




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}

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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 health-care 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



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For numbered affiliations see end of article.

Correspondence to

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

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) guideline¹⁹. 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

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 | <ul style="list-style-type: none"> ▶ 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.

hypertension interventions in detail in order to broaden the scope of the existing evidence.

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 RCTs²⁰ 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 (EndNote²¹). 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, $\geq 180/\geq 110$ 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

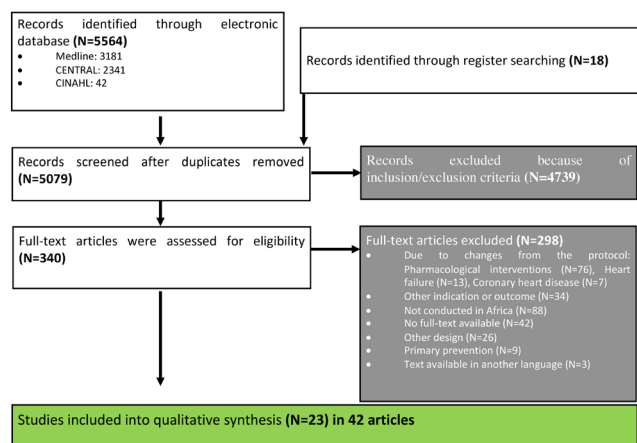


Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart describing the process of study selection.

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 (17090 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) | | Participants | | Intervention (IG) vs control (CG) group | | Results on adherence and BP | |
|---|----------------------|--------------|---------------|--|--|-----------------------------|---|
| | | Country | n | Age (years)/females | Hypertension; SBP/DBP (mm Hg) | Description | Follow-up (months) |
| Educational strategies for patients (11 RCTs) | | | | | | | |
| Adeyemo <i>et al</i> 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 Oluokun 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 <i>et al</i> ²⁸ (PAC;TR2014 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 <i>et al</i> ²⁹ (PAC;TR2016 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 <i>et al</i> 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

| Name (design) | Participants | | Intervention (IG) vs control (CG) group | | Results on adherence and BP | |
|--|-------------------------|------|---|--|-----------------------------|--|
| | Country | n | Age (years)/females | Description | Follow-up (months) | IG vs CG; treatment effect (95% CI) |
| Owolabi <i>et al</i> ⁵⁶ (NCT01900756) (RCT) | Nigeria (mixed) | 400* | 57.2±11.7/37% | 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 <i>et al</i> ⁶⁸ (NCT02568137) (cluster RCT) | Ghana (urban) | 60* | 55±13/35% | 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 ₁ : 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 <i>et al</i> ⁶⁰ (RCT) | South Africa (urban) | 224 | 65% between 40 and 50/73% | 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 <i>et al</i> ⁶¹ (RCT) | South Africa (urban) | 83 | Late middle-aged/n.r. | 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 <i>et al</i> ⁶⁴ (NCT01844596) (cluster RCT) | Kenya (rural) | 1460 | 54.2±16.4/58% | 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 ₁ : 1.21 (0.70 to 2.01) IG1 vs CG: OR ₁ : 0.64 (0.43 to 0.91) IG2 vs IG1: OR ₁ : 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 ₁ : -2.13 mm Hg (-4.89 to 0.42) IG1 vs CG: MD ₁ : -0.06 mm Hg (-3.61 to 3.20) IG2 vs IG1: MD ₁ : -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 ₁ : 0.95 (0.61 to 1.38) IG1 vs CG: OR ₁ : 0.97 (0.63 to 1.42) IG2 vs IG1: OR ₁ : 1.00 (0.69 to 1.40) |

Continued

Table 2 Continued

| Name (design) | | Participants | | Intervention (IG) vs control (CG) group | | Results on adherence and BP | | |
|---|--|----------------------|------|---|---|--|--------------------|---|
| | | Country | n | Age (years)/ females | Hypertension; SBP/DBP (mm Hg) | Description | Follow-up (months) | IG vs CG; treatment effect (95% CI) |
| Wahab <i>et al</i> ⁶⁵ (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 <i>et al</i> ⁶² (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: no difference BP controlled: no difference: 33% vs 32%; RR 1.01 (0.2 to 1.8) |
| Gougeon <i>et al</i> ⁶⁴ (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 <i>et al</i> ⁶⁵ (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 <i>et al</i> ⁶² (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 <i>et al</i> ⁶² (PACTR201303000493351) (cluster RCT) | | South Africa (urban) | 920 | 60.3 ± 11.1/79% | All hypertensives 151.2 ± 26.7/87.1 ± 12.4 | Multifaceted 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

| 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) |
| Akintunde <i>et al</i> 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 <i>et al</i> ²⁵ (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 <i>et al</i> 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 <i>et al</i> 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 <i>et al</i> 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 <i>et al</i> ⁵¹ (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: -6.2 mm Hg (-11.4 to -0.9) DBP: 82.2±9.5 vs 79.2±11.4 mm Hg; MD: -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.

