or Liberia* or Libya* or Madagascar* or Malawi*	
8	Mali* or Mauritania* or Mauritius* or Morocc* or Mozambique* or Namibia* or Niger*	
9	Nigeria* or Rwanda* or (Sao Tome and Principe) or Senegal* or Seychell*	

Nr.	Searches (23th June 2020)	Results
10	Sierra Leone or Somalia* or (South Africa) or (South Sudan*) or Sudan* or Swasiland	
11	Tanzania* or Togo* or Tunisia* or Uganda* or Zambia* or Zimbabwe* or Somaliland or (Sahrawi Arab Democratic Republic)	
12	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11	60 623
13	MeSH descriptor: [Hypertension] explode all trees	
14	hypertensi* or (high near 2 blood pressure)	
15	#13 or #14	67 954
16	#12 and #15	2929
	Trials, 2017-Current	**333**

CINAHL, Search on 23.06.2020

(Africa$ or Africa$ or Algeria$ or Angol$ or Benin$ or Botswan$ or (Burkina Faso) or Burund$ or Cameroon$ or (Cape Verde) or (Central African Republic) or Chad$ or Comoros$ or Cote d'Ivoire or Congo$ Djibout$ or Egypt$ or (Equatorial Guinea$) or Eritrea$ or Ethiop$ or Gabon$ or Gambia$ or Ghana$ or Guinea$ or Guinea-Bissau or Kenya$ or Lesoth$ or Liberia$ or Libya$ or Madagascar$ or Malawi$ or Mali$ or Mauritania$ or Mauritius$ or Morocc$ or Mozambique$ or Namibia$ or Niger$ or Nigeria$ or Rwanda$ or (Sao Tome and Principe) or Senegal$ or Seychell$ or Sierra Leone or Somalia$ or (South Africa) or (South Sudan$) or Sudan$ or Swasiland or Tanzania$ or Togo$ or Tunisia$ or Uganda$ or Zambia$ or Zimbabwe$ or Somaliland or (Sahrawi Arab Democratic Republic)) in Abstract
AND
hypertension or high blood pressure or elevated blood pressure or htn or hypertensive in Abstract
AND
randomized or rct or randomised in Abstract
AND
In English
AND
Peer-reviewed
And
Humans
Total: 42 results

International Clinical Trials Registry Platform (http://apps.who.int/trialsearch/AdvSearch.aspx), Search on 22 October 2019

hypertension or (blood pressure control) or (high blood pressure) in the condition,

Recruitment status: all

Countries of recruitment:

- Africa or African in the title: 90 trials
- Algeria or Angola or Behin or Burkina Faso or Botswana or Burundi or Cameroon or Central Africa Republic or Chad or Congo or Cabo Verde or Cite D'Ivoire: 13 trials
- Democratic Republic of Congo or Djibouti or Egypt or Equatorial Guinea or Eritrea or Ethiopia or Gabon or Gambia or Ghana or Guinea or Guinea-Bissau or Kenya: 78 trials
- Lesotho or Liberia or Libya or Madagascar or Malawi or Mali or Mauritius or Morocco or Mozambique: 14 trials
- Namibia or Niger or Nigeria or Rwanda or Sao Tome andPrincipe or Senegal or Seychelles or Sierra Leone or Somalia or Sudan or South Sudan or Swaziland: 23 trials
- Togo or Tunezia or United Republic of Tanzania or Uganda or Zambia or Zimbabwe: 25 trials

Total: 18 results

Heart failure (N=13)

1. Adigun AQ, Ajayi OE, Sofowora GG, Ajayi AA (1998) Vasodilator therapy of hypertensive acute left ventricular failure: comparison of captopril-prazosin with hydralazine-isosorbide dinitrate. International Journal of Cardiology, 67(1):81-6.

2. Ajayi AA, Balogun MO, Oyewo EA, Ladipo GO (1989) Enalapril in African patients with congestive cardiac failure. British Journal of Clinical Pharmacology, 27(3):400-3.

3. Ajayi AA, Sofowora GG, Adigun AQ, Asiyanbola B (2003) Adjunctive sympathoplegic therapy to ACE inhibition in Blacks with congestive heart failure: a comparison of alpha-1 with beta-1 blockade on exercise tolerance and cardiac sympathovagal reflex activity. Ethnicity & Disease, 13(1):71-9.

4. Ajiboye OA, Anigbogu CN, Ajuluchukwu JN, Jaja SI (2013) Therapeutic Effects of Exercise Training On Selected Cardio-Pulmonary Parameters and Body Composition of Nigerians with Chronic Heart Failure (A Preliminary Study). Nigerian Quarterly Journal of Hospital Medicine, 23(4):295-301.

5. Ajiboye OA, Anigbogu CN, Ajuluchukwu JN, Jaja SI (2015) Exercise training improves functional walking capacity and activity level of Nigerians with chronic biventricular heart failure. Hong Kong Physiotherapy Journal 33(1): 42-9.

6. Ibrahim MH, Elmahdy MA (2014) Improvement of exercise performance and ventilator efficiency in patients with chronic heart failure after sildenafil use for 8 weeks. Egyptian Journal of Chest Diseases and Tuberculosis 63(2): 477-81.

