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Review Article

Key contents of health education and their impact on improving medication adherence among hypertensive patients: A systematic review and meta-analysis

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Abstract

Hypertension is a global health issue with significant effects on morbidity and mortality, and medication adherence is crucial for effective management. Despite its importance, adherence remains low among hypertensive patients. Health education has been shown to improve medication adherence, though its effectiveness varies across studies. The aim of this study was to systematically synthesize evidence on the impact of health education in enhancing medication adherence among hypertensive patients. This study followed preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines and employed the population, intervention, control, and outcome (PICO) approach to develop keywords for a search across five databases: Emerald, ProQuest, PubMed, ScienceDirect, and Scopus. All randomized control trials published between 2019 and 2024 in English, evaluating health education's impact on medication adherence in hypertensive patients aged ≥18 years were included. The protocol was registered on PROSPERO (CRD42024532890), and study quality was assessed using the CEBMa scale. Twelve high-quality articles (CEBMa score of ≥7) involving 1,827 participants were included, identifying four key themes in health education for hypertension: an overview of hypertension and complications, medication and side-effect management, healthy lifestyle modification, and medication adherence strategies. Health education significantly improved medication adherence by 33% (risk ratio (RR): 1.33; 95%CI: 1.08–1.64; p=0.008), with a medium-large effect on improving medication adherence (d=0.70; 95%CI: 0.34–1.05; p<0.0001) and a small-medium effect on reducing non-adherence (d=-0.45; 95%CI: -0.66–(-0.24); p<0.0001). Health education delivered 1 to 3 months and with individualized approaches showed better adherence outcomes compared to more than three months and group-based methods. Face-to-face education was more effective than the digital method. In conclusion, health education improves medication adherence in hypertensive patients when delivered comprehensively over 1–3 months through individualized face-to-face sessions. These findings support its integration as a key strategy in hypertension management to enhance adherence.

Keywords: Health education, hypertension, medication adherence, medication compliance, systematic review and meta-analysis

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Introduction

Hypertension is a significant global public health concern, affecting approximately 30% of adults worldwide, with a higher prevalence in low- and middle-income countries (LMICs) [1-3]. Uncontrolled hypertension leads to severe complications, including cardiovascular disease, renal

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impairment, cerebrovascular accidents, and increased mortality [4]. Effective blood pressure control strategies are crucial to mitigating these risks [5].

Medication adherence is a key determinant of hypertension management, yet adherence rates remain suboptimal, particularly in resource-limited settings [6-8]. Poor adherence is a major contributor to uncontrolled hypertension, leading to a higher disease burden [9,10]. Medication adherence is influenced by multiple factors, including patient-related behaviors, healthcare-provider communication, and systemic barriers. One commonly used method to assess adherence is self-reported measures [10-12]. Various interventions have been explored to improve adherence among hypertensive patients, including home blood pressure monitoring device as a hypertension management method [13], community-based intervention in Ghana [14], and lifestyle modification counseling intervention in Ethiopia [15]. In Turkey, the hypertension education booklet program enhanced patients' social, psychological, and physiological adaptation to their condition [16]. Pharmacist-led intervention has also been effective, particularly for hypertensive patients with comorbid type 2 diabetes [17]. Additionally, health education programs in rural areas have aimed to improve knowledge and attitudes toward hypertension management [18].

Interventions focusing on patient behavior have shown greater effectiveness in improving adherence compared to provider- or system-targeted approaches [19]. Patients with chronic conditions, including hypertension, demonstrate better adherence when provided with structured health education [20-23]. Moreover, advances in information technology, such as website-based, smartphone, telehealth, and WeChat, have been used to improve health education for individuals diagnosed with hypertension [24-27]. However, a meta-analysis demonstrated that educational interventions benefited patients with type 2 diabetes more than those with hypertension [28]. Currently, there is no comprehensive review that synthesizes which health education content is most effective in improving medication adherence among hypertensive patients. Therefore, the aim of this study was to synthesize health education content that effectively improves medication adherence in hypertensive patients. This study's findings can help assist in the creation of a health education approach that effectively increases adherence to medications in hypertension patients.

Methods

Study design and protocol registration

This study was performed using the principles of preferred reporting items for systematic reviews and meta-analyses (PRISMA) guideline [29]. The research questions were formulated using the PICO framework to define the population, intervention, comparison, and outcome, facilitating a systematic search strategy [30]. A predefined search protocol was applied across multiple databases, incorporating Boolean operators, field codes, and parentheses for precision [31]. The protocol of this study has been prospectively registered in PROSPERO under the registration number CRD42024532890.

Search strategy

A systematic literature search was conducted across five electronic databases: Emerald, ProQuest, PubMed, ScienceDirect, and Scopus. Keywords were structured based on the population, intervention, control, and outcome (PICO) framework to ensure a comprehensive and targeted retrieval of relevant studies. Database searches were conducted on April 18, 2024, using keyword combinations aligned with Medical Subject Headings (MeSH) terms. The search terms were structured as follows: population (hypertensive, hypertension, high blood pressure), intervention (health promotion, health education), and outcome (medication adherence, medication compliance). The final Boolean search string used was ("hypertensive" OR "hypertension" OR "high blood pressure") AND ("health promotion" OR "health education") AND ("medication adherence" OR "medication compliance").

Study eligibility criteria

This study applied the PICO framework to define study eligibility. The population included adults aged ≥18 years diagnosed with hypertension. The intervention of interest was health education

or health promotion. The comparison groups were not specifically defined. The primary outcome was medication adherence to anti-hypertension medication.

