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Precision prevention interventions for non-communicable diseases among youth in sub-Saharan Africa: A scoping review

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Background. Hypertension significantly contributes to the global burden of cardiovascular disease, especially in low- and middle- income countries, including sub-Saharan Africa.
Objective. To identify existing interventions targeting hypertension prevention among youth aged 13 - 25 years and evaluate the incorporation of precision prevention strategies. In doing so, this review seeks to guide future efforts in reducing hypertension among young populations in SSA.
Methods. We conducted a scoping review aimed to identify interventions for hypertension risk reduction in SSA and map research in this area. Searches across academic databases and grey literature identified 3 301 articles. After removing duplicates, 3 089 articles were screened, with data extracted using a custom template on Covidence and analysed descriptively using narrative synthesis.
Results. The review identified 6 interventions targeting hypertension prevention among youth in SSA. While some interventions reported efficacy in improving adherence to dietary guidelines and physical activity, others showed mixed results, particularly regarding substance use. Interventions varied in design, setting, and duration, with a focus on internal (psychological/knowledge-based) and external (health behaviour) conditions. None of the interventions utilised precision prevention methodologies.
Conclusion. This review identified limited but diverse youth-focused interventions for NCD prevention in SSA, none specifically targeting hypertension or using precision prevention (PP). Despite structural and sociocultural barriers, tailored PP strategies, youth involvement, and theory-based frameworks show promise for enhancing engagement, sustainability, and impact in hypertension prevention for high-risk youth in SSA.

Keywords. youth; paediatric; hypertension; sub-Saharan Africa; lifestyle; diet; healthy living medicine; precision medicine; precision prevention; precision intervention.

S Afr J Child Health 2025;20(1):e2841. https://doi.org/10.7196/SAJCH.2025.v20i1.2841

Hypertension, a leading risk factor for cardiovascular disease (CVD), contributes significantly to the growing burden of non-communicable diseases (NCDs) worldwide, accounting for 74.36% of global mortality.[1] This issue is especially pronounced in low- and middle-income countries (LMICs), including those in sub-Saharan Africa (SSA), where limited healthcare resources exacerbate the impact of hypertension and related conditions.[2] Approximately 75% of total deaths secondary to CVDs occur in LMICs.[3] While global health responses have largely focused on treating and detecting hypertension in adults, there is an urgent need to address the rising risk of hypertension among adolescents and young adults, where early-life risk factors contribute to CVD and other NCDs.

The foundations of adult hypertension begin in youth.[4] Findings from the Lifepath research consortium demonstrate that health inequalities start early, with risk factors like poor diet and physical inactivity being more prevalent in lower socioeconomic groups.[4] These early exposures translate to adverse biological markers such as elevated cholesterol and blood pressure that accumulate over time, leading to higher rates of hypertension and CVD in adulthood.[5] This cumulative risk underscores youth as a critical period for targeted interventions to establish healthy habits and prevent the onset of such diseases.[6]

Prevalence of CVD risk factors among youth in SSA has increased. As an example, a recent study of youth in Mozambique found high rates of smoking (10.8% among rural men), alcohol use (38.6% among urban men), limited physical activity (particularly among women in urban areas) and obesity (21.6% among urban women and 25.2% among urban men).[7] Despite some progress in implementing interventions targeting existing cases of NCDs, there is a gap in the literature regarding preventive strategies specifically designed to target CVD risk factors in younger populations.

Precision prevention (PP) is an emerging approach in public healthcare that seeks to tailor interventions based on distinct risk profiles of individuals or specific subpopulations. This approach builds on the foundations of precision medicine, which began gaining traction in the early 2000s with advancements in genomic sequencing technologies. Defined as 'an approach for disease treatment and prevention that takes into account individual variability in genes, environment and lifestyle',[8] PP aims to manage health risks to offset the onset of disease.[9] PP entails personalising interventions

based on individual risk profiles by integrating multi-dimensional data from genomic, environmental, behavioural and social sources. Although it is unclear whether PP frameworks have been studied or implemented for youth in SSA, high-income countries have illustrated the potential of PP through targeted lifestyle interventions and genetic risk profiling.[10,11]

The CARDIOPLUS study[12] employed personalised primary care behavioural counselling tailored to individual patients' needs to mitigate CVD risk factors. The study focused on improving diet, increasing physical activity, reducing alcohol consumption and promoting smoking cessation among adults, with personalised advice provided by general practitioners.[12] The intervention was effective in achieving significant reductions in body weight, blood pressure, cholesterol levels, and triglycerides, alongside improved patient compliance and satisfaction with treatment.[12] By customising lifestyle modifications based on individual health profiles and monitoring progress over time, the study demonstrated the potential of PP to reduce CVD risk and enhance treatment outcomes in a high-income setting like Poland.[12] This personalised approach, grounded in the specific needs and behaviours of patients, highlights the effectiveness of targeted interventions in preventing the onset of NCDs.

