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Review Article

Utilization and Effectiveness of the PRECEDE-PROCEED Model as a Tool in Public Health Interventions: A Systematic Review

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Abstract

Background: The PRECEDE-PROCEED Model (PPM) is a theoretical tool for comprehensively assessing population health priorities and practically guiding the planning, implementation, and evaluation of interventions. We aimed to analyze systematically the extent of PPM utilization in the development and evaluation of public health interventions and to appraise the effectiveness of PPM-based interventions.

Methods: PUBMED, Web of Science, ELSEVIER, EBSCO, and SCOPUS were systematically searched to identify relevant peer-reviewed studies from inception to June 2024. Data were extracted on study objectives, design, population, PPM utilization, interventions, and outcomes. Qualitative synthesis was performed to analyze how PPM was applied, to identify recurring themes, and to assess intervention effectiveness.

Results: A total of 54 studies were included, of which 51 reported effective outcomes. These studies spanned 11 domains including disease prevention and control, healthy behaviors, preventing domestic violence, and so on. Education and ecological assessment was most frequently adopted (96%) in the PRECEDE stage, and outcome assessment was most commonly adopted (94%) in the PROCEED phase. All studied interventions incorporated health education. Nine key intervention elements were identified including sustained implementation, adequate duration, multiple educational topics, diverse formats, social support, providing educational materials, participant interaction, intervention monitoring, and practice support. Participant interaction was most frequently utilized (85%), whereas practice support was least frequently used (54%).

Conclusion: Our findings highlight the importance of educational and ecological assessment in the PRECEDE stage and outcome evaluation in the PROCEDE phase for effective intervention design and assessment. Future PPM-based interventions should consider the nine identified core elements, with emphasis tailored to the specific health domain.

Keywords: The PRECEDE-PROCEED model; Public health interventions; Effectiveness; Systematic review

Introduction

Emerging and re-emerging infectious diseases, chronic diseases, and environmental health issues continue to pose significant threats to population health (1-4). In response, governments have introduced policies to facilitate the successful delivery of public health interventions (5, 6). Timely development and rigorous evaluation of these

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public health interventions are crucial to addressing these pressing public health challenges.

The PRECEDE-PROCEED Model (PPM), proposed by Green and Kreuter, provides a structured framework for the planning, implementation, and evaluation of health intervention through a multistep process comprising the PRECEDE and the PROCEED phases (7) (Fig. 1). The PRECEDE phase focuses on intervention planning, guided by a series of assessments—social, epidemiological, behavioral and environmental, educational and ecological, and administrative and policy assessments—to identify population health needs and related factors that may hinder or facilitate intervention success (8). The PROCEED phase emphasizes evaluation, encompassing process assessment, impact assessment, and outcome assessment, to determine implementation fidelity and intervention effectiveness (9, 10).

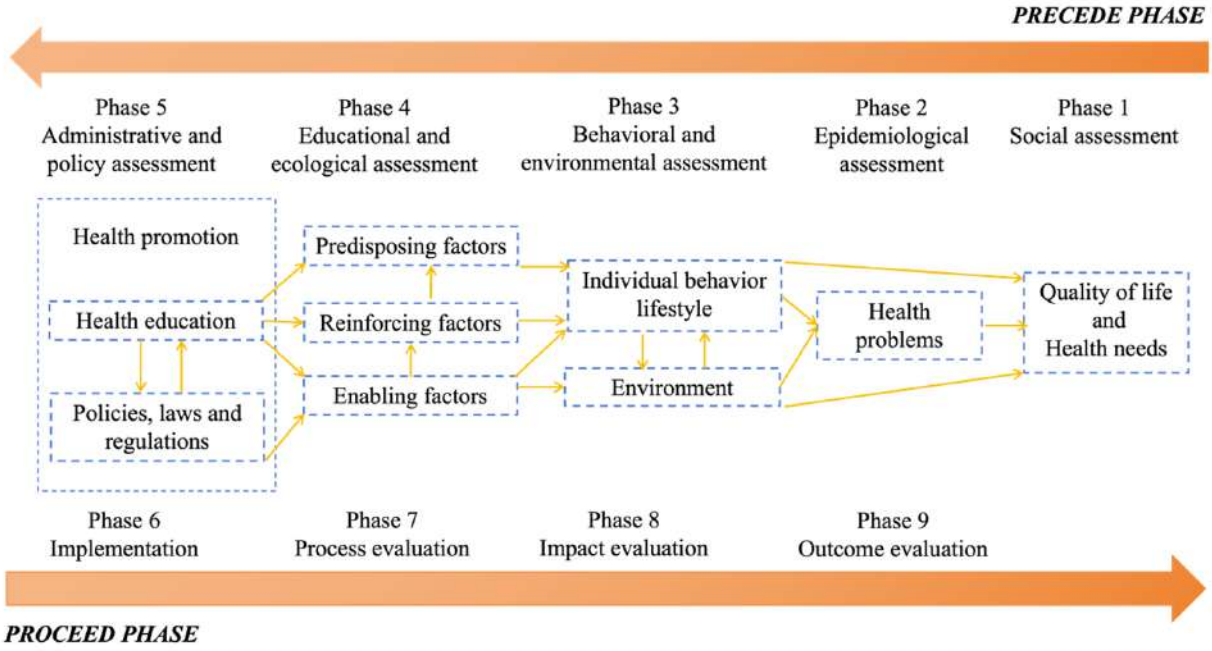

Fig. 1: The PRECEDE-PROCEED model developed by Green and Kreuter (7-10)