The selection process began with a review of titles and abstracts to identify studies evaluating health education as an intervention to improve medication adherence in hypertensive patients. Studies were included if they met the following criteria: (1) hypertensive patients aged ≥18 years; (2) adherence to antihypertensive medication was measured; (3) the study used a randomized controlled trial (RCT) design; (4) the study was published in English between 2019 and 2024; (5) the intervention consisted of health education or health promotion; and (6) the study reported the effect size of medication adherence as mean ± standard deviation (SD) or proportion. Review articles, meta-analyses, study protocols, editorials, and studies involving individuals not taking antihypertensive medication were excluded.

Screening of studies

Duplicate studies were identified and removed using a reference manager [32], with EndNote X9 (Clarivate, Philadelphia, United States) employed for article organization. Title and abstract screening were conducted independently by two reviewers (MM and EPP). Studies that did not align with the research objectives were excluded. Full-text articles were further assessed, and those deemed irrelevant were removed. Any discrepancies in study selection were resolved through discussion, with a third independent reviewer (HH) consulted when disagreements arose. The study selection and screening process were documented using the PRISMA flowchart.

Data extraction

Data were extracted using Microsoft Excel [33], capturing key study characteristics and outcomes. Extracted variables included author(s) and year of publication, study location (country and setting), study design, sample size, intervention details (method and duration), the instrument used to assess medication adherence, and adherence outcomes (scores or proportion of patients adhering to medication). The extracted data were systematically organized and presented in tables summarizing study characteristics and health education content.

Quality assessment

A feasibility assessment was conducted to evaluate the quality of each included study. Two reviewers (MM and EP) independently assessed study quality, with a third reviewer (HH) resolving any discrepancies. The assessment followed the critical appraisal criteria for controlled studies from the Center for Evidence-Based Management (CEBMa). The CEBMa tool comprises 12 key questions (**Table 1**) [34].

Table 1. CEBMa quality assessment criteria

No.	Assessment criteria
1.	Is the research question clearly defined and relevant?
2.	Is the study design appropriate for answering the research question?
3.	Is the sample size sufficient to ensure findings are not due to chance?
4.	Were participants randomly allocated to minimize selection bias?
5.	Were objective inclusion and exclusion criteria applied?
6.	Was intergroup comparability established at the beginning of the study?
7.	Were the outcome measures valid and unbiased?
8.	Were the measurement methods used objective and reliable?
9.	Does the effect size have practical relevance?
10.	Are effect size estimates precise, as indicated by confidence intervals?
11.	Were potential confounding factors controlled?
12.	Can the study results be applied to your study? (Modified from "your organization")

To align with the purpose of synthesizing evidence rather than organizational application, the 12th question, originally phrased as "Can the results be applied to your organization?" was modified to "Can the results be applied to your study?". Each study was scored on a scale of 0 to 12, with 1 point assigned for a "Yes" response and 0 points for a "No" or "Can't tell" response. A study scoring ≥7 was classified as high quality, scores between 5 and 7 indicated moderate quality, and scores ≤4 were considered weak. These scoring thresholds were adapted from criteria used in a previous systematic review [35]. A higher score reflects a well-defined research question, an

appropriate study design and methodology, objective and valid findings, and practical applicability. Consequently, systematic reviews and meta-analyses based on high-quality studies yield findings that are valid, reliable, and clinically or scientifically relevant.

Statistical analysis

The meta-analysis was conducted using RevMan 5.4 software (Cochrane Collaboration, London, United Kingdom). For continuous data, the standardized mean difference (*d*) with 95% confidence intervals (CI) was used as the effect measure, while for dichotomous data, the risk ratio (RR) with 95% CI was applied. The results of the meta-analysis assessing the effectiveness of health education were presented in a forest plot, while publication bias was evaluated using a funnel plot. Study heterogeneity was assessed using the I^2 statistic and the Q-test (*p*-value). Heterogeneity was classified as low (I^2<50%), moderate (I^2: 50–74%), or high (I^2>75%) [36]. If I^2<50%, a fixed-effects model was used for pooled effect size estimation, whereas a random-effects model was applied when I^2≥50%.

Subgroup analysis was conducted to compare groups and determine whether significant heterogeneity was attributed to differences within subgroups. Data were categorized based on patient, intervention, or outcome characteristics, with this study specifically analyzing subgroups according to the duration, approach, and method of the health education intervention.

Results

Literature search results and selection

A comprehensive database search identified 502 articles. After duplicate removal using EndNote X9, 492 articles proceeded to screening. Title and abstract evaluation excluded 439 articles due to irrelevance, leaving 53 for full-text assessment. Further scrutiny led to the exclusion of 41 articles that failed to meet the inclusion criteria. Ultimately, 12 RCTs were eligible for inclusion in final analysis [20,21,24-27,37-42] (**Figure 1**).

Study characteristics

A summary of the characteristics of the 12 included studies is presented in **Table 2**. The studies were conducted across seven countries, with China being the most contributing with four studies [21,24,27,42], the USA with three studies [25,26,41], and Palestine [37], Mexico [20], Iran [39], Turkey [38], and India [40] with one study each. The publication years ranged from 2019 to 2024, with the highest number published in 2020. The total sample size across the 12 studies was 1,827 individuals, comprising 902 patients in the intervention group and 925 in the control group. Regarding study settings, one study was conducted in a nursing home [38], four in hospitals [20,26,39,42], and seven in community health centers (CHCs) [21,24,25,37,40-42]. The duration of health education interventions varied, with six studies reporting durations of ≤3 months [25-27,37,39,42] and six studies reporting durations >3 months [20,21,24,38,40,41].