7. Mahgoub AA, El-Medany AH, Abdulatif AS (2002) A comparison between the effects of diltiazem and isosorbide dinitrate on digoxin pharmacodynamics and kinetics in the treatment of patients with chronic ischemic heart failure. Saudi Medical Journal, 23(6):725-31.

8. Mansour S, Youssef A, Rayan M, Ayman Saleh M (2011) Efficacy of ivabradine in idiopathic dilated cardiomyopathy patients with chronic heart failure. Egyptian Heart Journal63(2):79-85.

9. Marcus RH, Raw K, Patel J, Mitha A, Sareli P (1990) Comparison of intravenous amrinone and dobutamine in congestive heart failure due to idiopathic dilated cardiomyopathy. American journal of cardiology 66(15):1107-12.

10. Nouira S, Boukef R, Bouida W, Kerkeni W, Beltaief K, Boubaker H, et al. (2011) Noninvasive pressure support ventilation and CPAP in cardiogenic pulmonary edema: a multicenter randomized study in the emergency department. Intensive care medicine, 37(2):249-56.

11. Sliwa K, Damasceno A, Davison BA, Mayosi BM, Sani MU, Ogah O, et al. (2016) Bitreatment with hydralazine/nitrates vs. placebo in Africans admitted with acute Heart Failure (BA-HEF). European Journal of Heart Failure, 18(10):1248-58.

12. Sliwa K, Norton GR, Kone N, Candy G, Kachope J, Woodiwiss AJ, et al. (2004) Impact of initiating carvedilol before angiotensin-converting enzyme inhibitor therapy on cardiac function in newly diagnosed heart failure. Journal of the American College of Cardiology, 44(9):1825-30.

13. Wisenbaugh T, Katz I, Davis J, Essop R, Skoularigis J, Middlemost S, et al. (1993) Longterm (3-month) effects of a new beta-blocker (nebivolol) on cardiac performance in dilated cardiomyopathy. Journal of the American College of Cardiology, 21(5):1094-100.

Coronary heart disease (N=7)

1. Adel M, Mansour S, Sabri NA, Badary OA, Ayman Saleh M (2016) A clinical study evaluating the effect of ivabradine on inflammation in patients with non ST-segment elevation acute coronary syndromes. International Journal of Pharmaceutical Sciences and Research, 7(4):1441-9.

2. Ahmed RM, Mohamed el HA, Ashraf M, Maithili S, Nabil F, Rami R, et al. (2013) Effect of remote ischemic preconditioning on serum troponin T level following elective percutaneous coronary intervention. Catheterization & Cardiovascular Interventions, 82(5):E647-53.

3. Coetzee A, Roussouw G, Macgregor L (1996) Failure of allopurinol to improve left ventricular stroke work after cardiopulmonary bypass surgery. Journal of cardiothoracic and vascular anesthesia, 10(5):627-33.

4. Hamza MA, Galal A, Suweilam S, Ismail M (2014) Local intracoronary eptifibatide versus mechanical aspiration in patients with acute ST-elevation myocardial infarction. International journal of vascular medicine. Available from: http://onlinelibrary.wiley.com/o/cochrane/clcentral/articles/189/CN-00995189/frame.html

5. Harilall Y, Adam JK, Biccard BM, Reddi A (2014) The effect of optimising cerebral tissue oxygen saturation on markers of neurological injury during coronary artery bypass graft surgery. Heart, Lung & Circulation, 23(1):68-74.

6. Nassar YS, Laimud M, Afify M, Shawky MA (2014) Platelet aggregation inhibition by Eptifibatide versus high dose Tirofiban during primary percutaneous interventions. Egyptian Heart Journal, 66(3): 241-50.

7. Shehata M, Fayez G, Nassar A (2015) Intensive Statin Therapy in NSTE-ACS Patients Undergoing PCI: Clinical and Biochemical Effects. Texas Heart Institute Journal, 42(6):528-36.

Pharmacotherapy for hypertension (N=76)

1. Abengowe CU (1985) A double-blind comparison of acebutolol (Sectral) and propranolol (Inderal) in the treatment of hypertension in black Nigerian patients. Journal of International Medical Research. 13(2):116-21

2. Abson CP, Levy LM, Eyherabide G (1981) Once-daily atenolol in hypertensive Zimbabwean blacks. A double-blind trial using two different doses. South African Medical Journal Suid-Afrikaanse Tydskrif Vir Geneeskunde 60(2):47-8.

3. Ahaneku JE, Agbedana OE, Taylor OG (1995) Relationship between body mass index (BMI) and changes in plasma total and HDL-cholesterol levels during treatment of hypertension in African patients. Acta Medica Okayama. 49(5):267.

4. Ajayi AA, Oyewo EA, Ladipo GO, Akinsola A (1989) Enalapril and hydrochlorothiazide in hypertensive Africans. European Journal of Clinical Pharmacology. 36(3):229-34.

5. Ajayi AA, Akintomide AO (1995) The efficacy and tolerability of amlodipine and hydrochlorothiazide in Nigerians with essential hypertension. Journal of the National Medical Association. 87(7):485-8.