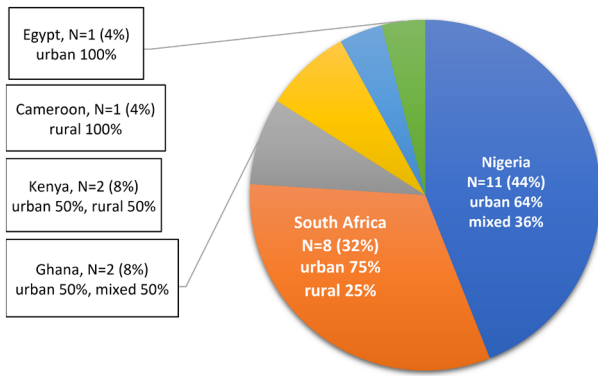
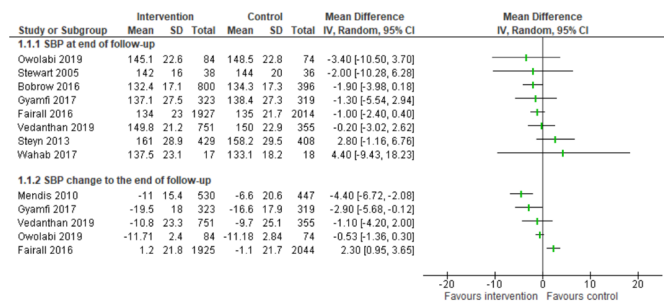


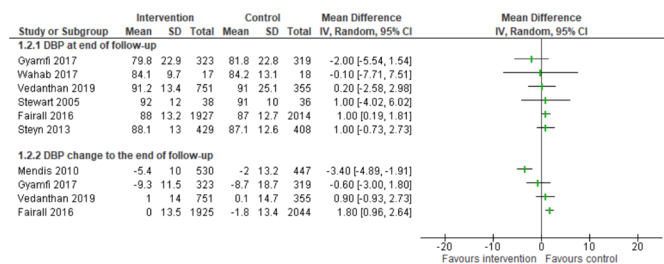
Figure 2 Spatial distribution of countries in which randomised studies were conducted.

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).

A: Results on systolic blood pressure (SBP)



B: Results on diastolic blood pressure (DBP)



C: Results on Blood pressure (BP) control

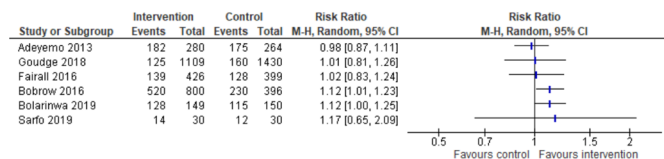
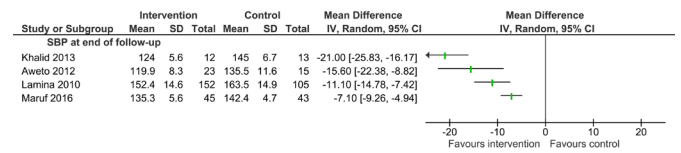


Figure 3 Results of educational strategies to improve adherence (3a Results on systolic blood pressure; 3b Results on diastolic blood pressure; 3c Results on blood pressure control)

A: Results on systolic blood pressure (SBP)



B: Results on diastolic blood pressure (DBP)

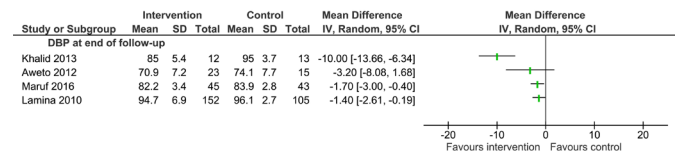


Figure 4 Results of strategies to enhance physical activity (4a Results on systolic blood pressure; 4b Results on diastolic blood pressure).