Health education delivery approaches differed across studies; five studies employed an individual approach [20,25,27,39,41], four used group approaches [21,24,40,42], and three utilized both individual and group approaches [26,37,38]. Health education varies among studies depending on the methods used. Seven studies used face-to-face methods [20,21,37-41], and five studies used digital-based methods [24-27,42]. Medication adherence assessment tools also varied. Nine studies used the Morisky Medication Adherence Scale (MMAS) [20,25,27,37,38,41-44], four studies employed researcher-developed questionnaires [21,39,40,45], one study used the Hypertension Patient's Self-Management Behavior Rating Scale (HBCHBPTS) [26], and one study utilized the Hill-Bone Compliance to High Blood Pressure Therapy Scale (HPSMBRS) [24].

Quality assessment of the included studies

Quality assessment of the included studies is presented in **Table 3**. Five studies received a quality score of 12 [20,21,38,39,42], indicating strong methodological quality. Four studies were rated 11 [24,26,37,41], two studies scored 10 [27,40], and one study obtained a score of 9 [25]. The assessment identified concerns regarding sample size adequacy, with two studies including fewer than 30 participants [25,27]. Three studies did not report CIs for effect size estimates, limiting the precision of their reported associations [24,26,40]. Furthermore, four studies acknowledged

potential confounding factors but did not explicitly describe the methods used for controlling them [25,37,40,41]. Despite these limitations, all studies scored ≥7, classifying them as high-quality research. This indicates that the included studies demonstrated clarity in research questions, employed appropriate study designs, ensured subject randomization to minimize bias, applied well-defined inclusion and exclusion criteria, compared groups at baseline, utilized valid measurement tools, and presented findings with clinical relevance.

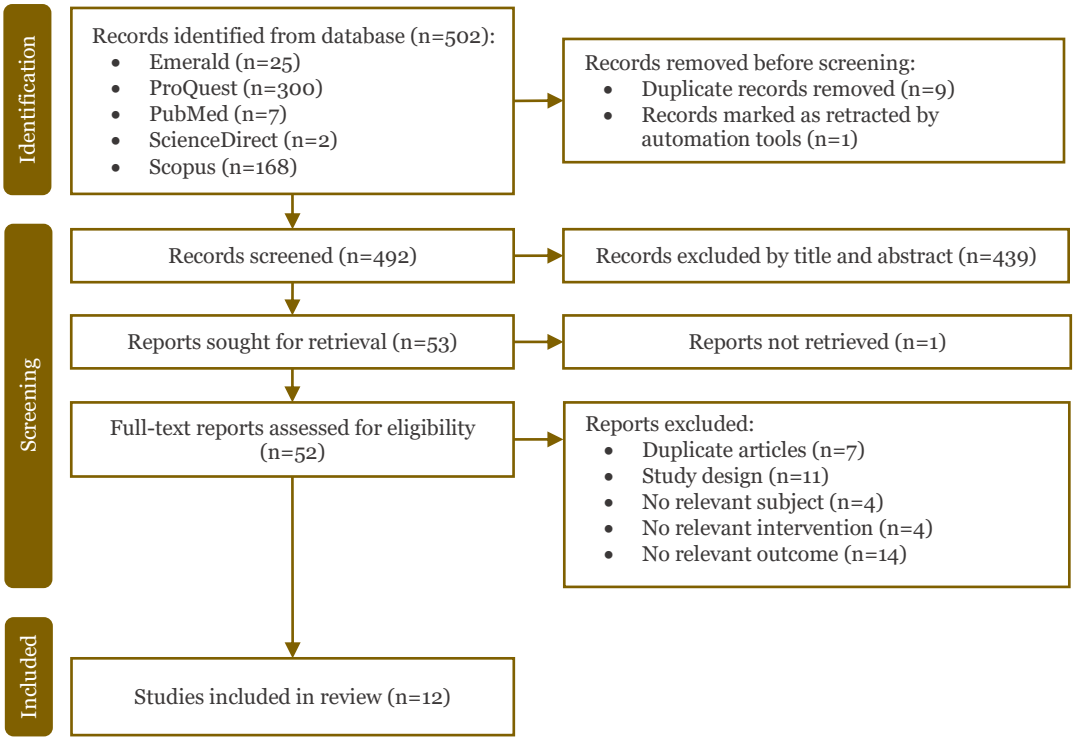

Figure 1. PRISMA flowchart of the study selection process.

Contents of health education

The content of health education for hypertensive patients is categorized into four main themes, as outlined in **Table 4**. The first theme, knowledge about hypertension and its complications, included an overview of hypertension, prevention of complications, and monitoring of blood pressure measurements. The second theme focused on appropriate medication use and side effect management, covering aspects such as medication adherence, the risks of non-adherence, determinants of adherence, barriers to medication use, side effects, and drug interactions. The third theme highlighted healthy lifestyle modifications, including dietary adjustments, physical activity, smoking cessation, alcohol restriction, and stress management. The fourth theme included behavioral strategies for medication adherence, emphasizing daily medication routines, enhancing patient motivation and confidence, and overcoming barriers to treatment.