6. Bosman AR, Goldberg B, McKechnie JK, Offermeier J, Oosthuizen OJ (1977) South African multicentre study of metoprolol and propranolol in essential hypertension. South African Medical Journal Suid-Afrikaanse Tydskrif Vir Geneeskunde. 51(3):57-61.

7. Cilliers AJ (1979) Atenolol as primary therapy in previously untreated hypertensives and as an adjuvant to other therapy. A South African Multicentre Study. South African Medical Journal Suid-Afrikaanse Tydskrif Vir Geneeskunde. 55(9):321-4.

8. Daniels AR, Opie LH (1987) Monotherapy with the calcium channel antagonist nisoldipine for systemic hypertension and comparison with diuretic drugs. American journal of cardiology 60(8): 703-7.

9. Dean G, Louw S, Hersch C, Kirsten HO, Brereton DN, Finnemore L, et al. (1971) A double-blind trial in hypertension comparing Baycaron (FBA 1500), hydrochlorothiazide and placebo. South African Medical Journal Suid-Afrikaanse Tydskrif Vir Geneeskunde. 45(12):323.

10. Djoumessi RN, Noubiap JJ, Kaze FF, et al. (2016) Effect of low-dose spironolactone on resistant hypertension in type 2 diabetes mellitus: a randomized controlled trial in a sub- Saharan African population. BMC Res Notes. 9:187.

11. Fadayomi MO, Akinroye KK, Ajao RO, Awosika LA (1986) Monotherapy with nifedipine for essential hypertension in adult blacks. Journal of Cardiovascular Pharmacology. 8(3):466-9.

12. Farag, SM, Rabea HM, Mahmoud HB (2018) Effect of Amlodipine/Valsartan Versus Nebivolol/Valsartan Fixed Dose Combinations on Peripheral and Central Blood Pressure. High Blood Pressure & Cardiovascular Prevention. 25:407-13.

13. Goodman C, Rosendorff C, Coull A (1985) Comparison of the antihypertensive effect of enalapril and propranolol in black South Africans. South African Medical Journal Suid-Afrikaanse Tydskrif Vir Geneeskunde. 67(17):672-6.

14. Habte B (1992) The efficacy of hydrochlorothiazide, timolol and enalapril in Ethiopians with essential hypertension. Ethiop Med J 30: 163–7.

15. Isles CG, Johnson AO, Milne FJ (1986) Slow release nifedipine and atenolol as initial treatment in blacks with malignant hypertension. British journal of clinical pharmacology 21(4): 377-83.

16. Iyalomhe GB, Omogbai EK, Isah AO, Iyalomhe OO, Dada FL, Iyalomhe SI (2013) Efficacy of initiating therapy with amlodipine and hydrochlorothiazide or their combination in hypertensive Nigerians. Clinical & Experimental Hypertension 35(8):620-7.

17. Iyalomhe GBSOEKIIOOBISI. (2013)Long-term effects of amlodipine and hydrochlorothiazide combination therapy on creatinine clearance in hypertensive Nigerians. Global journal of pharmacology. 7(1): 45-51.

18. Iyalomhe GBS, Omogbai EKI, Ozolua RI (2007) Antihypertensive and some biochemical effects of hydrochlorothiazide and furosemide in some Nigerians. Journal of medical sciences (Taipei, Taiwan) 7(6): 977-83.

19. Iyalomhe GBS, Omogbai EKI, Ozolua RI, Iyalomhe OOB (2008) Effects of hydrochlorothiazide and furosemide on creatinine clearance in some hypertensive Nigerians. African journal of biotechnology 7 (7): 848-51.

20. Leary WP, Maharaj B (1990) Comparison of felodipine and hydrochlorothiazide for the treatment of mild to moderate hypertension in black Africans. Journal of Cardiovascular Pharmacology. 15 Suppl 4:S91-3.

21. Leary WP, Reyes AJ, Byl K, Maharaj B (1987) Comparative antihypertensive effects of ketanserin and a ketanserin-hydrochlorothiazide combination administered once daily. Journal of cardiovascular pharmacology 10 Suppl 3: 127-34.

22. Leary WP, Reyes AJ, Maharaj B, Byl K (1991) Time course of the blood pressure response to oral isradipine in uncomplicated mild-to-moderate essential hypertension. American journal of hypertension 4(2 Pt 2): 147-50.

23. Levenstein JH (1978) Oxprenolol slow-release with cyclopenthiazide-KCl compared with methyldopa in the treatment of essential hypertension. A multicentre general practice trial. South African Medical Journal Suid-Afrikaanse Tydskrif Vir Geneeskunde. 54(21):860-4.

24. Lubbe WF (1974) Clonidine in the management of uncontrolled hypertension. South African medical journal 48(10): 391-6.

25. Mabadeje AFB (1977) Controlled clinical trial between oxprenolol and methyldopa in hypertensive Nigerians. Current therapeutic research - clinical and experimental 22(3): 391-7.

26. Mabadeje AF, Adebayo GI (1989) Comparative effects of labetalol and bromazepam on ambulatory blood pressure of Nigerians with labile and stress hypertension. Clinical &Experimental Hypertension - Part A, Theory & Practice. 11 Suppl 1:441-7.

27. Maharaj B, Byl K (1992) A comparison of the acute hypotensive effects of two different doses of nifedipine. American heart journal 124(3): 720-5.