The present paper has two primary aims: (*i*) to identify existing interventions in SSA designed to prevent hypertension among youth; and (*ii*) to evaluate whether any of these interventions incorporate PP strategies. By synthesising the scientific literature on interventions for hypertension among youth in SSA, the present study seeks to bridge the knowledge gap and guide future efforts in reducing the burden of hypertension. This research will build on existing reviews, including those by Adom *et al.*,[13] Sampson *et al.*,[14] and Daniels *et al.*[15] which explored lifestyle-based interventions in SSA targeting youth health, focusing on obesity prevention, cardiovascular health promotion and reducing risky behaviours, with varying emphasis on theory-based approaches, environmental factors and community involvement for sustainability. Unlike these reviews, which did not specifically investigate principles of PP or target youth aged 13 - 25 years, our review aims to expand the scope, aiming to explore PP strategies tailored to an older youth demographic in SSA.

Ethics

This paper is part of a larger research project which received ethical approval from the Human Ethics Research Committee University of the Witwatersrand, Johannesburg, South Africa (SA) (ref. no. M220818).

Methods

This scoping review is developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses-Scoping Review Extension (PRISMA).[16] It is also informed by the Joanna Briggs Institute framework for scoping reviews.[17]

Information sources

Searches were undertaken in 8 electronic bibliographic databases including PubMed, Scopus, PsycINFO, ScienceDirect, DOAJ, Web of Science, Cochrane Libraries and JSTOR, and grey literature databases including Google Scholar. Manual screening of the reference lists of reviews or discussion papers was also undertaken.

Search strategy and eligibility criteria

Preliminary searches and extensive prior reading established the final search terms and eligibility criteria. The search strategy was developed and implemented according to the Population, Concept and Context (PCC) format (Table 1).[16]

We first searched for peer-reviewed original studies on interventions for hypertension in youth (between the ages of 13 and 25 years) in SSA which focused on mitigating the prevalence of associated risk factors of hypertension. Thereafter, to understand the extent to which interventions utilised PP frameworks or concepts, we applied the following criteria: (*i*) inclusion of individual risk assessment using genetic and biometric data; (*ii*) involvement of continuous health monitoring; (*iii*) inclusion of tailored dietary and lifestyle recommendations; and (*iv*) inclusion of the integration of big-data analytics. Additionally, we searched directly for interventions labelled 'precision medicine' or its derivatives (e.g. 'personalised medicine').

Our search strategy for grey literature was guided by the specific database, i.e. Google search operators or website search fillers. Eligible articles included those published between September 2012 and September 2024. Articles were required to refer to 'hypertension' or its derivatives in the title and/or abstract and the introduction, methods and/or results.

We excluded reviews, case reports and case studies with a mean participant age >25 years or if <50% of participants were 13 - 25 years old. Articles were excluded if they were not relevant to the early prevention of hypertension, or if they focused on young participants who had already been diagnosed with hypertension. Only articles whose study context and setting were based within sub-Saharan Africa were included.

Screening

Search results were imported into EndNote (version 20). All stages of the screening process were conducted on Covidence (Veritas Health Innovation, Australia). Duplicates were removed automatically by Covidence, and we manually checked to ensure no duplicates remained. Title, abstract, and full-text screening against inclusion and exclusion criteria were performed independently in correspondence. Discrepancies at each screening stage were discussed until consensus was reached and disagreements were resolved between the three reviewers.

Data extraction, synthesis and analysis

The Covidence extraction document was modified using an iterative process. To structure how we reported preventative interventions, we created a data extraction form modelled after the template for Intervention Description and Replication (TIDieR) checklist.[16] Data extraction was conducted independently in duplicate. Data were analysed and summarised narratively in text and presented in tables and graphs where appropriate.

