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Review Article

Effectiveness of Physical Activity Interventions in the Management of Hypertension Among Adults in Europe: A Systematic Literature Review

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Abstract

Background: Hypertension is a primary modifiable risk factor for cardiovascular disease and continues to be a major public health issue around Europe. Despite the accessibility of pharmacological medications, blood pressure regulation rates remain inadequate, highlighting the significance of lifestyle interventions like physical activity. Regular exercise is frequently recommended as a non-pharmacological approach for managing hypertension; however, differences in intervention type, intensity, and delivery methods have led to inconsistent results across studies.

Objectives: To assess the effectiveness of physical activity interventions in managing hypertension in adults across Europe.

Methods: A systematic search of electronic databases such as PubMed, CINAHL, and EBSCO was used to identify relevant studies published between 2012 and 2025. The PICO framework was used to develop the search strategy, and predefined inclusion and exclusion criteria were applied to ensure that relevant studies were selected. A structured screening process was used to select studies, and data were extracted using a standardised extraction form. The methodological quality of included studies was evaluated using the Critical Appraisal Skills Programme (CASP) checklist, and findings were synthesised using a narrative synthesis approach due to study heterogeneity.

Results: Twelve studies met the inclusion criteria. The results showed that aerobic and combined exercise interventions reduced systolic blood pressure. However, the magnitude of these reductions differed depending on exercise modality and intensity. Smaller or less consistent effects were also observed in younger adults and studies with shorter intervention periods.

Conclusion: Overall, the review provides evidence that structured physical activity interventions, particularly aerobic and combined exercise programs, may benefit adults with hypertension reduce their systolic blood pressure. However, the effectiveness of these interventions appears to be affected by exercise modality, intensity, and duration. Strengthening the integration of structured physical activity into hypertension management strategies might therefore contribute to better blood pressure control and cardiovascular health outcomes in European populations.

Keywords: Hypertension, Physical activity, Blood pressure, systolic blood pressure, Intervention intensity.

Abbreviations: BP: Blood pressure; DBP: Diastolic blood pressure; HIIT: High Intensity interval training; IHG: Isometric handgrip training, NHS: National Health Service; PA: Physical activity; RCT: Randomised control trial; SPB: Systolic blood pressure; UK: United Kingdom.

Introduction

Hypertension accounts for over 10.8 million fatalities worldwide annually and continues to be a primary factor in the global burden of cardiovascular disease [1]. Approximately one in three European adults is estimated to fall short of the recommended physical

activity (PA) guidelines, thereby increasing their risk of chronic conditions such as hypertension [2]. In addition to its effects on individual health, uncontrolled hypertension significantly burdens healthcare systems through higher hospitalisations and long-term management of cardiovascular complications [3]. Substantial evidence suggests that regular PA can reduce systolic blood pressure (SBP) by approximately 5-8 mmHg, an effect comparable to first-line antihypertensive medication [4]. Aerobic exercise, resistance training, and combined exercise programs have been linked to improvements in blood pressure (BP) and cardiovascular health [5]. However, current research shows significant variability in intervention types, intensities, durations, and delivery contexts, which complicates the application of findings in practice and emphasizes the necessity for a systematic synthesis of evidence among European populations.

Despite strong clinical guidelines and increasing evidence that PA is an effective strategy for hypertension management, BP control rates in Europe remain low [6]. A significant proportion of individuals with diagnosed hypertension do not meet recommended BP targets, highlighting limitations in current management approaches and insufficient implementation of lifestyle-based interventions [7]. Although international research indicates that physical activity can significantly lower blood pressure, differences in healthcare systems, intervention delivery, and population characteristics across Europe may influence its effectiveness [5]. Furthermore, variations in intervention type, intensity, duration, and delivery settings contribute to disparities in findings across studies [4]. As a result, it remains unclear which PA interventions are most effective in managing hypertension in European populations.