28. Maharaj B, Byl K (1993) Randomised double-blind comparative study of efficacy and safety of hydroflumethiazide and reserpine and chlortalidone and atenolol in the treatment of mild to moderate hypertension in black patients. Journal of human hypertension 7(5): 447-50.

29. Maharaj B, Byl K (1993) A comparative study of isradipine SRO and enalapril in black patients with mild-to-moderate hypertension. American journal of hypertension 6(3 Pt 2): 80-1.

30. Mangoush M, Singh NK, Kumar S, Basha A, Gupta BS, Bolya YK, et al. (1990) Efficacy of enalapril in essential hypertension and its comparison with atenolol. Postgraduate medical journal 66 (776): 446-9.

31. Manyemba J (1997) A randomised crossover comparison of reserpine and sustained-release nifedipine in hypertension. Central African Journal of Medicine. 43(12):344-9.

32. M'Buyamba-Kabangu JR, Anisiuba BC, Ndiaye MB, Lemogoum D, Jacobs L, Ijoma CK, et al. (2013) Efficacy of newer versus older antihypertensive drugs in black patients living in sub-Saharan Africa. Journal of Human Hypertension. 27(12):729-35.

33. Osakwe CE, Jacobs L, Anisiuba BC, Ndiaye MB, Lemogoum D, Ijoma CK, et al. (2014) Heart rate variability on antihypertensive drugs in black patients living in sub-Saharan Africa. Blood Pressure, 23(3):174-80.

34. M'Buyamba-Kabangu JR, Lepira B, Lijnen P, Tshiani K, Fagard R, Amery A (1988) Intracellular sodium and the response to nitrendipine or atenolol in African blacks. Hypertension. 11(1):100-5

35. Mengesha HG, Welegerima AH, Hadgu A, Temesgen H, Otieno MG, Tsegay K, Fisseha T, Getachew S, Merha Z, Tewodros H, Dabessa J, Gebreegzabher B, Petrucka P (2018) Comparative effectiveness of antihypertensive drugs prescribed in Ethiopian healthcare practice: A pilot prospective, randomized, open label study. PLoS ONE 13(9): e0203166. https://doi.org/10.1371/journal.pone.0203166.

36. Middlemost SJ, Tager R, Davis J, Sareli P (1994) Effectiveness of enalapril in combination with low-dose hydrochlorothiazide versus enalapril alone for mild to moderate systemic hypertension in black patients. American journal of cardiology 73(15):1092-7.

37. Mngola EN (1980) The use of a spironolactone and althiazide combination (aldactacine) in the treatment of benign essential hypertension. Journal of International Medical Research. 8(3):199-204.

38. Norton GR, Woodiwiss AJ, Hartford C, Trifunovic B, Middlemost S, Lee A, et al. (1999) Sustained antihypertensive actions of a dual angiotensin-converting enzyme neutral endopeptidase inhibitor, sampatrilat, in black hypertensive subjects. American journal of hypertension 12(6): 563-71.

40. Nwachukwu DC, Aneke E, Nwachukwu NZ, Obika LF, Nwagha UI, Eze AA (2015) Effect of Hibiscus sabdariffaon blood pressure and electrolyte profile of mild to moderate hypertensive Nigerians: A comparative study with hydrochlorothiazide. Nigerian Journal of Clinical Practice. 18(6):762-70.

41. Nwachukwu DC, Aneke EI, Nwachukwu NZ, Azubike N, Obika LF (2017) Does consumption of an aqueous extract of Hibscus sabdariffa affect renal function in subjects with mild to moderate hypertension? Journal of Physiological Sciences: JPS, 67(1):227-34.

42. Nwachukwu DC, Aneke EI, Obika LF, Nwachukwu NZ (2015) Effects of aqueous extract of Hibiscus sabdariffa on the renin-angiotensin-aldosterone system of Nigerians with mild to moderate essential hypertension: A comparative study with lisinopril. Indian Journal of Pharmacology, 47(5):540-5.

43. Nwachukwu DC, Eze AA, Nwachukwu NZ, Aneke EI, Agu PU, Azubike NC, et al.(2017) Monotherapy with amlodipine or hydrochlorothiazide in patients with mild to moderate hypertension: Comparison of their efficacy and effects on electrolytes, Malawi Medical Journal 29 (2): 108-112.

44. Obel AO, Gitau W (1981) Comparison of the antihypertensive effect of metipranolol, butizide and torrat in Kenyan Africans. East African Medical Journal. 58(11):867-71.

45. Obel AO (1983) A comparison of timolol plus hydrochlorothiazide plus amiloride and methyldopa in essential hypertension in Black Africans. Tropical & Geographical Medicine. 35(3):285-91.

46. Obel A, Griffin L, Were J (1984) Comparison of slow-release frusemide (Lasix Retard) and bendrofluazide in the treatment of moderate hypertension in Kenyan negroes. Clinical trials 1(6): 443-50.

47. Obel AO (1989) Placebo-controlled trial of potassium supplements in black patients with mild essential hypertension. Journal of cardiovascular pharmacology 14(2): 294-6.

48. Obel AO (1989) Effects of chlorthalidone, oxprenolol, and their combination in hypertensive blacks: a randomized double-blind crossover study. Journal of cardiovascular pharmacology 13(3): 465-70.