Previous literature on PPM has primarily focused on identifying influencing factors as a precursor to the development of health interventions. For example, access to psychosexual care and self-efficacy could significantly affect sexual quality of life (11). James et al. identified health beliefs, social norms, knowledge and skills as key determinants affecting care-seeking behaviors among deaf and hard-of-hearing patients in emergency settings (12). Additionally, Louisa et al. proposed three guiding principles for applying PPM in health needs assessment: a population-centered approach, an ecological and educational perspective, and the importance of contextual and cultural sensitivity (13). However, existing reviews have rarely addressed the effectiveness of PPM-based interventions or have predominantly focused on single domains, and they have not yet synthesized the characteristics of effective PPM-based interventions across different health contexts.

Given PPM's long-standing application across diverse settings (14), conducting a review across multiple fields enables the identification of commonalities and differences, which aids in forming a more complete and holistic understanding of the subject. Such a cross-domain analysis can further validate its versatility and relevance (15). Identifying best practices across various fields not only enhances knowledge transfer but also sup-

ports innovative solutions to address complex, multidimensional public health challenges (16,17).

Therefore, we aimed to systemically analyze the application of PPM across multiple fields, appraise intervention effectiveness, and identify core elements of effective PPM-based interventions.

Methods

Search strategy

PUBMED, Web of Science, ELSEVIER, EBSCO, and SCOPUS were searched from inception to June 2024. The search utilized the following index terms or their synonyms: "PRECEDE PROCEED MODEL" AND "intervention*" AND "controlled trial" AND "effect*". The search strategy and review process adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Guidelines (18). The results of literature search are shown in supplementary table S1 (22-75) (Not published).

Inclusion and exclusion criteria

Studies were included if they met the following criteria: (a) only the experimental group implemented the PPM-based intervention; (b) any controlled experiments that contained a control group for comparison, such as randomized controlled trials, quasi-experimental studies, and controlled observational studies; (c) articles were published in English. The exclusion criteria included: (a) studies not reporting any data or lacking key data (e.g., data on intervention effectiveness or effect size estimation); (b) qualitative research, review, and protocol.

Study screening and data extraction

All initially retrieved articles were screened to identify relevant ones. Articles were discarded if they violated any selection criteria after screening the titles and abstracts. Full texts of the remaining articles were reviewed to determine eligibility for inclusion. Each relevant study was extracted for the following data: first author, publication year, country, research objective, study population, sample size, study design, application of PPM, description of intervention, intervention characteristics, intervention duration, outcome measures, and effects. Details of the extracted information are provided in supplementary Table S2.

Data synthesis and analysis

A qualitative approach was used for this review due to the heterogeneity of study designs, interventions, and outcomes. Core elements of interventions were derived using qualitative synthesis, following an approach already published (19, 20). One author (MY) independently reviewed and cataloged each study's characteristics. Intervention elements were inductively identified and iteratively refined by merging overlapping categories and differentiating distinct ones, based on semantic similarity across studies. A consolidated set of core elements was finalized once thematic saturation was reached and all components could be meaningfully categorized without redundancy or conceptual overlap. Each intervention was then re-evaluated to determine its adherence to the identified elements. Intervention outcomes were analyzed to infer potential associations between specific elements and effectiveness. Additional intervention characteristics were also narratively compared to identify common themes. The above steps were independently checked by a second author (LF), with discrepancies resolved through discussion and consensus.

Quality assessment

The methodological quality of the included studies was appraised by the Effective Public Health Practice Project (EPHPP), which assessed six domains on a three-point scale (strong, moderate, or weak): selection bias, study design, confounders, blinding, data collection methods, and withdrawals (21). Selection bias was evaluated based on participant representativeness and the participation rate; study design focused on randomization and methodological appropriateness; confounders referred to how relevant confounders

were controlled in the design or analysis; blinding examined whether outcome assessors or participants were aware of the intervention or exposure status; data collection methods reviewed the validation and reliability of the data collection tools; withdrawals/dropouts considered the follow-up rate. An overall global rating was then assigned to each study: strong (no weak ratings and ≥4 strong ratings); moderate (one weak rating or <4 strong ratings); and weak (≥2 weak ratings). Two researchers independently assessed the study quality and resolved any disagreements through a consensus discussion with a third reviewer.