This systematic literature review aims to critically synthesise evidence on the effectiveness of PA interventions in managing hypertension among adults in the UK. However, initial scoping searches revealed a limited number of UK-based intervention studies; therefore, the scope was broadened to include research conducted across Europe to provide a more comprehensive and robust evidence base. Furthermore, the review aims to identify effective intervention types, evaluate their impact on BP outcomes, and examine factors affecting intervention success. Considering the increasing prevalence of hypertension and the increased focus on preventive and lifestyle-based management strategies, synthesizing existing evidence is important to inform clinical practice, direct public health initiatives, and support future research.

Material and Methods

This systematic review followed the guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), which provides a standard format for reporting systematic reviews and meta-analyses, aiming to enhance clarity and transparency. This study was registered in the PROSPERO database of systematic reviews (ID number: CRD420261431693).

Research Question Formulation

A well-defined research question is important in systematic reviews because it guides the search strategy, study selection, and data synthesis while maintaining transparency and methodological rigour [8,9]. In reviews of intervention effectiveness, the research question assists in defining the target population, intervention characteristics, comparison groups, and measurable outcomes to be evaluated [10]. The research question in this study was formulated using the PICO framework (Population, Intervention, Comparison, Outcome), which is widely recommended for quantitative health research and intervention-based systematic reviews because it provides guidance in the identification of relevant evidence and supports a structured search strategy [11]. The PICO framework, as shown in Table 1, was used to formulate the following research question that guided this systematic review: "How effective are physical activity interventions in managing hypertension among adults in Europe?"

Table 1: PICO Framework.

PICO Framework	Description
Population	Adults with hypertension in Europe
Intervention	Physical activity interventions (e.g., aerobic exercise, structured exercise programmes, resistance trainings.
Comparison	Usual care, no interventions, non-physical interventions
Outcome	Changes in blood pressure outcomes

Databases Selection:

The use of appropriate databases is critical in systematic reviews to ensure a thorough and transparent search for relevant evidence while minimising publication bias [12]. This review searched three databases including PubMed, CINAHL, and EBSCO, to find studies on PA interventions for hypertension management. PubMed contains extensive biomedical literature [13], CINAHL focuses on nursing and allied health research [14], and EBSCO provides access to a wide range of peer-reviewed sources [15].

Search Strategy

A structured search strategy is required in systematic reviews to ensure the complete and transparent identification of relevant evidence while reducing selection bias [16]. As illustrated in Table 2, Keywords were extracted from the PICO framework and combined

with synonyms using Boolean Operators (AND, OR) to improve search sensitivity [17]. Wherever possible, controlled vocabulary, such as Medical Subject Headings (MeSH), was used to improve search precision [18]. Searches were restricted to English-language studies published within the last ten years to ensure relevance to current clinical practice. The following is an example of a search string that was used: (hypertension or "high blood pressure") AND ("physical activity" or exercise or "aerobic exercise" or "resistance training") AND ("adult" or "men" or "women") AND ("blood pressure" or "systolic blood pressure" or "diastolic blood pressure".

Table 2: Keywords and Synonyms Used.

Keywords	Synonyms
Hypertension	"High blood pressure" OR "HBP"
Physical activity	"Exercise" OR "aerobic exercise" OR "resistance training"
Adults	"Men" OR "Women"
Blood pressure	"Systolic blood pressure" OR "diastolic blood pressure" OR "BP"

Eligibility criteria

Systematic reviews require clearly defined inclusion and exclusion criteria to ensure transparency, consistency, and methodological rigour in study selection [19]. Using explicit eligibility criteria reduces selection bias and ensures that only studies relevant to the research question are included [20,21]. In this review, eligibility criteria were developed using the PICO framework, with a focus on the study population, intervention type, outcomes, study design, publication characteristics, and geographical relevance. As shown in Table 3, the review included English language peer-reviewed studies on adults with hypertension in Europe that evaluated PA interventions and reported quantitative BP results within last 12 years. Studies that did not meet these criteria were excluded.

Table 3: Inclusion and exclusion Criteria.