49. Obel AO (1990) Efficacy and tolerability of long term oxprenolol and chlorthalidone singly and in combination in hypertensive blacks. Japanese heart journal 31(2): 183-92.

50. Obel AO, Koech DK. (1991) Potassium supplementation versus bendrofluazide in mildly to moderately hypertensive Kenyans. Journal of Cardiovascular Pharmacology. 17(3):504-7.

51. Ogola EN, Yonga GO (1993) Comparative study of the efficacy and tolerability of hydroflumethiazide versus propranolol in Africans with mild to moderate hypertension. East African Medical Journal. 70(5):277-9.

52. Ojii DB, Mayosi B, Francis V, Badri M, Cornelius V, Poulter N et al. (2019) Comparison of Dual Therapies for Lowering Blood Pressure in Black Africans. The New England Journal of Medicine 380:2429-2439.

53. Okeahialam BN, Ohihoin EN, Ajuluchukwu JN (2012) Diuretic drugs benefit patients with hypertension more with night-time dosing. Therapeutic Advances in Drug Safety, 3(6):273-8.

54. Onwubere BJ, Obodo JO, Oke DA, Okeahialam BN, Danbauchi SS, Mbakwem AC (2001) A randomised trial to compare the efficacy and safety of Felodipine (Plendil) and Nifedipine (Adalat) retard in patients with mild-to-moderate hypertension. West African Journal of Medicine. 20(4):196-202.

55. Opie LH, Müller FO, Myburgh DP, Rosendorff C, Sareli P, Seedat YK, et al. (1997) Efficacy and tolerability of nisoldipine coat-core formulation in the treatment of essential hypertension: the South African Multicenter ANCHOR Study. Ambulatory Nisoldipine Coat-Core Hypertension Outpatient Response (ANCHOR) Investigators. American journal of hypertension 10(3): 250-60.

56. Opie LH, Haus M, Commerford PJ, Levetan B, Moore K, Brink J (2002) Antihypertensive effects of angiotensin converting enzyme inhibition by lisinopril in post-transplant patients. American journal of hypertension 15(10 Pt 1): 911-6.

57. Poulter NR, Sanderson JE, Thompson AV, Sever PS, Chang CL (1993) Comparison of nifedipine and propranolol as second line agent for hypertension in black Kenyans. BMJ 306(6878): 621-2.

58. Radevski I, Skudicky D, Candy G, Sathekge S, Strugo V, Sareli P (1999) Antihypertensive monotherapy with nisoldipine CC is superior to enalapril in black patients with severe hypertension. American Journal of Hypertension. 12(2 Pt 1):194-203.

59. Radevski IV, Valtchanova ZP, Candy GP, Wald AM, Ngcezula T, Sareli P (2002). Comparison of indapamide and low-dose hydrochlorothiazide monotherapy in black patients with mild to moderate hypertension. South African Medical Journal Suid-Afrikaanse Tydskrif Vir Geneeskunde. 92(7):532-6.

60. Rogers, GG, Rosendorff C, Goodman C, Radford HM (1988) Effects of angiotensin converting enzyme inhibition and beta-blockade on exercise responses in hypertensive patients: Journal of Hypertension, 6 (4): 662–S665.

61. Salako LA, Falase AO, Aderounmu AF (1979) Placebo-controlled, double-blind clinical trial of alprenolol in African hypertensive patients. Current Medical Research & Opinion. 6(5):358-63.

62. Salako LA, Falase AO, Aderounmu AF (1979) Comparative beta-adrenoreceptor-blocking effects and pharmacokinetics or propranolol and pindolol in hypertensive Africans. Clinical Science. 57 Suppl 5:393-6.

63. Salako LA, Falase AO, Aderounmu AF, Walker O (1990) Assessment of a fixed-dosage combination of atenolol and chlorthalidone (Tenoretic) in hypertensive Nigerians. African Journal of Medicine & Medical Sciences. 19(1):57-61.

64. Salako BL, Kadiri S, Walker O, Fehintola FA (1998) Evaluation of lacidipine (a calcium blocker) in the treatment of hypertension in black African people: a double-blind comparison with hydrochlorothiazide. African Journal of Medicine & Medical Sciences. 27(1-2):73-5

65. Sareli P, Radevski IV, Valtchanova ZP, Libhaber E, Candy GP, Den Hond E, et al. (2001) Efficacy of different drug classes used to initiate antihypertensive treatment in black subjects: results of a randomized trial in Johannesburg, South Africa. Archives of Internal Medicine. 161(7):965-71.

66. Seedat YK (1980) Trial of atenolol and chlorthalidone for hypertension in black South Africans. British Medical Journal. 281(6250):1241-3.

67. Seedat YK, Parag KB (1987) A comparison of lisinopril and atenolol in black and Indian patients with mild-to-moderate essential hypertension. South African Medical Journal Suid-Afrikaanse Tydskrif Vir Geneeskunde. 71(3):149-53.

68. Seedat YK, Parag KB, Nathoo BC (1990) Nitrendipine in a fixed stepped-dose study compared with methyldopa in black and Indian hypertensive patients. Current therapeutic research - clinical and experimental 48(1): 10-9.