Results

The initial search yielded 1104 publications. After screening titles and abstracts, 128 studies underwent full-text review according to inclusion criteria. Ultimately, 54 studies met the criteria and were included (Fig. 2).

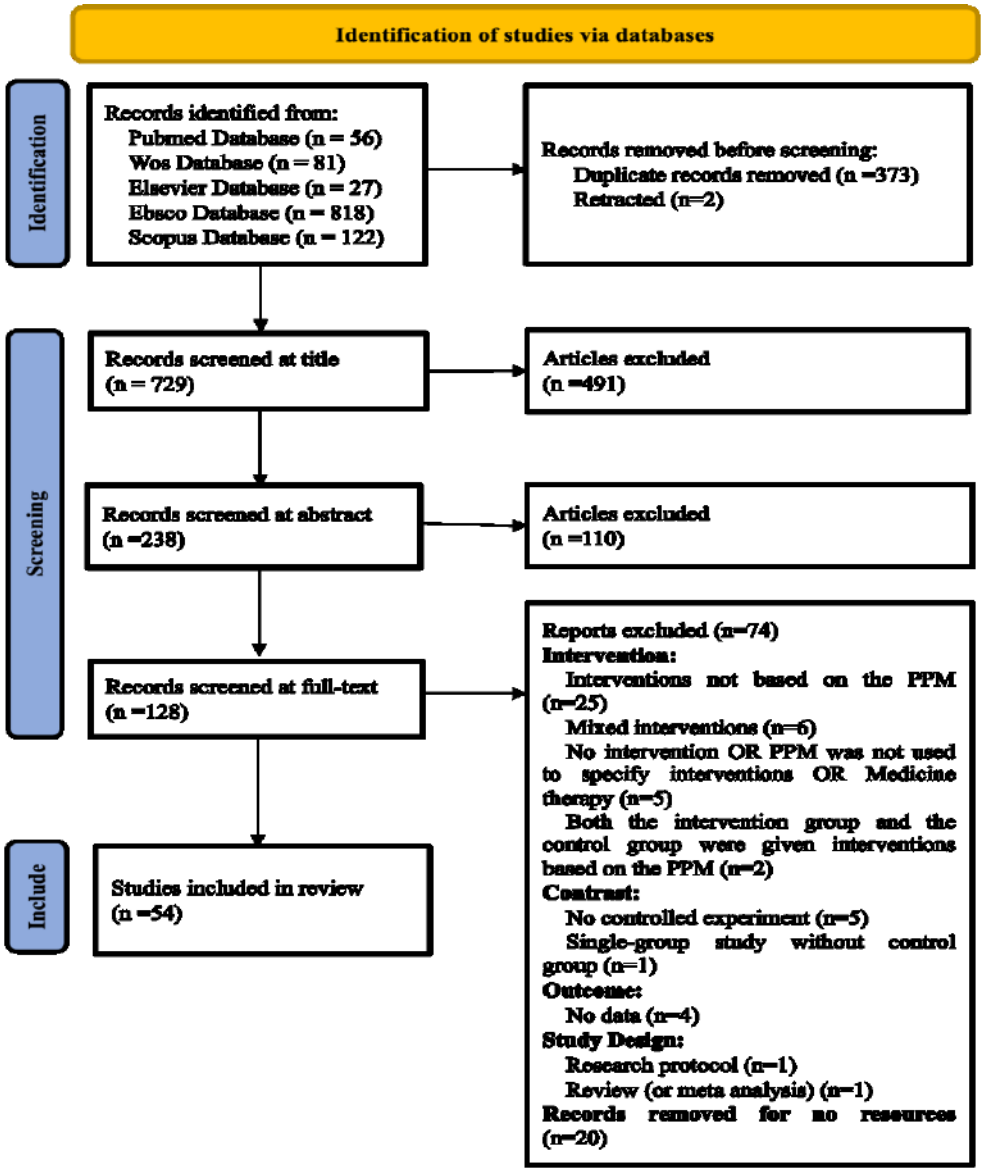

Fig. 2: Flowchart of included and excluded studies (18)