Inclusion Criteria	Exclusion Criteria
Adults diagnosed with hypertension	Children or Adolescents
Studies conducted in Europe	Studies conducted outside Europe
Physical activities or exercise-based interventions	Pharmacological-only or dietary-only interventions
Usual care, no interventions or non-physical activity interventions	Studies without a comparator
Quantitative blood pressure outcomes	Studies not reporting blood pressure outcomes
Quantitative methods studies	Qualitative methods studies
Peer-reviewed English language journals	Non-peer-reviewed and non-English articles
Studies published from 2012-2025	Studies published before 2012
Full-text available	Inaccessible full texts

Data Extraction

Data extraction is an important step in systematic reviews because it ensures that relevant information from included studies is collected consistently for accurate synthesis and interpretation [22]. A structured extraction approach improves transparency while decreasing the likelihood of reporting errors [23]. The two authors (LBN and FS) independently extracted relevant data from the 12 studies included utilising a data extraction form. Data collected included author and year, study design, sample size and gender distribution, participant age, country and setting, intervention duration, outcome measures, and key blood pressure findings (Table 4). This structured process allowed for consistent comparison and synthesis of findings across the included studies [24].

Table 4: Data extraction table showing the characteristics of the included studies.

Author (Year)	Study Design	No of participants/ Gender	Age	Country/ Setting	Study Duration	Outcome(s) Measured/ Measurement tool	Key findings
Herrod, et al. (2020)	RCT	n=41 All men	Mean= 71 years	UK/ (N/A)	6 weeks	PA	High intensity isometric interval training can result in statistically and clinically decrease in SBP in older adults by an average of 9mmHg 6 weeks. Reduction in SBP achieved by HIIT and IHG reduce the risk of stroke by 41%.
Williamson, et al. (2022)	RCT	n=203 All men	Mean= 27 years	UK/Hospital	16 weeks	BP	A 16-week aerobic exercise program did not significantly reduce BP in young adults with hypertension, but it did improve physical fitness.
Wiles, et al. (2025)	RCT	n=41 Women= 59% Men=41%	57 years	UK/Clinics & GP surgeries	26 weeks	BP	Isometric exercise was feasible to deliver within the NHS and was associated with significant SBP reduction of -12.9 mm Hg for wall squat, supporting progression to a fully powered RCT
Lopes, et al. (2021)	RCT	n=53 women= 45% men= 55%	54 years	Portugal/primary health care	12 weeks	24-hr ambulatory SBP & office BP	Aerobic exercise significantly reduced ambulatory and office SBP compared with usual care.
Danielsen, et al. (2023)	RCT	n= 48	64 years	Denmark/ community based	20 weeks	Clinic BP/ Home BP monitoring	Isometric handgrip training did not produce greater BP reductions than usual care.
Di Cango, et al. (2023)	RCT	n=130	66 years	Italy	104 weeks	BP	Long-term supervised PA significantly reduced antihypertensive drug load compared with control at 18 and 24 months
Guimaraes, et al. (2014)	RCT	32	55 years	Italy/ University hospital	12 weeks	24-hr ambulatory systolic blood pressure	Heated water-based exercise significantly reduced ambulatory SBP and DBP compared with control after 12 weeks.
Kruk & Nowicki (2018)	Non- RCT	53	18-70 years	Poland/ Primary health care	26 weeks	BP/ PA levels (Accelerometer)	Structured physical activity increased activity levels and transiently reduced office BP, but changes in 24-h ambulatory BP were not sustained at 6 months.
Molmen-Hansen, et al. (2012)	RCT	n=88 Women= 44.3 % Men= 55. 7%	52-7± 7.8 years	Norway/ Clinics	12 weeks	24-h Ambulatory SBP & DBP/ echocardiography	Aerobic interval training exercise significantly reduced ambulatory systolic and diastolic blood pressure more than moderate intensity training
Bischoff-Ferrari, et al. (2020)	RCT	n=2157 women= 61.7% men= 38.3%	70 years	Multiple countries (France, Germany, Portugal)	156 weeks	Clinical SBP & DBP/ sphygmomanometer	Treatment with vitamin D3, omega-3 fatty acids, or strength training exercise program had no significant impact in the improvement of SBP or DBP.
Arija, et al. (2018)	RCT	n=207 women= 76.8% men= 23.2%	68.2 years	Spain/Primary care centers	39 weeks	BP	A 9-month supervised walking program effectively decreased systolic blood pressure (−8.68 mmHg) and improved hypertensive participants' BP management.
Burchert, et al. (2023)	RCT	n=203	30 years	UK/ Research centres	16 weeks	24-hr awake Ambulatory BP change	Aerobic exercise improved cardiovascular fitness and vascular structure in preterm-born young adults with high blood pressure and stage 1 hypertension, but it had no significant effect on ambulatory systolic or diastolic blood pressure when compared to control