69. Skoularigis J, Eitzman L, Davis J, Strugo V, Sareli P (1994) Nifedipine versus captopril in the management of moderate hypertension in black patients. American journal of hypertension 7(5): 440-7.

70. Skoularigis J, Strugo V, Zambakides C, Eintracht S, Reddy K, Tshele E, et al. (1996) Comparison of captopril-thiazide and enalapril-thiazide combinations in the management of mild to moderate black hypertensive patients: how important is diuretic dose and duration of action of the ACE-inhibitor? International journal of clinical pharmacology and therapeutics 34(6): 263-8.

71. Sobngwi E, Mfeukeu-Kuate L, Kouam M, Tankeu AT, Nganou-Gnindjio CN, Hamadou B, et al. (2019) Short-term effects of perindopril-amlodipine vs perindopril-indapamide on blood pressure control in sub-Saharan type 2 diabetic individuals newly diagnosed for hypertension: A double-blinded randomized controlled trial, Journal of Clinical Hypertension. 21:1002-9.

72. Stein CM, Neill P, Kusemamuriwo T (1992) Antihypertensive effects of low doses of hydrochlorothiazide in hypertensive black Zimbabweans. International Journal of Cardiology. 37(2):231-5.

73. Venter CP, Joubert PH, Booyens J (1988) Effects of essential fatty acids on mild to moderate essential hypertension. Prostaglandins, leukotrienes, and essential fatty acids 33(1): 49-51.

74. Venter CP, Venter HL, Muntingh GL (1991) The effect of enalapril and prazosin on mild to moderate hypertension in black Africans. Results of a clinical trial. South African medical journal 80(7): 324-6.

75. Wadhawan DN (1981) Antihypertensive therapy with diuretics without potassium supplement. Medical journal of zambia 16(1): 4-6.

76. Wahab KW, Owolabi M, Akinyemi R, Jenkins C, Arulogun O, Akpa O, et al. (2017) Shortterm pilot feasibility study of a nurse-led intervention to improve blood pressure control after stroke in Nigeria. Journal of the Neurological Sciences. 377:116-20.

Adeyemo 2013

Adeyemo A, Tayo BO, Luke A, Ogedegbe O, Durazo-Arvizu R, Cooper RS. The Nigerian antihypertensive adherence trial: a community-based randomized trial. Journal of Hypertension. 2013.

DOI: https://doi.org/10.1007/s11892-019-1161-2

Akintunde 2018

Akintunde A, Nondi J, Gogo K, Jones ESW, Rayner BL, Hackam DG, et al. Physiological Phenotyping for Personalized Therapy of Uncontrolled Hypertension in Africa. Am J Hypertens. 2017.

DOI: https://doi.org/10.1093/ajh/hpx066

Aweto 2012

Aweto HA, Owoeye OB, Akinbo SR, Onabajo AA. Effects of dance movement therapy on selected cardiovascular parameters and estimated maximum oxygen consumption in hypertensive patients. Nigerian Quarterly Journal of Hospital Medicine. 2012.

PMID: https://europepmc.org/article/med/23175912

Ayodapo 2019

Ayodapo AO, Olukokun TAV. Lifestyle counselling and behavioural change: role among adult hypertensives in a rural tertiary institution. South African Family Practice. 2019.

DOI: https://doi.org/10.1080/20786190.2019.1569453

Bobrow 2016

Bobrow K, Farmer AJ, Springer D, Shanyinde M, Yu LM, Brennan T, et al. Mobile Phone Text Messages to Support Treatment Adherence in Adults With High Blood Pressure (SMS-Text Adherence Support [StAR]): A Single-Blind, Randomized Trial. Circulation. 2016.

DOI: https://doi.org/10.1161/CIRCULATIONAHA.115.017530

Leon N, Surender R, Bobrow K, Muller J, Farmer A. Improving treatment adherence for blood pressure lowering via mobile phone SMS-messages in South Africa: a qualitative evaluation of the SMS-text Adherence SuppoRt (StAR) trial. BMC Family Practice. 2015.

DOI: https://doi.org/10.1186/s12875-015-0289-7

Bolarinwa 2019

Bolarinwa OA, Juni MH, Nor Afiah MZ, Salmiah MS, Akande TM. Mid-term impact of home-based follow-up care on health-related quality of life of hypertensive patients at a teaching hospital in Ilorin, Nigeria. Niger J Clin Pract. 2019.

PMID: https://europepmc.org/article/med/30666023

Cappuccio 2006

Cappuccio FP, Kerry SM, Micah FB, Plange-Rhule J, Eastwood JB. A community programme to reduce salt intake and blood pressure in Ghana. BMC Public Health. 2006.

DOI: https://doi.org/10.1186/1471-2458-6-13

Charlton 2009

Charlton KE, Steyn K, Levitt NS, Peer N, Jonathan D, Gogela T, et al. A food-based dietary strategy lowers blood pressure in a low socio-economic setting: a randomised study in South Africa. Public Health Nutrition. 2008.