Utilization of the PRECEDE-PROCEED model in public health interventions

The study analyzed the application of PPM along the main framework of "problem-diagnosis-intervention-assessment". In the problem identification phase, the PPM assessed health priorities, study settings, and population. Health-related problems of 54 studies were categorized into 11 domains: disease prevention and control, healthy behaviors, physical function improvement, disease self-management, risk factors control, mental health, quality of life and lifestyle program, preventing domestic violence, ability promotion, resources utilization and mixed fields. Among them, 35 were conducted in Iran (22-24, 29-37, 39-41, 44, 46, 49-55, 57, 58, 60-63, 67, 68, 73-75), five in China (25, 43, 45, 64, 69), three in America (28, 48, 66), three in Australia (38, 65, 70), two in Spain (42, 71), and one in each of the following countries: Belgium (59), Turkey (27), Malaysia (26), Pakistan (56), Kenya (72), and India (47). The sample size ranged from 24 to 497 for the intervention group and 23 to 505 for the control group (22-75). The age of participants included children (26, 59), adolescents (23, 31, 52, 55, 56, 58, 66, 68, 70, 71), and middle-aged and older individuals (30, 33, 45, 53, 54, 60, 63, 64). The participants included both men and women (22-75). Additionally, the disease types for participants covered chronic diseases (25, 29, 40, 42, 44, 46, 51, 57, 61, 62, 64, 74, 75), infectious diseases (28, 72), cancer (73), autism spectrum (70), gynecological diseases (39), and hepatobiliary (43). The occupation of participants covered healthcare workers (27, 35, 38) and livestock breeders (22). Some studies intervene with mixed groups, such as high school students aged 13-16 years and their mothers (36), eighth-grade adolescents, and their parents and teachers (47).

The diagnosis phase was problem-oriented, aiming to identify influencing factors relevant to the health issue. Educational and ecological assessment was the most frequently applied, reported in 52 articles (22-46, 48-64, 66-75). In contrast, administrative and policy assessment was utilized less often, appearing in 13 studies (25, 27, 34, 40, 49, 53, 56, 58, 59, 66, 68, 69, 75). Interventions were developed based on pre-diagnostic findings, and all studies incorporated a health education component (22-75). The intervention duration varied from 2 weeks to 10 months (22-75). To assess the effect, outcome evaluation was the most frequently employed method, observed in 51 articles (22-33, 35-46, 48-57, 59-73, 75), while process evaluation was conducted in 28 studies (22, 24-28, 34, 38, 40, 45, 47-49, 53, 56-59, 61, 64-66, 68-71, 74, 75). An overview of the overall utilization of PPM across the included studies is presented in Fig. 3.

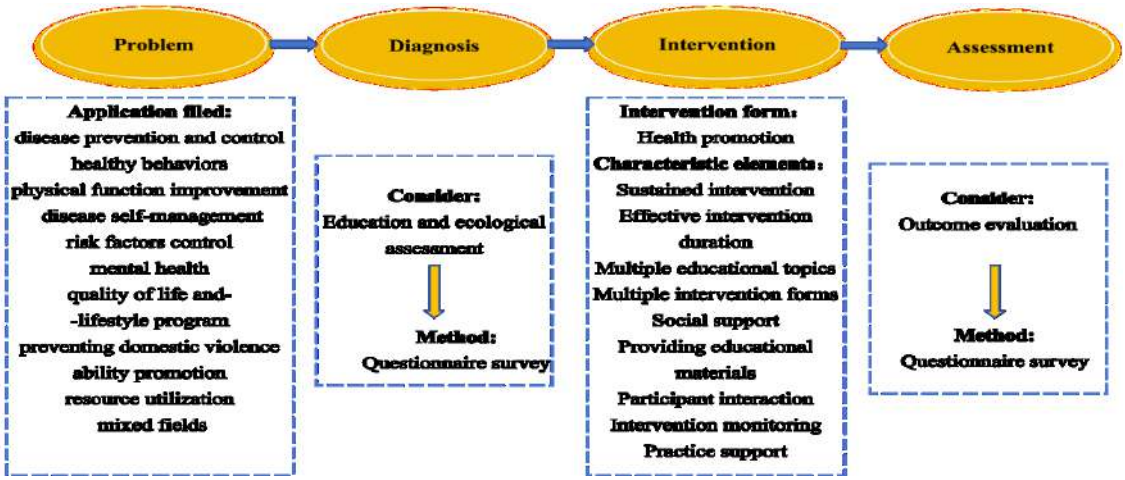

Fig. 3: The utilization diagram of the PRECEDE-PROCEED model

Effectiveness of interventions across diverse fields

Nine core elements integral to the studied interventions were identified and are listed in Table 1. The definitions of nine elements were as follows: (E1) Sustained implementation: involves at least 4 training sessions; (E2) Adequate duration: each session lasts at least 40 minutes; (E3) Multiple educational topics: includes at least 3 educational themes; (E4) Diverse formats: incorporates at least 3 intervention formats; (E5) Social support: means various forms of external support; (E6) Providing educational materials: shares any educational resources with participants; (E7) Participant interaction: represents the interaction between participants and others; (E8) Intervention monitoring: ongoing assessment and feedback during the intervention process; (E9) Practice support: encourages participants to practice the skills or knowledge gained from interventions. Within-group and between-group differences were considered to evaluate the effectiveness of interventions resulting in four possible scenarios: Scenario A: both within-group and between-group differences are valid and significant; Scenario B: both within-group and between-group differences are valid, but only one is significant; Scenario C: both within-group and between-group differences are valid, but neither difference is significant; Scenario D: either the within-group or (and) the between-group difference is not valid(Scenario A, Scenario B, Scenario C, and Scenario D are respectively denoted as [A], [B], [C], and [D] in Table 1).