Abbreviations: BP: Blood pressure; DBP: Diastolic blood pressure; N/A: Not available; PA: Physical activity; RCT: Randomised controlled trial; SBP: Systolic blood pressure; UK: United Kingdom

Methodological Quality Assessment

Assessing the methodological quality of included studies is an important component of systematic reviews as it allows the evaluation of the evidence base's reliability, validity, and potential for bias [25]. For quantitative research, several appraisal tools are available, such as the Cochrane Risk of Bias tool, the Critical Appraisal Skills Programme (CASP), and the Joanna Briggs

Institute (JBI) tools [26,27]. However, the CASP checklist was selected for this review because it is frequently used to assess methodological rigour and validity in health research [28]. The tool evaluates key aspects such as study design, recruitment strategy, outcome measurement, confounding factor consideration, and statistical analysis appropriateness. The two authors (LBN and FS) independently assessed the quality of the included studies utilising the JBI checklist. Each criterion was assessed systematically using (yes, no, unclear, not applicable) to determine the overall quality and potential bias of the included studies [29]. Table 5 presents the summary of the quality appraisal results.

Table 5: Methodological quality assessment using the CASP checklist.

Author/ Year	Q1: Did the study address a clearly formulated research question?	Q2: Was the assignment of participants to interventions randomised?	Q3: Were all participants who entered the study accounted for at its conclusion?	Q4a: Were the participants 'blind' to intervention they were given?	Q4b: Were the investigators 'blind' to the intervention they were giving to participants?	Q4c: Were the people assessing/ analysing outcome/s 'blinded'?	Q5: Were the study groups similar at the start of the randomised controlled trial?	Q6: Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally)?	Q7: Were the effects of intervention reported comprehensively?	Q8: Was the precision of the estimate of the intervention or treatment effect reported?	Q9: Do the benefits of the experimental intervention outweigh the harms and costs?	Q10: Can the results be applied to your local population/ in your context?	Study Quality
Arija et al. (2018)	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Bischoff-Ferrari et al. (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	High quality
Burchert et al. (2023)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Danielsen et al. (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Di Cango et al. (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Guimaraes et al. (2014)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Herrod et al. (2020)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Kruk & Nowicki (2018)	No	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Moderate quality
Lopes et al. (2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Molmen-Hansen et al. (2012)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	High quality
Wiles et al. (2025)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Williamson et al. (2022)	No	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Moderate quality

Data Analysis

Data analysis is a crucial process in systematic reviews as it allows findings from included studies to be organised, compared, and interpreted systematically [30]. Although meta-analysis is a typical approach for synthesising quantitative evidence, it was not appropriate for this review due to significant heterogeneity among the included studies. Variations in study design, intervention types, duration, and outcome measures made it difficult to statistically pool results. As a result, findings were synthesized using a narrative synthesis approach, which enables structured comparison and interpretation of evidence when methodological or clinical diversity exists [23].