Results

A flow diagram of the article selection process is shown in Fig. 1. Searches retrieved 3 301 articles, of which a total of 6 articles corresponding to 6 unique intervention projects were included in this review.

Context and characteristics of included papers

The included studies, detailed in Table 2, primarily focused on SA, with one conducted in Ghana. Among them, three were cluster-randomised controlled trials, one was a randomised controlled trial, one was a public awareness media campaign and one was a demonstration at a science festival. Three interventions were conducted in educational settings (two in schools and one in a university), one at a science festival, one as a public media campaign, and one as a community-based intervention. The duration of interventions varied from 1 - 2 hours up to 6 months.

Table 1. Search strategy according to the PPC framework for scoping reviews

Search category	Domain	Search terms
Population	Youth	"youth" OR "adolescent" OR "teen" OR "teenager" OR "paediatric" OR "pediatric" OR "young adult"
Concept	Studies that adopt a preventative approach to hypertension	"precision prevention" OR "intervention" OR "precision medicine" OR "precision intervention" OR "hypertension" OR "high blood pressure" OR "elevated blood pressure" OR "raised blood pressure" OR "bp" OR "lifestyle" OR "diet" OR "community" OR "healthy living medicine"
Context	Sub-Saharan Africa	"sub-Saharan Africa" OR "Angola" OR "Benin" OR "Botswana" OR "Burkina Faso" OR "Burundi" OR "Cabo Verde" OR "Cameroon" OR "Central African Republic" OR "Chad" OR "Comoros" OR "Congo" OR "Cote d'Ivoire" OR "Equatorial Guinea" OR "Eritrea" OR "Eswatini" OR "Ethiopia" OR "Gabon" OR "Gambia" OR "Ghana" OR "Guinea" OR "Guinea-Bissau" OR "Kenya" OR "Lesotho" OR "Liberia" OR "Madagascar" OR "Malawi" OR "Mali" OR "Mauritania" OR "Mauritius" OR "Mozambique" OR "Namibia" OR "Niger" OR "Nigeria" OR "Rwanda" OR "Sao Tome and Principe" OR "Senegal" OR "Seychelles" OR "Sierra Leone" OR "Somalia" OR "South Africa" OR "Sudan" OR "Tanzania" OR "Togo" OR "Uganda" OR "Zambia" OR "Zimbabwe"