Table 1: Adherence of interventions based on the PRECEDE-PROCEED model to the nine elements(√ represents the intervention has the element, and [blank] represents the intervention does not have the element.) (22-75)

First author(Ref No.)	E1	E2	E3	E4	E5	E6	E7	E8	E9
Disease Prevention and Control									
[A]Bahadori (22)	√	√		√			√	√	
[A]Jeihooni A (23)	√	√	√	√	√	√	√	√	
[A]Moradi (24)	√	√	√	√		√	√	√	
[A]Wen (25)	√	√	√	√	√	√	√	√	√
[B]Al-Delaimy (26)			√	√	√	√	√	√	√
[B]Sezgin (27)				√		√	√	√	√
[D]Han (28)	√			√		√	√	√	√
Healthy Behaviors									
[A]Barasheh (29)	√	√	√	√	√	√	√		√
[A]Jeihooni A (30)	√	√	√	√	√	√	√	√	√
[A]Jeihooni A (31)	√	√	√	√	√	√	√	√	
[A]Jeihooni A (32)	√	√	√	√	√	√	√	√	
[A]Jeihooni A (33)	√	√	√	√	√	√	√	√	
[A]Jajarmi (34)	√	√	√	√	√		√	√	√
[A]Rakhshani (35)	√	√	√	√			√		
[A]Rezaei (36)		√	√	√			√		
[B]Ghahremani (37)	√	√		√	√	√	√		
[C]Brown (38)				√	√	√	√	√	√
Physical Function Improvement									
[A]Hosseini (39)	√	√	√	√		√	√		
[A]Ranjbaran (40)	√	√	√		√	√	√	√	√
[B]Kashfi S (41)	√	√	√	√			√		
[B]Salinero-Fort A (42)	√	√			√			√	√

Table 1: Continued…

[B]Yang (43)				√	√	√	√	√	√
Disease Self-Management									
[B]Bozorgi (44)			√	√	√		√	√	√
[B]Li (45)	√	√	√	√	√	√	√	√	√
[B]Nejhaddadgar (46)	√				√				
Risk Factors Control									
[A]Kaur (47)	√		√	√	√	√	√	√	√
[C]Gary (48)	√	√		√	√	√	√	√	
Mental Health									
[B]Beydokhti T (49)	√	√	√		√		√		
[B]Hajmohamadi (50)	√	√	√		√		√		√
[B]Hazavei S (51)	√	√	√	√	√		√	√	√
[B]Moshki (52)	√		√				√		
[B]Moshki (53)	√	√	√				√		
[B]Sharifirad (54)	√	√	√	√	√		√	√	√
Quality of Life and Lifestyle Program									
[A]Jeihooni A (55)	√	√	√	√	√	√	√	√	√
[B]Arshad (56)	√	√		√	√		√	√	
[B]Azar F (57)		√	√						
[B]Bazpour (58)	√	√	√		√	√	√		√
[B]Craemer M (59)	√	√		√	√	√		√	√
[B]Mazloomymahmoodabad (60)					√				√
[B]Meripour (61)	√		√	√	√		√	√	
[B]Nejad M (62)	√	√		√	√		√		√
[B]Solhi (63)	√	√		√		√	√		
[B]Wang (64)	√	√	√	√	√	√		√	√
[C]Ashton (65)	√	√	√	√	√	√	√	√	√
[D]Kattelmann K (66)	√		√					√	√
Preventing Domestic Violence									
[A]Afshari (67)	√	√		√		√	√		
[B]Ekhtiari Y (68)	√		√	√	√	√	√		√
Ability Promotion									
[A]Li (69)	√	√		√	√	√	√	√	√
[C]Hatfield (70)				√	√			√	
Resource Utilization									
[B]Adamuz (71)			√	√	√		√		√
[D]Kimani H (72)	√		√	√	√		√		
Mixed Fields									
[A]Gholampour(73)	√	√	√	√	√	√	√	√	
[A]Jeihooni A (74)	√	√	√	√	√	√	√		
[C]Sabzmakan (75)	√	√	√	√	√	√	√	√	√

(E1) Sustained implementation; (E2) Adequate duration; (E3) Multiple educational topics; (E4) Diverse formats; (E5) Social support; (E6) Providing educational materials; (E7) Participant interaction; (E8) Intervention monitoring; (E9) Practice support

Overall, each element was used in more than 28 studies. Participant interaction was most frequently used, while practice support was least frequently used. Out of included studies, 20 interventions belonged to Scenario A, 26 were in Scenario B, 5 were in Scenario C, and only 3 were ineffective (Fig. 4).