Impact of health education on medication adherence

Eight studies [20,21,24,25,27,39,41,42], examining a total of 1,243 subjects (606 in intervention and 637 in control group), reported medication adherence in continuous data using the criterion that a high score indicated high adherence. A forest plot is used to represent the studies (**Figure 2A**). Using the random effects model, the meta-analysis revealed a significant effect size, indicating that the health education intervention was helpful in improving adherence to medication, as evidenced by the pooled standardized mean difference (d=0.70; 95%CI: 0.34–1.05; p=0.0001). However, high and significant heterogeneity was found among the studies (I^2=87%; p<0.0001). Therefore, subgroup analysis was necessary. The funnel plot revealed an unequal distribution between the right and left plots, which was indicative of a publishing bias (**Figure 3A**). One plot touched the vertical line, four plots were on the left, and three plots were on the right. The standard error (SE) of the left-hand plot ranged from 0 to 0.4, whereas the SE of the right-hand figure ranged from 0.2 to 0.3.

Table 2. Characteristics of the included studies

Author (year)	Country	Setting	Sample size		Intervention of education			Medication adherence scale	Results	
			Intervention	Control	Approaches	Methods	Duration (month)		Intervention	Control
Continuous data									Mean±SD	Mean±SD
Li *et al.*, 2019 [24]	China	CHC	110	143	GA	Digital	>3	HPSMBRS	145.40±14.90	140.90±14.90
Shen *et al.*, 2019 [21]	China	CHC	262	256	GA	FtF	>3	DR	4.62±0.78	4.39±1.02
Schoenthaler *et al.*, 2020 [41]	USA	CHC	52	50	IA	FtF	>3	MMAS-8	6.46±1.65	6.01±1.35
Schoenthaler *et al.*, 2020 [25]	USA	CHC	21	21	IA	Digital	≤3	MMAS-8	5.60±2.00	5.50±2.10
Still *et al.*, 2020 [26]*	USA	Hospital	30	30	IGA	Digital	≤3	HBCHBPTS	10.72±2.20	11.93±4.43
Sun *et al.*, 2020 [42]	China	Hospital	59	58	GA	Digital	≤3	MMAS-4	3.10±0.68	2.38±0.64
Khadoura *et al.*, 2021 [37]*	Palestine	CHC	159	151	IGA	FtF	≤3	MMAS-8	2.45±1.80	3.35±2.00
Contreras-Vergara *et al.*, 2022 [20]	Mexico	Hospital	46	43	IA	FtF	>3	MMAS-8	7.04±1.40	5.10±1.40
Kordvarkane *et al.*, 2023 [39]	Iran	Hospital	33	35	IA	FtF	≤3	DR	34.78±3.82	27.17±4.84
Sun *et al.*, 2024 [27]	China	CHC	23	31	IA	Digital	≤3	MMAS-8	7.65±0.49	7.09±1.00
Dichotomous data									n (%)	n (%)
Kolcu & Ergun, 2020 [38]	Turkey	NH	37	37	IGA	FtF	>3	MMAS-4	37 (100.00)	32 (86.50)
Kundapur *et al.*, 2023 [40]	India	CHC	70	70	GA	FtF	>3	DR	27 (38.60)	16 (22.90)

CHC: community health center; DR: developed by the researchers; FtF: face-to-face; GA: group approach; HBCHBPTS: hypertension patients self-management behavior rating scale; HPSMBRS: Hill-Bone Compliance to High Blood Pressure Therapy Scale; IGA: individual and group approach; MMAS: Morisky Medication Adherence Scale; NH: nursing home; SD: standard deviation; USA: United State of America

In the two studies marked with *, lower scores indicate higher medication adherence, whereas, in the other eight studies, higher scores indicate higher adherence

Table 3. Quality assessment of each study included in the meta-analysis

Study	Appraisal questions												Score total	Study quality
	1	2	3	4	5	6	7	8	9	10	11	12		
Li *et al.*, 2019 [24]	1	1	1	1	1	1	1	1	1	0	1	1	11	High
Shen *et al.*, 2019 [21]	1	1	1	1	1	1	1	1	1	1	1	1	12	High
Kolcu & Ergun, 2020 [38]	1	1	1	1	1	1	1	1	1	1	1	1	12	High
Schoenthaler *et al.*, 2020 [41]	1	1	1	1	1	1	1	1	1	1	0	1	11	High
Schoenthaler *et al.*, 2020 [25]	1	1	0	1	1	1	1	1	0	1	0	1	9	High
Still *et al.*, 2020 [26]	1	1	1	1	1	1	1	1	1	0	1	1	11	High
Sun *et al.*, 2020 [42]	1	1	1	1	1	1	1	1	1	1	1	1	12	High
Khadoura *et al.*, 2021 [37]	1	1	1	1	1	1	1	1	1	1	0	1	11	High
Contreras-Vergara *et al.*, 2022 [20]	1	1	1	1	1	1	1	1	1	1	1	1	12	High
Kordvarkane *et al.*, 2023 [39]	1	1	1	1	1	1	1	1	1	1	1	1	12	High
Kundapur *et al.*, 2023 [40]	1	1	1	1	1	1	1	1	1	0	0	1	10	High
Sun *et al.*, 2024 [27]	1	1	0	1	1	1	1	1	0	1	1	1	10	High

Table 4. Summary of health education contents

Themes	Contents of health education
Knowledge about hypertension and its complications	Hypertension overview, prevention of hypertension complications, monitoring of blood pressure measurement [20,21,24-27,37,39,41,42]
Proper medication usage and side effects management	Medication use, the significance of medication adherence, the risks of medication non-adherence, determinants of medication adherence, barriers to taking medication, side effects, and drug interactions [20,21,24-27,38,39,41,42]
Modification of a healthy lifestyle	Healthy lifestyle, diet balanced nutrition, physical activity, quitting smoking, limiting alcohol, and stress management [24,26,27,38,40,42]
Behavioral strategies for medication adherence	Strategies to take medication every day, enhanced patient motivation and confidence, overcoming barriers to treatment [25,37,41]

Two studies [26,37] reported medication non-adherence in continuous data with criteria of low score indicating high adherence, evaluating 270 subjects (189 in intervention and 181 in control group). The results of the meta-analysis through the fixed effects model showed a small-medium effect size that health education significantly decreased medication non-adherence (d=-0.45, 95%CI: -0.66–(-0.24); p<0.0001) (**Figure 2B**). Heterogeneity between these two studies was minimal and not significant in this instance (I^2=0%; p=0.65). The funnel plot revealed a balance between the right and left plots in the study, indicating that there was no publication bias (**Figure 3B**). One plot on the left contacted the line to create an inverted funnel, and the other plot on the right did the same. The right-hand plot had an SE between 0.2 and 0.3, while the left-hand plot had an SE between 0.1 and 0.2.