PPC = Population, Concept, Context

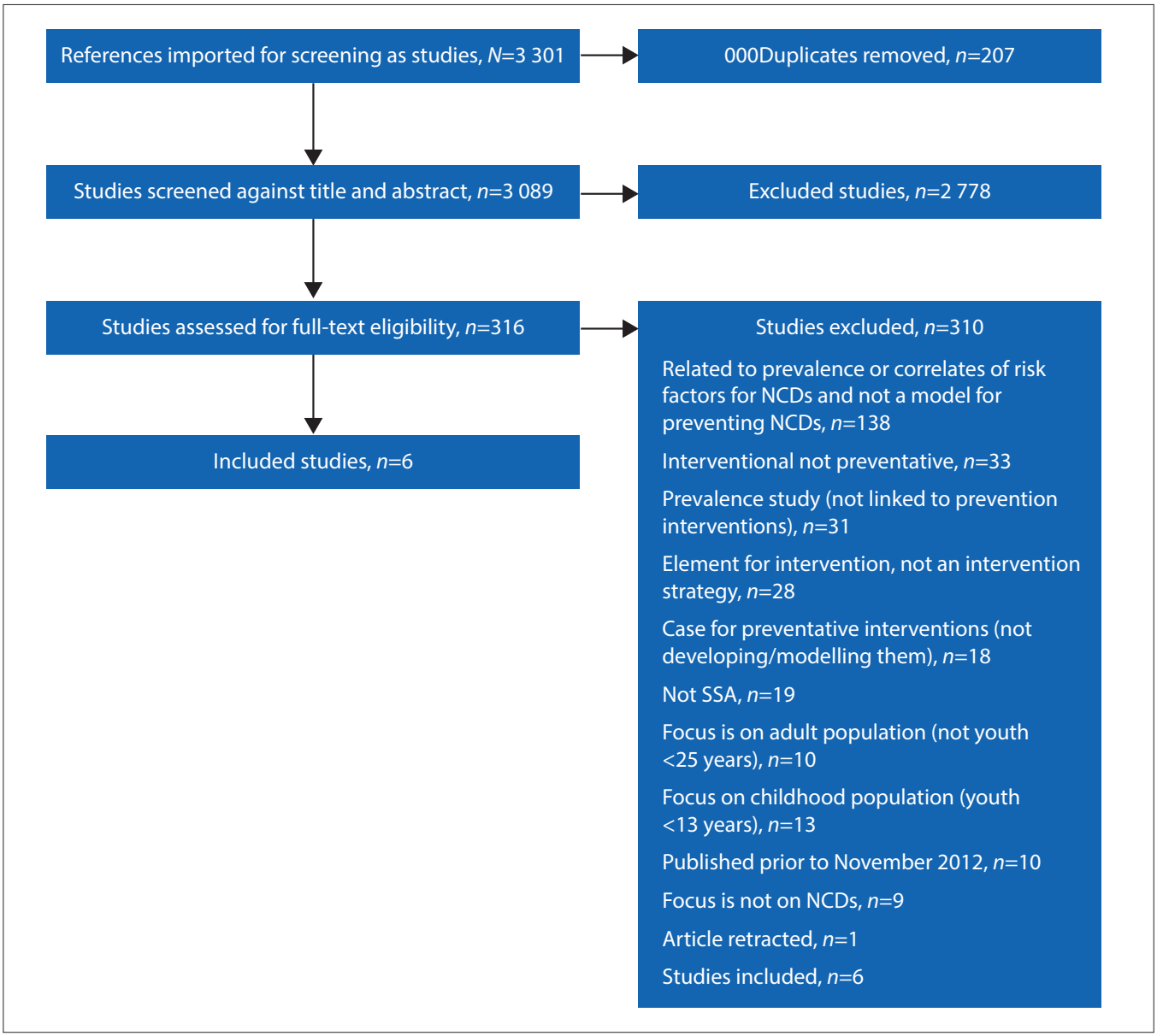

Fig. 1. Diagram representing the step-by-step results of the literature search following the PRISMA guidelines for scoping reviews. (NCD = non-communicable disease; SSA = sub-Saharan Africa)

Table 2. Intervention characteristics

Authors	Design	Country	Aim	Setting	Population characteristics	Primary outcome(s)
Jemmott *et al.*[35]	Cluster-randomised controlled trial	South Africa	To bolster beliefs, attitudes, self-efficacy and skills to adhere to PA guidelines and 5-a-day fruit and vegetable consumption, and to limit alcohol and fat intake	Community-based	Men aged 18 - 45 years living in a selected neighbourhood reporting vaginal intercourse in the previous 3 months	Self-reported adherence to physical-activity guidelines averaged over 6-month and 12-month post-intervention period
Wentzel-Viljoen *et al.*[36]	Non-experimental design	South Africa	To increase public awareness of the association between high salt intake, blood pressure and CVD, and focused on the reduction of discretionary salt intake	National media campaign ("Salt Watch")	Black women aged 18 - 55 years (50.2% of participants were between 18 and 35 years)	-
Hereen *et al.*[37]	Randomised controlled trial	South Africa	To evaluate the efficacy of a health-promotion intervention in increasing self-reported PA among university students in SSA	University based	Male and female university students aged 18 - 24 years	Self-reported adherence to the PA guidelines