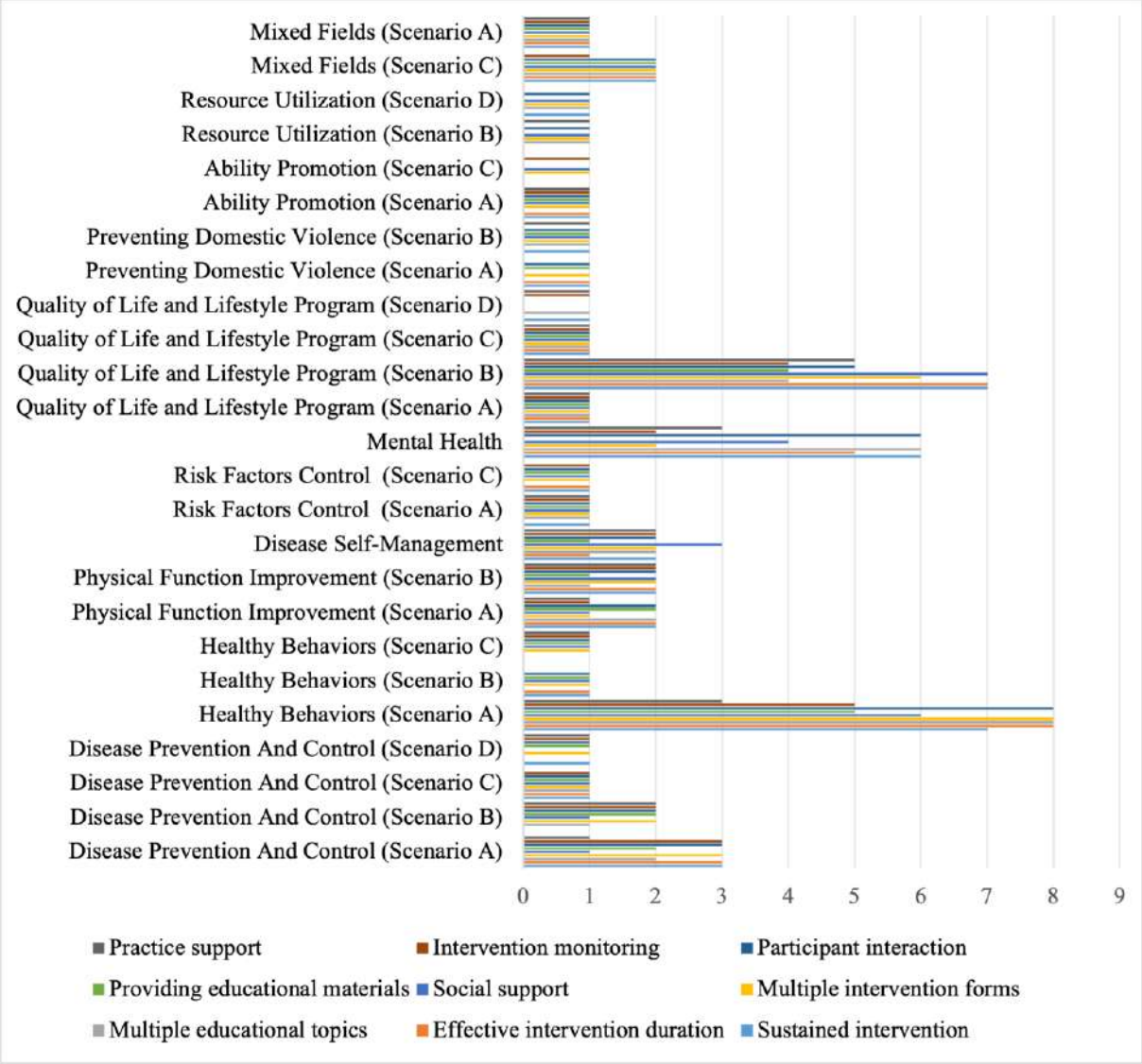

Fig. 4: Frequency plot of the application of characteristic elements across multiple fields

The application of elements across different fields was analyzed from four perspectives. Firstly, from the perspective of simultaneous inclusion, Scenario A interventions addressing disease prevention and control (e.g., brucellosis, iron deficiency anemia, otitis media, and fatigue) commonly included sustained implementation, adequate duration, diverse formats, participant interaction and intervention monitoring. In the physical function improvement field (e.g., sexual function, sleep quality), scenario A interventions concurrently included sustained implementation, adequate duration, multiple educational topics, providing educational materials and participant interaction. In the ability promotion field (e.g., improving care knowledge, skill competence, and self-determination), interventions included sustained implementation, adequate duration, providing educational materials, participant interaction and practice support. Secondly, from the perspective of missing elements compared to scenario A, non-Scenario A interventions in the