Results

Characteristics of the Included Studies

The characteristics of the included studies are illustrated in Table 4. Most studies were carried out in community and healthcare settings in Europe, with four studies conducted in the UK [31-34], two in Italy [35,36], and one each in Spain [37], Portugal [38], Denmark [39] (Danielsen et al., 2023), [40] Norway, and Poland [41]. These studies were conducted in a variety of real-world settings, including primary care, hospitals, community program, and research centers. Out of the 12 studies included in this review, 11 used randomised controlled trials, while one did not [41]. The sample sizes varied greatly, ranging from 32 [36] to 2,157 [42]. Most studies included male and female participants and focused on middle-aged and older adults, apart from two studies that included only male participants [32,34]. Aerobic exercise, aerobic interval training, isometric exercise, water-based exercise, and supervised walking programmes were all evaluated for durations ranging from six weeks to three years. BP outcomes were primarily assessed through clinic measurements and, in some cases, 24-hour ambulatory monitoring. While some studies found clinically significant reductions in SBP after PA interventions [33,37], others found improvements in cardiovascular fitness or medication use without significant changes in BP [31,34,39].

Study selection process

Figure 1 provides a PRISMA flow diagram showing an overview of the study selection process. The study selection followed systematic review processes in accordance with PRISMA guidelines. An initial search of PubMed, CINAHL, and Scopus identified 2175 peer-reviewed articles. After removing duplicates (1217 articles), 958 titles and abstracts were assessed using the inclusion and exclusion criteria. At this point, 893 articles were removed because they were irrelevant to the review objectives. Furthermore, 65 full-text articles were then evaluated for eligibility, with 57 articles being excluded due to factors such as improper study design (17 studies), lack of relevant blood pressure outcomes (28 studies), and failure to meet population or intervention criteria (12 studies). The remaining 12 studies were included in the final synthesis.