Secondary outcome(s)	Intervention characteristics	Results	Precision prevention
The number of days of moderate-aerobic, intensive-aerobic, and strength-building activity in the previous 7 days	6 × 75-minute modules with 2 modules delivered during each of three sessions in three consecutive weeks (1) Beginning each session with a relationship-building activity wherein participants expressed their thoughts and feelings. (2) Brainstorming session exploring what it means to be a man - how men can make a difference in protecting themselves/ others against health problems. (3) Asked to construct a house from shoeboxes and contact paper, told to destroy it with a brick labelled "heart disease", "stroke", "hypertension", "diabetes" (4) Video magazine addressed how good health habits like PA, fruit and veg consumption etc. can lead to a longer and healthier life (5) Encouraged to partake in PA (combination of aerobic and strength) each week: (a) either 30 mins of moderate intensity PA on five days or at least 20 mins of vigorous intensity PA on 4 days; and (b) strength building activity on at least 2 days (6) Brainstorming ways to overcome barriers to PA (7) Take-home assignments to reach goals	Areas of improvement: (1) Reduced self-reported fried-potato intake. (2) Increased self-reported adherence to PA guidelines (vigorous and moderate intensity aerobic PA) Areas of no improvement: (1) No increase to adherence to dietary guidelines (men in health-promotion intervention reported eating fewer vegetables than those in the control condition). (2) No change to binge drinking behaviour. (3) No change to adherence to strength-building PA guidelines	No
-	(1) One 30-second television advertisement and two radio advertisements for the most popular television channels and radio stations that are utilised by the target population. (2) Salt Watch website (included lower salt recipes) (3) Use of the HFSA platform: public health screenings, wellness days etc. (4) Engaging healthcare professionals since they were identified as being highly influential stakeholders to provide salt reduction messages during health care interactions	Areas of improvement: (1) Most of the indicators of knowledge, attitudes, and behaviour change show a significant move towards considering and initiating reduced salt consumption. (2) Increases found for knowledge relating to high salt intake and its health outcomes. (3) Increased report of behaviour/ action to reduce salt intake (substituting salt for other herbs/spices) Areas of no improvement: No change in avoiding/ minimising the consumption of processed food	No
Fruit and vegetable consumption and fried food intake	"Wake Up!" (1) 8 × 45 min modules, with 2 modules implemented during each of 4 weekly sessions (a) Structured - guided by a standardised intervention module) (b) Highly interactive	Areas of improvement: (1) Increased self-reported adherence to the PA guidelines; specifically the number of reported days the participants engaged in aerobic activity (2) decrease in the number of servings of fried food Areas of no improvement: (1) no increase in strength-building activity (2) no increase in adherence to the 5-a-day guideline of fruits and vegetables	No

(continued)

Table 2. (continued) Intervention characteristics

Authors	Design	Country	Aim	Setting	Population characteristics	Primary outcome(s)
Srinivas *et al.*[38]	Non-experimental design	South Africa	To investigate the effects of a service-learning-based health promotion elective in influencing knowledge of hypertension and ways to prevent it	Science festival (National Festival of Science and Technology)	Learners (male and female) between the ages of 9 and 18 attending 'SciFest'	-
Amoah *et al.*[39]	Cluster-randomised controlled trial	Ghana	To develop, implement and evaluate the effects of a behavioural modification intervention program to reduce CVD risk factors among secondary school students	School-based	Male and female students aged 14 - 19 years old)	PA
Pienaar *et al.*[40]	Cluster-randomised controlled trial	South Africa	To determine over a 3-year period what the PA levels and patterns will be after participating in a PA intervention	School-based	Black adolescents aged 13 - 17 years (boys and girls)	-

PA = physical activity; CVD = cardiovascular disease; HFSA = Heart Failure Society of America; BP = blood pressure; BMI = body mass index.

Conditions targeted or addressed

The interventions targeted two main types of conditions, i.e. internal (psychological/knowledge-based) and external (health behaviour-related). Internal conditions focused on aspects like health beliefs, attitudes, awareness, knowledge, and self-efficacy. External factors addressed included adherence to physical activity guidelines, fruit and vegetable consumption, alcohol intake, salt intake, smoking (tobacco and marijuana), and fat intake.

Theoretical bases

Of the 6 interventions included, 3 had no theoretical basis. 2 of the 6 interventions were based on a combination of both Social Cognitive Theory and the Theory of Planned Behaviour, and 1 of the interventions was based on the Theory of Reasoned Action.

Precision prevention

The interventions reviewed incorporated elements such as physical activity guidelines, dietary recommendations, and health education modules, focusing largely on lifestyle modifications. However, none of the interventions fully utilised PP frameworks based on the established criteria. Specifically, there was no evidence of conducting individual risk assessments that leverage genetic or biometric data, which are essential components of PP. Furthermore, the reviewed interventions lacked continuous health monitoring beyond periodic check-ins to evaluate the success of the programmes. Additionally, the reviewed interventions did not integrate big-data analytics for tailoring the recommendations.

Efficacy

The efficacy of the interventions varied across different areas of focus. While some interventions showed limited efficacy in improving adherence to dietary guidelines, others reported reduced consumption of fried foods. Only one intervention showed improvement in adherence to dietary guidelines along with a reduction in fats, oils and sugar. Regarding PA, some interventions increased adherence to aerobic PA but not strength-building guidelines. Substance use findings were also mixed, with some interventions reporting changes in binge-drinking behaviour while others reported higher rates of quitting alcohol. None of the interventions showed a reduction in smoking.