healthy behaviors field (e.g., self-care, cancer screening, prevention behaviors of skin or oral cancer, osteoporosis, menstrual health, malaria, cutaneous leishmaniasis, musculoskeletal disorders) consistently lacked multiple educational topics. In risk factor control, one Scenario C intervention lacked both multiple educational topics and practice support. In domestic violence prevention domain, only one scenario B intervention lacked adequate duration. Thirdly, from the perspective of only scenario B in one field, three interventions targeting self-management of hypertension or diabetes and general self-management behaviors consistently utilized social support. Another six mental health interventions (addressing depression, self-esteem, self-efficacy, and self-acceptance) all omitted the provision of educational materials. Lastly, in the quality of life and lifestyle program domain, only one scenario A intervention incorporated nine elements. However, two scenario A interventions addressing multiple domains (health promotion, quality of life, health behaviors) excluded practice support. All non-scenario A interventions targeting resource utilization lacked adequate duration, provision of educational materials, and intervention monitoring.

The methodological quality of 54 studies is presented in Fig. 5 and detailed in supplementary Table S2. Of them, 10 studies were rated as strong, 33 studies as moderate, and 11 studies as weak, with blinding being the most common limitation contributing to lower quality ratings.

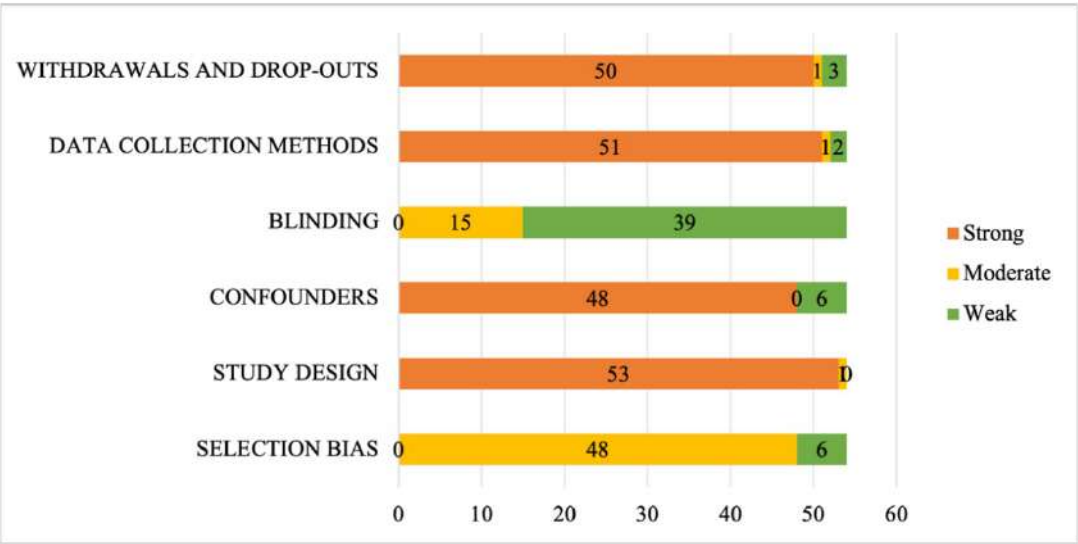

Fig. 5: Frequency of the six components of the Effective Public Health Practice Project tool and Global ratings of included studies (21)

Discussion

The application of PPM highlights its advantages in terms of people orientation, realistic responsiveness, regional adaptability, and practical flexibility. Foremost, person-centered interventions based on PPM could support individuals across the lifespan—particularly vulnerable populations such as patients, older adults, and children—by addressing diverse public health challenges and meeting varied needs (22-75). One review identified population-centeredness as a core principle of PPM, emphasizing its use in assessing population health needs (13). Notably, the PPM model has been predominantly applied to health promotion (22-54).

PPM's realistic responsiveness is evident in its capacity to address practical, context-specific

problems. As society becomes increasingly diverse and complex, PPM has expanded beyond health promotion to encompass quality of life and lifestyle program, prevention of domestic violence, ability promotion, resource utilization and mixed domains, reflecting its dual focus on survival-oriented and development-oriented outcomes. Unlike prior reviews that focused on a single domain of PPM application, this review offers a cross-domain synthesis aligned with the complexities of multifaceted social development (11-13).

PPM has also demonstrated regional adaptability. Carolyn and Coburn have demonstrated that Western behavior change models for promoting health including PPM, can be effectively applied to Asian populations (76). The included studies spanned both developing and developed countries, with consistent effectiveness observed despite diverse cultural or contextual settings. Approximately 65% of the included studies were conducted in Iran (22-24, 29-37, 39-41, 44, 46, 49-55, 57, 58, 60-63, 67, 68, 73-75). Several plausible reasons may explain this disproportionate representation. Beyond Iran's national emphasis on health promotion and community-based management—which aligns well with PPM's focus on health education and community participation (77, 78)—Iranian academic institutions have shown a strong commitment to applying theoretical frameworks like PPM in public health research, particularly in university-led projects. Moreover, the widespread publication of Iranian studies in English-language journals may have increased their visibility and likelihood of inclusion. Additionally, Iran's primary healthcare system, which integrates education and prevention, could have provided a conducive environment for implementing structured models such as PPM across various settings (79, 80).