Four studies [38,40,43,45] reported medication adherence in dichotomous data, evaluating 214 subjects (107 in intervention and 107 in control group). The forest plot indicated a small and statistically significant effect size was found in the meta-analysis of the fixed effect model (RR= 1.33; 95%CI: 1.08–1.64; p=0.008) (**Figure 2C**). Heterogeneity between the studies was significant (I^2=80%; p=0.03). The funnel plot revealed a balance between the right and left plots, which indicated no publication bias (**Figure 3C**). An inverted funnel was formed by two plots on the right and two plots on the left. The right-hand plot had SE between 0.2 and 0.3, while the left-hand plot had SE between 0 and 0.1.

Subgroup analysis

A subgroup analysis was performed to examine disparities among the studies, focusing specifically on the duration (≤3 months vs >3 months), approaches (individual vs group), and methods (face-to-face vs digital) of health education. Subgroup analysis based on the duration (≤3 months vs >3 months) is presented in **Figure 4A**. In the group with a duration of ≤3 months, health education showed a significant and large effect (d=0.93; 95%CI: 0.35–1.51; p=0.002), while in the group with a duration >3 months, the effect of health education was also significant with a medium effect size (d=0.48; 95%CI: 0.06–0.09; p=0.02), there was no significant

difference and low heterogeneity between subgroups (I^2=32%; p=0.22). Subgroup analysis based on the individual vs group approach is presented in **Figure 4B**. In the group with the individual approach, a significant and large effect was shown (d=0.91; 95%CI: 0.33–1.48; p=0.002), while in the group with the group approach, a small and significant effect was shown (d=0.29; 95%CI: 0.16–0.43; p<0.0001), there was a significant difference and high heterogeneity between the individual approach and the group approach (I^2= 75.9%; p=0.04). Subgroup analysis based on health education methods (face-to-face vs digital) is presented in **Figure 4C**. In the face-to-face method, it showed a significant and large effect size (d=0.84; 95%CI: 0.06–1.16; p<0.0001), while in the group with the digital method, it showed a significant and medium effect size (d=0.57; 95%CI: 0.18–0.96; p=0.006), there was no significant difference and heterogeneity between the subgroups (I^2=0%; p=0.54). The publication bias of the duration, approach, and method of health education are presented in **Figures 3D**, **3E**, and **3F**. The funnel plots show an imbalance in the right and left distribution of studies within each subgroup section, indicating publication bias (**Figures 3D**, **3E**, and **3F**).