DOI: https://doi.org/10.1017/S136898000800342X

Fairall 2016

Fairall LR, Folb N, Timmerman V, Lombard C, Steyn K, Bachmann MO, et al. Educational Outreach with an Integrated Clinical Tool for Nurse-Led Non-communicable Chronic Disease Management in Primary Care in South Africa: A Pragmatic Cluster Randomised Controlled Trial. PLoS Medicine / Public Library of Science. 2016.

DOI: https://doi.org/10.1371/journal.pmed.1002178

Folb N, Timmerman V, Levitt NS, Steyn K, Bachmann MO, Lund C, et al. Multimorbidity, control and treatment of noncommunicable diseases among primary healthcare attenders in the Western Cape, South Africa. S Afr Med J. 2015.

DOI: http://dx.doi.org/10.7196/SAMJNEW.7882

Goudge 2018

Goudge J, Chirwa T, Eldridge S, Gómez-Olivé FXF, Kabudula C, Limbani F, et al. Can lay health workers support the management of hypertension? Findings of a cluster randomised trial in South Africa. BMJ Glob Health. 2018.

DOI: https://doi.org/10.1136/bmjgh-2017-000577

Gyamfi 2017

Gyamfi J, Plange-Rhule J, Iwelunmor J, Lee D, Blackstone SR, Mitchell A, et al. Training nurses in task-shifting strategies for the management and control of hypertension in Ghana: a mixed-methods study. BMC Health Serv Res. 2017.

DOI: https://doi.org/10.1186/s12913-017-2026-5

Ogedegbe G, Plange-Rhule J, Gyamfi J, Chaplin W, Ntim M, Apusiga K, et al. Health insurance coverage with or without a nurse-led task shifting strategy for hypertension control: A pragmatic cluster randomized trial in Ghana. PLoS Med. 2018.

DOI: https://doi.org/10.1371/journal.pmed.1002561

Ogedegbe G, Plange-Rhule J, Gyamfi J, Chaplin W, Ntim M, Apusiga K, et al. A cluster-randomized trial of task shifting and blood pressure control in Ghana: study protocol. Implement Sci. 2014.

DOI: https://doi.org/10.1186/1748-5908-9-73

Labhardt 2011

Labhardt ND, Balo JR, Ndam M, Manga E, Stoll B. Improved retention rates with low-cost interventions in hypertension and diabetes management in a rural African environment of nurse-led care: a cluster-randomised trial. Tropical Medicine & International Health. 2011.

DOI: https://doi.org/10.1111/j.1365-3156.2011.02827.x

Lamina 2010

Lamina S. Effects of continuous and interval training programs in the management of hypertension: a randomized controlled trial. Journal of clinical hypertension. 2010.

DOI: https://doi.org/10.1111/j.1751-7176.2010.00315.x

Lamina S. Comparative effect of interval and continuous training programs on serum uric acid in management of hypertension: a randomized controlled trial. Journal of Strength & Conditioning Research. 2011.

PMID: https://www.ncbi.nlm.nih.gov/pubmed/20574413

Lamina S, Okoye CG. Effect of low intensity continuous training programme on serum uric acid in the non pharmacological management of hypertension: a randomized controlled trial. Nigerian journal of medicine : journal of the national association of resident doctors of nigeria. 2010.

PMID: https://pubmed.ncbi.nlm.nih.gov/23672102/

Lamina S, Okoye CG. Uricaemia as a cardiovascular events risk factor in hypertension: the role of interval training programme in its downregulation. Journal of the Association of Physicians of India. 2011.

PMID: https://pubmed.ncbi.nlm.nih.gov/21751661/

Lamina S, Okoye CG. Effect of interval training program on white blood cell count in the management of hypertension: A randomized controlled study. Nigerian Medical Journal. 2011.

PMID: https://pubmed.ncbi.nlm.nih.gov/22529513/

Lamina S, Okoye CG, Dagogo TT. Managing erectile dysfunction in hypertension: the effects of a continuous training programme on biomarker of inflammation. BJU international. 2009.

DOI: https://doi.org/10.1111/j.1464-410X.2008.08254.x

Lamina S, Okoye CG, Dagogo TT. Therapeutic effect of an interval exercise training program in the management of erectile dysfunction in hypertensive patients. Journal of clinical hypertension (greenwich, conn) [Internet]. 2009.

DOI: https://doi.org/10.1111/j.1751-7176.2009.00086.x

Lamina S, Okoye CG, Hanif SM. Randomised controlled trial: effects of aerobic exercise training programme on indices of adiposity and metabolic markers in hypertension. JPMA - Journal of the Pakistan Medical Association. 2013.

PMID: https://pubmed.ncbi.nlm.nih.gov/23901664/

Lamina S, Okoye CG, Hanif SM. Effects of interval exercise training programme on the indices of adiposity and biomarker of inflammation in hypertension: a randomised controlled trial. Nigerian Postgraduate Medical Journal. 2014.

PMID: https://pubmed.ncbi.nlm.nih.gov/25126867/

Lamina S, Okoye G. Effects of aerobic exercise training on psychosocial status and serum uric Acid in men with essential hypertension: a randomized controlled trial. Annals of Medical & Health Sciences Research. 2012.

PMID: https://pubmed.ncbi.nlm.nih.gov/23439606/

Lamina S, Okoye GC. Therapeutic effect of a moderate intensity interval training program on the lipid profile in men with hypertension: a randomized controlled trial. Nigerian journal of clinical practice. 2012.