Facilitators of intervention success

Incorporating aerobic exercise into physical activity interventions was shown to boost adherence to guidelines, promoting more active

Secondary outcome(s)	Intervention characteristics	Results	Precision prevention
-	(1) A model used to explain the effects of hypertension on the heart to SciFest attendeees (2) A model used to explain how fat deposits/ atheromata obstruct the flow of blood in blood vessels (3) A model was used to explain how fat deposits/ atheromata build up in blood vessels over time and obstruct the flow of blood	Areas of improvement: (1) Understanding of hypertension as a silent killer (2) What a desirable BP reading is (3) Conditions that may arise from uncontrolled hypertension Areas of no improvement: (1) Understanding of high blood pressure/ hypertension: who is at risk; what causes it; understanding of obesity; can it be controlled	No
Weight, body mass index, diastolic blood pressure, systolic blood pressure	Schools were visited 3 × a week for 6 months. Intervention had 2 modules: health education module; and PA module. Health education module was delivered through lectures and discussions and took 1 hour per session. The PA module was delivered in a hands-on way through field exercise and took 25 - 30 minutes per session.	Areas of improvement: (1) Higher total PA and consumption of fruit, veg, seafood and water (2) Reduction in carbohydrates, fats, oils and sugar (3) Reduction in weight, BMI and diastolic BP (4) Higher rates of quitting alcohol Areas of no improvement: (1) no change to smoking (2) no change to systolic BP	No
-	1 hour 2 × a week for 23 weeks with an increase to 3 × per week for 19 weeks Intervention consisted of: (1) 20 mins of aerobic exercise at a moderate to high intensity to the beat of music (2) 20 mins of active participation in a sports related ball games/ skills (specifically concentrating on soccer/ netball) (3) 20 mins of strength and flexibility exercises	Areas of improvement: (1) Increased time spent on exercise related activities during the week and weekend (as opposed to leisure activities) (2) Significant increase in boys PA levels Areas of no improvement: (1) No significant effect on the PA levels of girls	No

lifestyles among youth. Utilising popular media platforms effectively disseminated hypertension prevention information. Involving influential figures like community leaders enhance intervention impact. Peer-led interventions garner higher acceptability and engagement from adolescents, emphasising community involvement in health promotion. Embedding interventions in existing structures like schools reduces attrition rates and ensures sustained commitment to the programme.

Barriers to intervention success

Barriers to intervention success include household members' exclusion from interventions, which affects behaviour change, particularly in diet control influenced by meal preparers. Urbanisation saturates health messages, impeding behavioural change, while rural areas need structural interventions for increased vegetable consumption. Sustained lifestyle changes require continuous access to information, beyond one-time interventions for awareness. Gender, socioeconomic and cultural factors impact physical activity, while neighbourhood safety influences activity levels. Tailoring interventions to specific contexts and demographics is vital for overcoming these barriers and enhancing hypertension prevention efficacy.

Discussion

Only six studies met all inclusion criteria – although they addressed some general NCD preventative behaviours, none specifically targeted hypertension in youth. None of the interventions incorporated elements of PP. The reviewed studies were implemented in diverse settings, including schools, universities, community venues, and science festivals, each presenting unique benefits and limitations for intervention reach and sustainability. Schools and universities provided structured environments that facilitated engagement and follow-up, though they relied on sustained staff involvement for continuity.[18,19] Less structured settings, such as community venues and festivals, enabled broader demographic reach but struggled with long-term impact owing to short-term engagement.[20] Notably, online and mobile health interventions, which show promise in enhancing youth health outcomes through caregiver involvement,[21] were not utilised in these studies.