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*⁸¹ 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 anti-hypertensive 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 multi-level 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 diagnosis⁷ 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 | | Incomplete outcome data | Selective reporting | Other sources |
|---------------------------------------|---------------------|------------------------|-------------------------|-------------------|-------------------------|---------------------|---------------|
| | | | Personnel/ participants | Outcome assessors | | | |
| Educational strategies | | | | | | | |
| Adeyemo <i>et al</i> ²⁴ | 😊 | 😊 | 😐 | 😊 | 😐 | 😊 | 😐 |
| Ayodapo and Olukokun ²⁷ | 😊 | 😊 | 😐 | 😐 | 😊 | 😊 | 😊 |
| Bobrow <i>et al</i> ²⁸ | 😊 | 😊 | 😐 | 😊 | 😐 | 😊 | 😊 |
| Bolarinwa <i>et al</i> ²⁹ | 😊 | 😊 | 😐 | 😐 | 😐 | 😐 | 😐 |
| Fairall <i>et al</i> ³² | 😊 | 😊 | 😐 | 😊 | 😊 | 😊 | 😊 |
| Goudge <i>et al</i> ³⁴ | 😊 | 😊 | 😐 | 😐 | 😐 | 😊 | 😊 |
| Gyamfi <i>et al</i> ³⁵ | 😊 | 😊 | 😐 | 😊 | 😐 | 😐 | 😊 |
| Labhardt <i>et al</i> ³⁶ | 😊 | 😊 | 😐 | 😐 | 😐 | 😐 | 😊 |
| Mendis <i>et al</i> ⁵² | 😐 | 😐 | 😐 | 😐 | 😐 | 😊 | 😊 |
| Owolabi <i>et al</i> ⁵⁶ | 😊 | 😊 | 😐 | 😊 | 😊 | 😐 | 😊 |
| Sarfo <i>et al</i> ⁵⁸ | 😊 | 😊 | 😐 | 😊 | 😊 | 😊 | 😊 |
| Saunders <i>et al</i> ⁶⁰ | 😊 | 😊 | 😐 | 😐 | 😊 | 😊 | 😊 |
| Stewart <i>et al</i> ⁶¹ | 😊 | 😊 | 😐 | 😐 | 😐 | 😊 | 😊 |
| Steyn <i>et al</i> ⁶² | 😊 | 😊 | 😐 | 😐 | 😊 | 😊 | 😊 |
| Vedanthan <i>et al</i> ⁶⁴ | 😊 | 😊 | 😐 | 😐 | 😐 | 😊 | 😐 |
| Wahab <i>et al</i> ⁶⁶ | 😊 | 😊 | 😐 | 😐 | 😊 | 😊 | 😐 |
| Standardised treatment | | | | | | | |
| Akintunde <i>et al</i> ²⁵ | 😐 | 😊 | 😊 | 😊 | 😐 | 😊 | 😐 |
| Okeahialam <i>et al</i> ⁵⁵ | 😊 | 😊 | 😐 | 😊 | 😐 | 😊 | 😐 |
| Physical activity | | | | | | | |
| Aweto <i>et al</i> ²⁶ | 😊 | 😊 | 😐 | 😐 | 😐 | 😊 | 😐 |
| Lamina ³⁷ | 😐 | 😊 | 😊 | 😊 | 😐 | 😊 | 😊 |
| Maruf <i>et al</i> ⁵¹ | 😊 | 😊 | 😊 | 😊 | 😊 | 😐 | 😐 |
| Khalid <i>et al</i> ⁶³ | 😊 | 😊 | 😐 | 😐 | 😐 | 😊 | 😐 |
| Modified nutrition | | | | | | | |
| Charlton <i>et al</i> ³¹ | 😊 | 😊 | 😊 | 😊 | 😊 | 😊 | 😊 |

😊: low; 😐: unclear; 😐: high risk of bias.

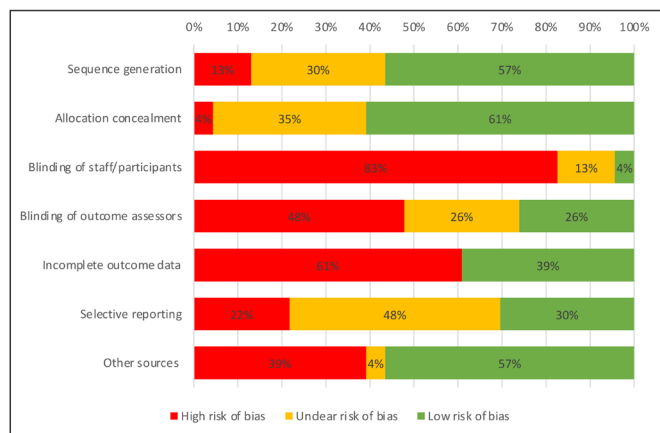


Figure 5 Summary of risk of bias.

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 hypertension⁸¹ 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 disproportionately 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

¹Institute of General Practice and Family Medicine, Center of Health Sciences, Martin-Luther-Universität Halle-Wittenberg Medizinische Fakultät, Halle, Germany

²School of Public Health, Addis Ababa University, Addis Ababa, Ethiopia

³Institute for Medical Epidemiology, Biostatistics and Informatics, Center of Health Sciences, Martin-Luther-Universität Halle-Wittenberg Medizinische Fakultät, Halle, Germany

⁴Physiotherapy Department, Regional Hospital Bamenda, Bamenda, Cameroon

⁵Research Organization for Health Education and Rehabilitation-Cameroon(ROHER-CAM), St. Louis University Bamenda, Bamenda, Cameroon

⁶African Regional Community, Guidelines International Network (G-I-N), Bamenda, Cameroon

⁷Department 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.

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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>

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