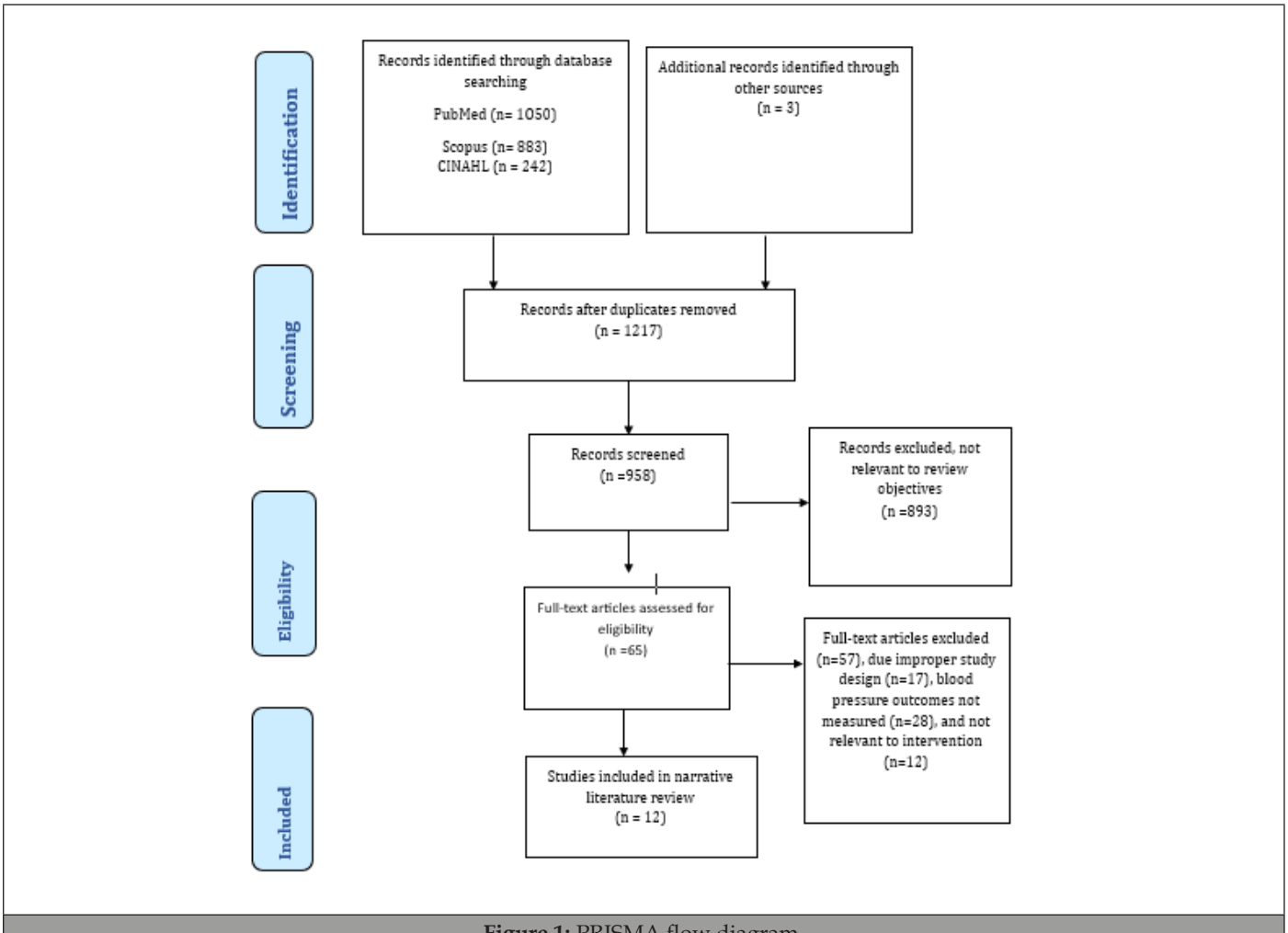

Figure 1: PRISMA flow diagram.

Methodological quality assessment results

The results of the methodological quality assessment are summarised in Table 5 for the 12 studies included in this review. Overall, the appraisal showed a strong evidence base. Nine studies were rated as high quality, indicating a low risk of bias and strong research design, outcome assessment, and statistical analyses. Three studies were rated as moderate quality due to limitations such as incomplete reporting of allocation procedures or potential confounding [34,41]. However, no studies were rated as low quality. Overall, the findings indicate that the included studies have strong methodological rigor, which supports the reliability of evidence on PA interventions for hypertension management.

Summary of key findings

The following three key findings were identified from this systematic review examining effectiveness of PA interventions in the management of hypertension:

Aerobic and Combined Exercise and Systolic Blood Pressure Reduction

One of the key findings from this review suggested that aerobic exercise or combination aerobic-resistance therapies reduced SBP, particularly in 12-week or longer programmes. These interventions were linked to consistent decreases in systolic blood pressure, implying that regular aerobic-based physical exercise may be effective in managing BP in persons with hypertension.

Influence of Exercise Modality and Intensity on Blood pressure Outcomes

Another key finding of this review indicated that BP responses varied with the type and intensity of the PA intervention. Higher-intensity aerobic exercise or interval training was found to be more effective in lowering SBP than lower-intensity or resistance-only exercises. This research emphasizes the importance of exercise prescription variables in influencing BP outcomes.

Variable Blood Pressure Effects in Younger adults and shorter intervention

Finally, another key finding on this review, as reported by some studies, was that there were no statistically significant changes in BP, especially among younger individuals or interventions of short duration. These findings show variation in intervention effectiveness and imply that population variables and program duration may influence observed BP outcomes.