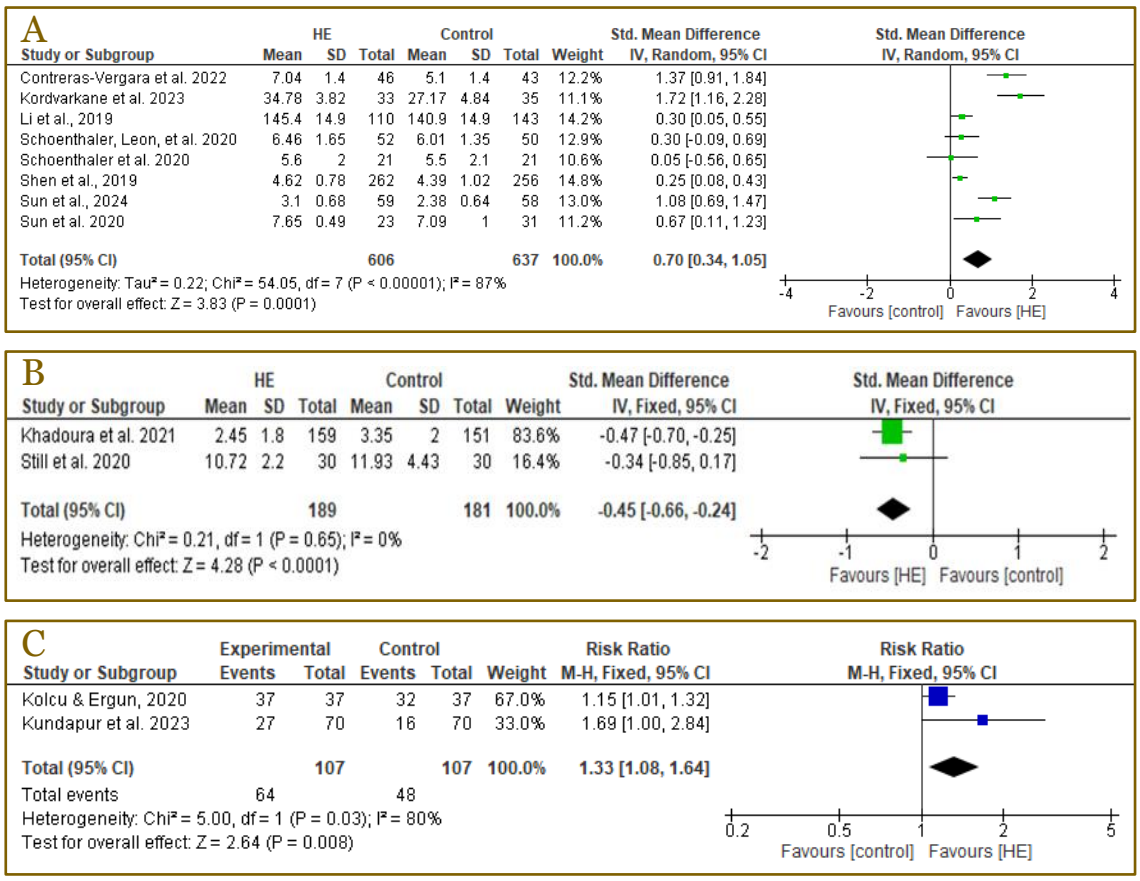

Figure 2. Meta-analysis assessing the impact of health education on medication adherence among individuals with hypertension. (A) The pooled effects size of health education on adherence to medication (continuous data). (B) The pooled effects size of health education on non-adherence to medication (continuous data). (C) The pooled effects size of health education on adherence to medication (dichotomous data).

Discussion

Health education in hypertensive patients in this study covers four main themes that are relevant and fundamental to the effective management of hypertension. Our analysis found that educational resources were offered to enhance medication adherence, such as an overview of hypertension and its complications, proper treatment including management of drug side effects, healthy lifestyle modification, and behavioral change strategies towards medication adherence behavior. A previous study has reported that patients' knowledge of hypertension is a major factor influencing medication adherence [45]. For example, education on the importance of medication

for hypertension patients [46,47], how to take antihypertensive drugs correctly [19,48], and management of side effects [49], which is an important element in improving medication adherence. In addition, education tailored to the patient's literacy level affects blood pressure control [43].

Furthermore, our review emphasizes that health education should be provided comprehensively and according to the needs of the patient. Comprehensive health education is crucial in today's healthcare landscape, as it equips patients with the essential tools, resources, and knowledge they need to make informed decisions regarding their treatment plans and lifestyle choices. The theme of education for hypertensive patients is consistent with recommendations from global health organizations and several study results that emphasize the importance of lifestyle changes in the management of hypertension, the use of psychological mechanisms in lifestyle intervention, improving doctor-patient communication, implementing first-line therapy, and innovation in treatment [50-54]. Furthermore, appropriately implemented lifestyle changes can improve the effectiveness of pharmacologic therapy for hypertension [55]. Therefore, hypertensive patients should be educated about antihypertensive drugs and healthy lifestyles comprehensively so that they can control their condition. Educational materials in health must align with patients' needs and literacy levels. The International Society of Hypertension College of Experts recommends sustaining lifestyle modifications alongside antihypertensive medications to prevent and manage hypertension [56].