The use of theory-based frameworks, including Social Cognitive Theory and the Theory of Planned Behaviour, strengthened intervention strategies by addressing both personal motivators, like self-efficacy, and environmental supports, such as family and school.[22] These frameworks are particularly relevant in SSA, where cultural adaptation is key to sustainability and impact.[23] Findings

highlighted variable effectiveness across interventions targeting diet, physical activity and substance use, reflecting the need for context-specific adaptations in SSA. Socioeconomic and cultural barriers – such as addiction, neighbourhood safety and family support – impact feasibility, while facilitators like peer-led initiatives and community leader involvement were shown to improve engagement and support.[18] Including youth in the design of interventions proved beneficial, enhancing alignment with autonomy needs and addressing barriers like limited voice in decision-making and power dynamics with providers.[24-26]

Previous reviews have assessed lifestyle-based interventions for youth in SSA with a general focus on NCD prevention but few have specifically addressed hypertension in this demographic. For instance, Adom *et al.*[13] evaluated school-based interventions for childhood obesity in children aged 6 - 15 years, showing mixed effectiveness and noting that most lacked essential environmental supports, such as family involvement, and often relied on short-term implementation. Sampson *et al.*[14] examined cardiovascular health interventions in SSA, emphasising health promotion principles and the potential of WHO's 'best buy' strategies, particularly when combined with community and economic partnerships to enhance sustainability. Daniels *et al.*[15] explored interventions for health-risk behaviours among SA youth aged 9 - 19 years, suggesting that locally tailored, theory-based and culturally relevant approaches could significantly improve engagement and outcomes. However, none of these studies explicitly targeted hypertension. Collectively, these findings indicate a gap in SSA youth health interventions addressing hypertension specifically and suggest that future initiatives should leverage theory-based frameworks and incorporate local cultural and socioeconomic factors to enhance their relevance and long-term impact.

None of the reviewed interventions in this review incorporated PP strategies, such as individualised genetic or biometric risk assessments, continuous health monitoring or the integration of big-data analytics to tailor interventions.[27-30] Instead, the existing interventions relied on traditional public health models, providing broad recommendations for physical activity, diet and health education. Additionally, none of the previous reviews by Adom *et al.*,[13] Sampson *et al.*[14] or Daniels *et al.*[15] spoke to interventions that incorporated PP strategies. The absence of PP in SSA interventions can be attributed to several challenges that inhibit its adoption in LMICs, including limited healthcare infrastructure,[31] resource constraints for large-scale data collection, and the significant costs associated with advanced technologies like genomic sequencing and real-time monitoring. These barriers are particularly pronounced in SSA, where healthcare systems often lack the resources to support PP's data-driven approach.[31]

In high-income settings, PP has been applied with positive results, particularly for managing cardiovascular health and preventing hypertension. Trials in these regions have utilised data-driven approaches to identify high-risk individuals, enabling more effective and timely interventions.[32,33] The success of PP trials in high-income settings highlights the potential for PP in SSA to efficiently reduce costs by targeting high-risk youth populations, enabling early identification of risk factors and timely interventions to prevent disease onset while optimising resource use. PP also offers a scalable solution that could bridge the gap between traditional public health models and emerging technologies, ensuring more sustainable and impactful NCD prevention efforts across diverse populations in SSA.[8]

Conclusion and recommendations

This review highlights a gap in PP applications for hypertension prevention in SSA youth, emphasising the need for research to integrate PP into targeted interventions. Future studies should assess the feasibility of using biometric data to develop personalised prevention strategies. Collaborative efforts among governments, healthcare organisations, and academic institutions are essential to address infrastructure challenges and ensure PP approaches are culturally relevant. Direct engagement with youth can enhance the design and implementation of interventions by aligning with social and cultural factors that influence health behaviours. Understanding youth perspectives will improve intervention relevance, acceptability, and sustainability, potentially mitigating unique environmental challenges and fostering program buy-in.[34]

While the infrastructural and economic challenges in SSA pose obstacles to adopting PP, evidence from high-income countries suggests that data-driven, targeted approaches could enable cost-effective, timely interventions for high-risk youth. Addressing these gaps with culturally adapted youth-inclusive PP strategies could support sustainable, impactful hypertension prevention across SSA.

Declaration. None.

Acknowledgements. We would like to express our sincere gratitude to the people that have contributed to the completion of this research and the preparation of this article.

Author contributions. MJS conceived and designed the research, conducted the literature search and analysed data, drafted and revised the manuscript, prepared figures and tables and co-ordinated the submission process. SSS assisted with data collection, reviewed and edited the manuscript for grammar, style and formatting. SAN conceived and designed the research, and supervised the research including providing critical input and guidance in the formulation of this research and throughout the research process.

Funding. None.

Conflicts of interest. None.

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Received 26 November 2024. Accepted 11 November 2025.