Discussion

Aerobic and Combined Exercise and Systolic Blood Pressure Reduction

One of the key findings of this review suggested that several PA interventions resulted in significant reductions in SBP among adults with hypertension. This is consistent with extensive evidence that exercise is an important non-pharmacological intervention for lowering BP [43,44]. For example, recent meta-analyses indicated that aerobic exercise could reduce SBP by about 5-7 mmHg on average, with larger reductions observed when exercise is performed on a regular basis at recommended weekly levels [45,46]. Dose-response analyses revealed that approximately 150 minutes of moderate-intensity aerobic exercise per week resulted in particularly significant BP reductions [47]. According to clinical evidence, even minor reductions in SBP are associated with significant reductions in hypertension risk [48], with epidemiological studies indicating that a 10 mmHg decrease in SBP can reduce the risk of major cardiovascular events by approximately 20% [49]. However, the current review found that the magnitude of BP reductions varied across studies. While some interventions resulted in significant improvements, others showed limited or non-significant changes in BP despite increased physical fitness [44]. This inconsistency reflects a common pattern in exercise-hypertension research, where intervention effectiveness is frequently determined by factors such as baseline BP levels, exercise program adherence, and individual physiological responses [50]. Individuals with higher baseline BP tend to see greater reductions from lifestyle interventions, whereas younger adults or those with borderline hypertension may demonstrate smaller physiological changes due to lower baseline cardiovascular risk and more stable vascular regulation [51]. These variations emphasize the importance of taking individual characteristics and intervention context into account when assessing the effectiveness of PA interventions for hypertension management [52].

Influence of Exercise Modality and Intensity on Blood pressure Outcomes

Another important finding from this review is the effect of exercise modality and intensity on BP outcomes. Aerobic exercise interventions, such as continuous aerobic training and interval-based programmes, were more frequently linked to lower SBP than lower-intensity or shorter-duration interventions [53]. This finding is consistent with previous research showing that aerobic exercise improves endothelial function, decreases arterial stiffness, and improves autonomic BP regulation [54]. These physiological adaptations help to improve vascular function and are regarded as key mechanisms by which exercise reduces cardiovascular risk [55]. In addition to aerobic exercise, this review included studies that looked at the effects of isometric exercise interventions across some European countries, such as handgrip training and wall squat protocols. Isometric exercise seems to be a time-efficient and accessible strategy for lowering BP [56], with some systematic reviews reporting significant reductions in both systolic and diastolic BP following short-duration isometric training programmes [57,58]. However, the findings across studies are inconsistent, and some interventions were not successful in surpassing standard care. This inconsistency suggests that the optimal intensity, frequency, and duration of isometric exercise interventions are unclear, emphasizing the need for additional research [59,60]. Furthermore, considering isometric training is relatively new in hypertension management, its long-term effectiveness and feasibility in real-world healthcare settings have not been thoroughly studied [61].

Variable Blood Pressure Effects in Younger adults and shorter intervention

Another key finding from this review was the variation in intervention outcomes across different participant groups and

study settings. While some studies found significant reductions in BP, others showed improvements in physical fitness or cardiovascular markers but no significant changes in BP levels [62]. These variations could be attributed to differences in participant characteristics such as age, baseline BP, comorbidities, and lifestyle habits [63, 64]. This is aligned to previous research, suggesting that older adults with more severe hypertension or higher cardiovascular risk may respond more strongly to lifestyle interventions than those with lower baseline risk [65], whereas younger populations might experience smaller BP reductions despite improved overall cardiovascular fitness [5]. Furthermore, differences in study duration and intervention intensity could have influenced the observed results [66]. This is probably because short-term interventions may not allow enough time for the physiological adaptations required to produce measurable blood pressure changes [67,68]. Therefore, the variability observed across studies emphasizes the importance of considering intervention design and participant characteristics when interpreting the effectiveness of PA interventions across European countries [69]. These findings support existing public health recommendations, such as the UK Chief Medical Officers' Physical Activity Guidelines, which recommend 150 minutes of moderate-intensity PA per week [70], and the National Institute for Health and Care Excellence (NICE) hypertension guideline, which emphasizes PA as an important lifestyle strategy for hypertension management [71].