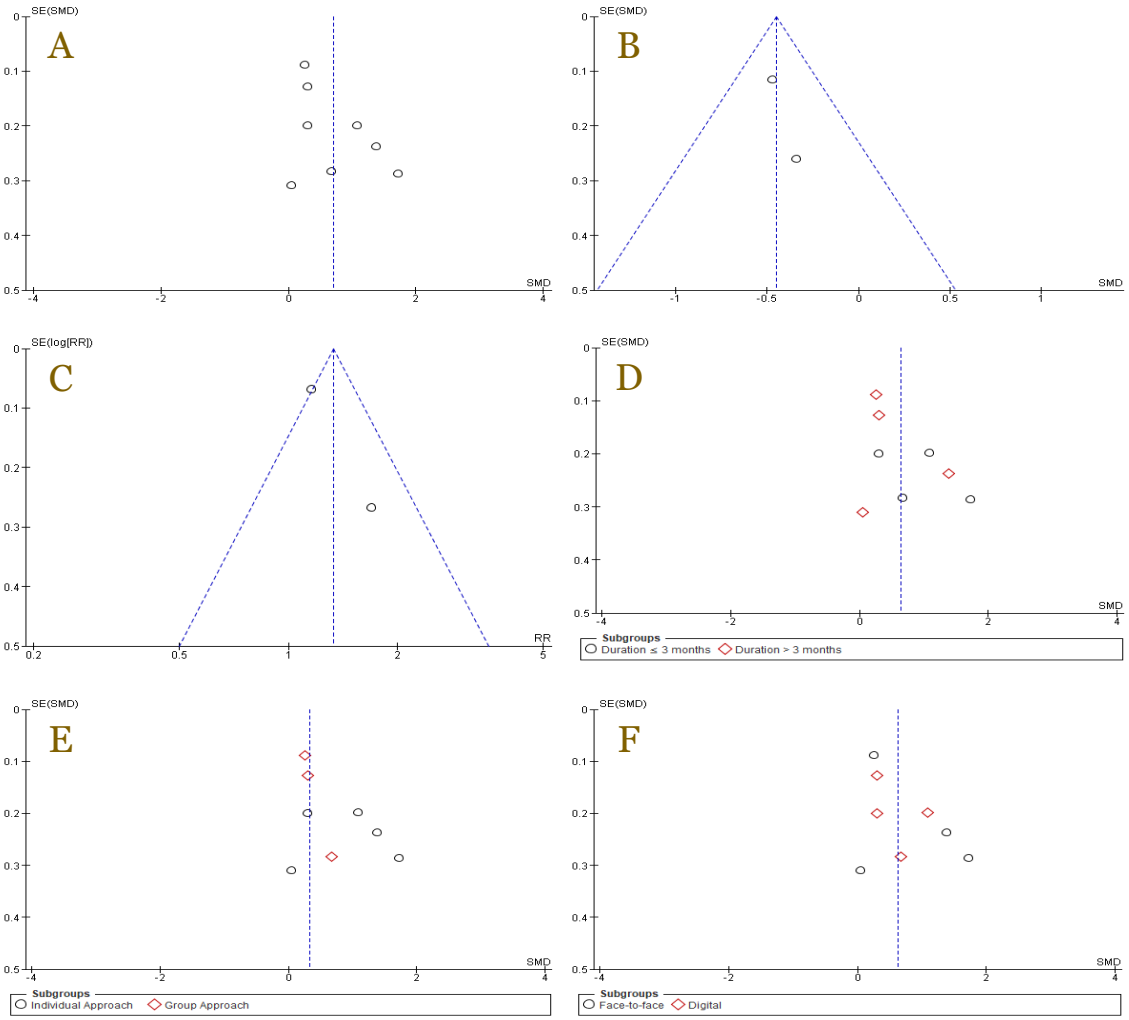

Figure 3. Publication bias in all studies on medication adherence in various datasets: (A) continuous data for medication adherence; (B) continuous data for medication non-adherence; (C) dichotomous data; (D) subgroup analysis based on duration; (E) subgroup analysis based on approaches; and (F) subgroup analysis based on methods.

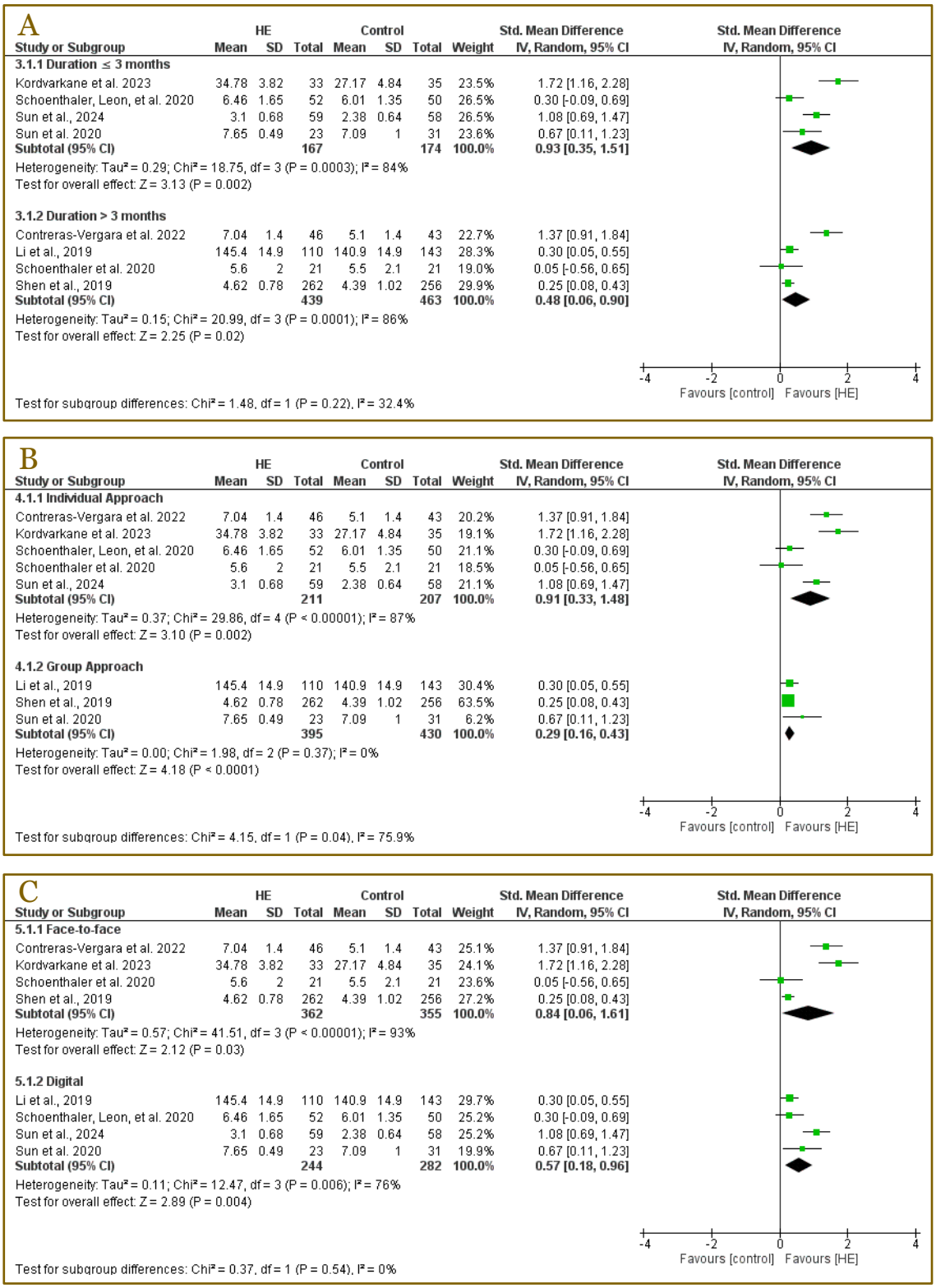

Figure 4. Pooled effects size of health education on adherence to medication in individual with hypertension based on: (A) duration (≤3 months vs >3 months), (B) approach (individual vs group), and (C) method (face-to-face vs digital).