PMID: https://pubmed.ncbi.nlm.nih.gov/22437088/

Lamina S, Okoye GC. Effect of interval exercise training programme on C-reactive protein in the non-pharmacological management of hypertension: a randomized controlled trial. African journal of medicine and medical sciences. 2012.

PMID: https://pubmed.ncbi.nlm.nih.gov/23672102/

Maruf 2013

Maruf FA, Akinpelu AO, Salako BL. Self-reported quality of life before and after aerobic exercise training in individuals with hypertension: a randomised-controlled trial. Applied Psychology Health and Well-being. 2013.

DOI: https://doi.org/10.1111/aphw.12005

Maruf FA, Akinpelu AO, Salako BL, Akinyemi JO. Effects of aerobic dance training on blood pressure in individuals with uncontrolled hypertension on two antihypertensive drugs: a randomized clinical trial. Journal of the american society of hypertension. 2016.

DOI: https://doi.org/10.1016/j.jash.2016.02.002

Mendis 2010

Mendis S, Johnston SC, Fan W, Oladapo O, Cameron A, Faramawi MF. Cardiovascular risk management and its impact on hypertension control in primary care in low-resource settings: a cluster-randomized trial. Bulletin of the World Health Organization. 2010.

PMID: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2878142/

Okeahialam 2011

Okeahialam B, Ohihoin E, Ajuluchukwu J. Chronotherapy in Nigerian hypertensives. Therapeutic Advances in Cardiovascular Disease. 2011;5(2):113-8.

DOI: https://doi.org/10.1177%2F1753944711402119

Owolabi 2019

Owolabi MO, Gebregziabher M, Akinyemi RO, Akinyemi JO, Akpa O, Olaniyan O, et al. Randomized Trial of an Intervention to Improve Blood Pressure Control in Stroke Survivors. Circulation Cardiovascular Quality & Outcomes. 2019.
DOI: https://doi.org/10.1161/CIRCOUTCOMES.119.005904

Sarfo 2019

Sarfo FS, Ovbiagele B. Stroke minimization through additive anti-atherosclerotic agents in routine treatment (SMAART): a pilot trial concept for improving stroke outcomes in sub-Saharan Africa. Journal of the neurological sciences. 2017.

DOI: https://doi.org/10.1016/j.jns.2017.04.012

Sarfo FS, Treiber F, Gebregziabher M, Adamu S, Nichols M, Singh A, et al. Phone-based intervention for blood pressure control among Ghanaian stroke survivors: A pilot randomized controlled trial. Int J Stroke. 2019.

DOI: https://doi.org/10.1177%2F1747493018816423

Sarfo FS, Treiber F, Jenkins C, Patel S, Gebregziabher M, Singh A, et al. Phone-based Intervention under Nurse Guidance after Stroke (PINGS): study protocol for a randomized controlled trial. Trials. 2016.

DOI: https://doi.org/10.1186/s13063-016-1557-0

Saunders 1991

Saunders LD, Irwig LM, Gear JS, Ramushu DL. A randomized controlled trial of compliance improving strategies in Soweto hypertensives. Medical Care. 1991.

PMID: https://pubmed.ncbi.nlm.nih.gov/2072772/

Stewart 2005

Stewart A, Noakes T, Eales C, Shepard K, Becker P, Veriawa Y. Adherence to cardiovascular risk factor modification in patients with hypertension. Cardiovascular journal of South Africa. 2005

PMID: https://pubmed.ncbi.nlm.nih.gov/15915277/

Steyn 2013

Steyn K, Lombard C, Gwebushe N, Fourie JM, Everett-Murphy K, Zwarenstein M, et al. Implementation of national guidelines, incorporated within structured diabetes and hypertension records at primary level care in Cape Town, South Africa: a randomised controlled trial. Glob Health Action. 2013.

DOI: http://dx.doi.org/10.3402/gha.v6i0.20796

Turky 2013

Turky K, Elnahas N, Oruch R. Effects of exercise training on postmenopausal hypertension: Implications on nitric oxide levels. Medical journal of Malaysia [Internet]. 2013.

PMID: https://pubmed.ncbi.nlm.nih.gov/24632913/

Vedanthan 2019

Vedanthan R, Kamano JH, DeLong AK, Naanyu V, Binanay CA, Bloomfield GS, et al. Community Health Workers Improve Linkage to Hypertension Care in Western Kenya. J Am Coll Cardiol. 2019.

DOI: https://doi.org/10.1016/j.jacc.2019.08.003

Vedanthan R, Kamano JH, Naanyu V, Delong AK, Were MC, Finkelstein EA, et al. Optimizing linkage and retention to hypertension care in rural Kenya (LARK hypertension study): study protocol for a randomized controlled trial. Trials. 2014.

DOI: https://doi.org/10.1186/1745-6215-15-143

Wahab 2017

Wahab KW, Owolabi M, Akinyemi R, Jenkins C, Arulogun O, Akpa O, et al. Short-term pilot feasibility study of a nurse-led intervention to improve blood pressure control after stroke in Nigeria. Journal of the Neurological Sciences. 2017.

DOI: https://doi.org/10.1016/j.jns.2017.04.005