Implications

This findings of this review have several implications for public health practice and policy, particularly in terms of hypertension prevention and management. First, consistent evidence that aerobic and combined exercise interventions can lower SBP emphasizes the significance of integrating structured PA promotion into routine healthcare practice. As part of hypertension management, primary care practitioners and community health workers should prioritize lifestyle counselling and referrals to exercise-based interventions. These findings support the NICE hypertension guideline (NG136), which accentuates PA as an important non-pharmacological strategy in addition to pharmacological treatment [71]. Second, the variability in outcomes across exercise modalities and intensities suggests that public health interventions should provide more specific guidance on appropriate exercise prescriptions for people with hypertension. National policy frameworks, such as the UK Chief Medical Officers' Physical Activity Guidelines, recommend that adults engage in at least 150 minutes of moderate-intensity PA per week to reduce their cardiovascular risk [70]. Strengthening the implementation of these guidelines through community-based exercise programs, primary care interventions, and social prescribing initiatives may improve adherence to physical activity recommendations [72]. Third, the finding that BP reductions were less consistent among younger adults and shorter PA intervention programs less effective at reducing BP highlights the importance of encouraging sustained PA throughout the life course. As a result, public health strategies across the European countries should prioritize long-term behavioural change over short-term interventions. Policies aligned with national prevention strategies, such as those outlined by the Office for Health Improvement and Disparities (OHID) and the NHS Long Term Plan [73], have the potential to strengthen population-level initiatives that promote regular PA and reduce the long-term burden of hypertension and cardiovascular disease in Europe [7].

Strengths and Limitations

This systematic review has several strengths. First, the review used a structured and transparent methodology which will improve its replicability. This ensured the inclusion of high-quality studies on the effectiveness of PA interventions in hypertension management. The use of a structured search strategy across multiple databases, as well as the CASP appraisal tool, improved the reliability of the evidence synthesis [74]. Furthermore, the review focused on recent peer-reviewed research to ensure that the findings reflected current approaches to PA promotion and hypertension management. The review provides a comprehensive overview of how different exercise strategies can contribute to BP control by synthesizing evidence from various intervention types. However, several limitations should be acknowledged. The review included only a small number of studies, which may limit the generalizability of the findings. Furthermore, the included studies showed significant heterogeneity in terms of intervention type, duration, participant characteristics, and outcome measurement methods, which prevented the use of a of meta-analysis, necessitating a narrative synthesis of the findings [75]. Including only studies published in English language may exclude some other important studies published in other languages.

Future research

Based on the findings of this review, future research should focus on larger randomised controlled trials with longer follow-up periods to better understand the long-term effectiveness of physical activity interventions for hypertension management in Europe. Multicomponent lifestyle interventions that combine physical activity with strategies such as dietary modification and weight management should also be studied in European countries, as these approaches may result in greater blood pressure control benefits [76]. In addition, more research is needed to examine the effectiveness of physical activity interventions across diverse population groups, including younger adults and socioeconomically disadvantaged communities in Europe, to better address health disparities in hypertension outcomes. Future research should also investigate how digital health technologies, such as wearable devices and mobile health applications, can help people in Europe engage in physical activity for longer periods of time and adhere to lifestyle interventions better [77].

Conclusion

This review indicated that PA interventions can lead to significant reductions in BP, particularly SBP, emphasizing the importance of lifestyle-based cardiovascular disease prevention. The review identified several key findings. First, aerobic, and combined exercise interventions were consistently linked to lower SBP, providing relevance to previous research that regular PA is an effective non-pharmacological strategy for hypertension management. Second, the success rate of interventions varied

according to exercise modality and intensity, implying that different types of PA may influence BP outcomes differently. Third, differences in intervention duration and participant characteristics, particularly among younger adults or in short-term programs, appeared to influence the magnitude of BP changes. These findings collectively indicate that consistent participation in appropriately designed PA programs is critical for achieving maximum cardiovascular health benefits. This review also demonstrated that PA interventions can help manage hypertension and reduce cardiovascular risk. The evidence presented emphasizes the potential of exercise-based interventions as accessible and cost-effective approaches to complement pharmacological treatment strategies. However, the effectiveness of such interventions varies by population and program design, underlining the importance of targeted and sustained PA promotion. This review improves the understanding of how PA interventions can help with hypertension management by synthesizing current evidence and accentuates the importance of incorporating lifestyle-based approaches into public health and clinical practice.

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript. All authors have approved the final version of the manuscript and agree with its submission. The research was conducted independently, and no external funding or influence affected the study's design, data collection, analysis, or interpretation.

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