Our analysis demonstrated that health education significantly improves hypertension patients' adherence to their medication. Overall, the analysis showed strong effect sizes for both continuous and dichotomous data, indicating that health education interventions can significantly improve medication adherence. This finding is consistent with the results of previous

studies [57,58]. According to earlier studies, educating hypertension patients increased their health literacy and medication adherence [57,58]. Providing health education also improves perceptions of severity, susceptibility, and benefits of treatment, which in turn promotes improved adherence to treatment [28]. Other studies reported that health behavioral theory approaches such as the health belief model or transtheoretical model are used to develop health education models for hypertensive patients [28,59].

We looked at different groups, and we found that medication adherence increased significantly when education lasted less than three months, was delivered in an individualized manner, and was delivered face-to-face. In this review, one study was conducted on health education for one month [39], but many studies were conducted for three months [25-27,37,42]. Patients were given health education in 2 to 9 sessions, with each session lasting 15 to 45 minutes [21,38-41]. In addition, family members are involved in helping patients get used to compliant behavior [40]. A previous study found that verbal education enhances medication adherence and health literacy in hypertensive patients by encouraging patient involvement and active participation [57]. In addition to providing knowledge about hypertension and its treatment, health education is also aimed at motivating to increase patient self-efficacy. As reported in previous studies, self-efficacy is the key to success in hypertension treatment adherence [37,39,44,49,60].

The development of information technology can be used for health education, but not to replace the role of doctors in educating patients. For example, we found that after health education was provided, patients were given 15 minutes of counseling conducted face-to-face or via telephone [41], and video consultations developed in the form of telemedicine [61]. Information technology, such as telehealth education, must play a role as a supporter of direct doctor-patient interaction and can enhance self-care practices in hypertensive individuals. [62,63]. Another study indicates a number of obstacles to the broad adoption of telehealth, including poor adoption by vulnerable groups, worries about service quality, and convenience [64]. However, these obstacles do not hinder the emergence of more innovative health education. Innovation in information technology within health education must consider the principles of engagement and direct interaction between patients and doctors.

In addition, factors such as cultural belief, medication literacy, education level, self-efficacy, skill of health worker communication, and access to information media influence the effectiveness of health education, and lower wealth. An individual's capacity to comprehend and respond to health education from a health practitioner is influenced by their cultural views on health and illness [22,60]. Patient satisfaction with health worker communication has a significant effect on medication adherence in hypertension, with higher levels of satisfaction associated with increased adherence [65]. World Health Organization mentioned that the patient's condition, media availability, and health educator, all play an essential role in influencing the success of health education [66]. Lower income and education levels are important in poor hypertension awareness, treatment, and control [67]. However, comprehensive health education will increase patients' understanding of their condition and encourage their belief in positive behavioral changes to comply with treatment. As reported in previous study, health education based on the health belief model can increase compliance with treatment in hypertension patients by changing their beliefs [44].

LMICs have a greater prevalence of hypertension than high-income countries [2]. In contrast, LMICs have lower levels of awareness, treatment, and control for hypertension in individuals than in high-income countries [9,68]. This disparity is attributable to higher disease awareness and a superior healthcare system in high-income nations compared to LMICs [69]. This should be a serious concern for LMICs, as untreated hypertension can result in complications such as heart disease, kidney disease, and stroke [4,5,50,55] of which these diseases require better healthcare and high costs [3,51,69]. Thus, health education is a rational choice for LMICs. Comprehensive health education is designed to encourage hypertension patients to have a healthy lifestyle and follow regular therapy. This approach not only enables individuals to manage their health effectively but also reduces the burden on the healthcare system by reducing the incidence of severe complications associated with untreated hypertension.

This review showed that health education significantly improves medication adherence in hypertensive patients, both through continuous and dichotomous data. Health education interventions cover an overview of hypertension and its risk of complications, medication management, a healthy lifestyle, how to improve medication adherence behavior and blood pressure monitoring. These educate patients on the necessity of adhering to antihypertensive treatment. These findings highlight the importance of a systematic, comprehensive, and personalized health education strategy in the early stages of treatment, with a focus on short duration and delivered face-to-face. Future studies should examine how information technology, such as telehealth use and other outside variables can increase the efficacy of educational programs.

This review has limitations, namely the potential to omit eligible studies, particularly those written in non-English languages. Research with RCTs in other relevant languages may not be included, even though they may make important contributions. In addition, although only involving individuals with hypertension taking antihypertensive drugs, studies that included comorbidities were not excluded, which may lead to differences in participant characteristics and increase heterogeneity between studies. Variations in health education approaches (individual vs group) contributed to heterogeneity.

Conclusion

This study underscores the critical role of structured health education in enhancing medication adherence among hypertensive patients. Interventions delivered over one to three months, primarily through individualized, face-to-face sessions, demonstrated significant effectiveness. Effective educational programs should comprehensively address four key themes: understanding hypertension and its complications, proper medication use and side effect management, lifestyle modifications, and behavioral strategies for adherence. Our findings reinforce the need to integrate structured health education into hypertension management, particularly in LMICs, where such interventions remain underutilized. Leveraging information technology alongside direct patient-provider interactions may further enhance the reach and sustainability of these programs.

Ethics approval

Not required.

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Competing interests

All authors state that they do not have conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

This study used artificial intelligence (AI) tool for manuscript writing support of which QuillBot was used for language refinement (increasing grammar, sentence structure, and readability). We confirm that the authors extensively assessed all AI-assisted processes to ensure that the results were accurate and reliable. The authors took full responsibility for the final conclusions and interpretations given in this article.

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