Lastly, the application of PPM is inherently flexible and can be adapted depending on study objectives, population, setting, and environmental factors. Among its key components, educational and ecological assessment, as well as outcome evaluation, are central to pre-intervention diagnosis and post-intervention evaluation, respectively. In particular, Louisa et al. emphasized the ecological and educational approach as a core principle in applying PPM (13). Some literature reviews on PPM have focused on the identification of predisposing, enabling, and reinforcing factors (11, 12). Notably, one review found that educational strategies addressing all three of these components (i.e., predisposing, enabling, and reinforcing factors)—rather than one or two—led to improved recognition of delirium (81), underscoring the value of comprehensive intervention design. These phases often rely primarily on self-administered questionnaires due to their efficiency and easy data analysis. However, questionnaires are also susceptible to self-report bias. Future research may benefit from incorporating qualitative methods such as focus group interviews or supplementary literature reviews.

Moving forward, we propose that the nine core elements identified in this review be prioritized when designing PPM-based interventions. Unlike prior reviews that primarily focused on identifying influencing factors (11-13), our study emphasizes how PPM can be operationalized across various domains to address real-world problems. For instance, adequate duration emerged as a critical factor: approximately half of the successful interventions included adequate duration (22-25, 29-37, 39-42, 45, 48, 49-51, 53-59, 62-65, 67, 69, 73-75), whereas none of the ineffective interventions did (28, 66, 72). Furthermore, the required elements for successful interventions vary by domain. Firstly, in the disease prevention and control domain, sustained implementation, adequate duration, diverse formats, participant interaction, and intervention monitoring are commonly integrated. In the physical function improvement domain, sustained implementation, adequate duration, multiple educational topics, providing educational materials, and participant interaction are recommended. Similarly, interventions targeting ability promotion often include sustained implementation, adequate duration, providing educational materials, participant interaction, and practice support. Secondly, for the

promotion of healthy behaviors, multiple educational topics are frequently employed, while the control of risk factors typically involves both multiple educational topics and practice support. In the context of preventing domestic violence, adequate duration has emerged as a particularly important element. Thirdly, social support plays a crucial role in the disease self-management field, whereas the provision of educational materials not stands out as a key component in the mental health domain. Lastly, interventions aimed at enhancing quality of life and lifestyle program domain tend to incorporate all nine core elements. In contrast, practice support may be omitted in interventions addressing mixed fields. Additionally, in the resource utilization field, adequate duration, providing educational materials and intervention monitoring are simultaneously recommended.

To our knowledge, this is the first critical review to examine the application, effectiveness and constituent elements of PPM-based interventions across diverse fields. Our study has several limitations as well. First, publication bias may have contributed to an overestimation of the effectiveness of PPM-based interventions, as studies with positive or significant findings are more likely to be published and included in systematic reviews. Second, the exclusion of non-English literature may have limited the comprehensiveness of the review and led to the omission of relevant studies from non-English-speaking regions. Third, a substantial proportion of the included studies were rated as moderate or weak in quality, which may weaken the attribution of reported effects to the actual interventions. Even among high-quality randomized controlled experiments, caution is warranted when interpreting findings regarding their translatability and applicability in practice, as the controlled conditions of trials may not fully reflect real-world settings. Last, the majority of included studies were conducted in Iran, which may limit the generalizability and applicability of the findings to broader populations and diverse contexts. It remains unclear whether the reported outcomes were driven by the interventions themselves or by interactions with specific contextual factors unique to Iran. Identical interventions may yield different results in other practice environments. Nonetheless, PPM has been applied in various international public health contexts, with findings largely consistent with those observed in Iran. Future research should further explore the influence of local cultural or policy environments and adapt PPM-based interventions accordingly to enhance their relevance and effectiveness across diverse settings.

Conclusion

PPM-based interventions demonstrate broad applicability across diverse fields related to human survival and development. The inherent flexibility of PPM framework enables its diagnostic and assessment phases to be adapted to specific study objectives and contextual needs. Educational and ecological assessments, along with outcome evaluation, should be prioritized for incorporation into intervention design and implementation. The nine identified elements offer a practical foundation for future development of PPM-based interventions, with tailored recommendations suggested for different domains and local contexts. Despite certain limitations, the review provides meaningful insights and contributes to the growing body of evidence supporting the effectiveness and versatility of the PPM in public health practice.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of Interest

The authors declare that there is no conflict of interests.

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