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Fourth-Generation Multi-Theory Model (MTM) of Health Behavior Change as a Novel Strategy for Sustainable Health Promotion: A Systematic Review

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ABSTRACT

Background: Health promotion has evolved significantly since its conceptualization, emphasizing the need for sustainable interventions to address population health challenges. This systematic review explored the effectiveness of the multi-theory model (MTM) of health behavior change in promoting sustainable health behavior.

Methods: Following PRISMA guidelines, a comprehensive search was conducted across MEDLINE, CINAHL, APA PsycINFO, and Academic Search Premier databases. From 883 records sourced after removal of duplicates, abstracts were screened and followed by complete article reading and screening. Eight experimental studies (four randomized controlled trials and four quasi-experimental studies) published between 2016 and 2024 were included. Data extraction focused on study design, population, interventions, and outcomes, with risk of bias assessed using Cochrane tools (RoB 2 and ROBINS-I).

Results: The findings revealed significant improvements in health behaviors, including reduced water pipe smoking, increased physical activity, healthier diets, and enhanced quality of life. MTM constructs—particularly participatory dialogue, behavioral confidence, emotional transformation, and practice for change—showed strong, statistically significant effects ($p < 0.001$). Process evaluations confirmed high intervention fidelity, strong engagement, and feasibility for community implementation. Despite small sample sizes, biases, and heterogeneous designs, the interventions effectively promoted sustainable, equitable behavior change across diverse populations. Overall, the results demonstrate the MTM's potential for long-term health promotion through integrated behavioral and environmental strategies that align with public health sustainability goals.

Conclusion The review underscores MTM's potential as a robust framework for sustainable health promotion. By integrating environmental sustainability principles and fostering community engagement, MTM-based interventions can address social determinants of health and promote long-term behavior change. Future research should focus on scaling MTM interventions, addressing methodological limitations, and exploring its integration with other sustainability frameworks to enhance public health outcomes.

Keywords: Health Promotion, Multi-Theory Model (MTM), Health Behavior Sustainable, Health Interventions Behavior, Health Care, Public Health, Sustainable Growth

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Introduction

Health promotion is an old concept. However, it was not until the 1980s that it started to increase in popularity; since then, it has gained more recognition as an idea that access to medical care was necessary but not enough to improve population health (Sharma, 2022; Tulchinsky et al., 2023). In 1945, the medical historian Henry Sigerist framed the term "health promotion" as one of the core functions of medicine (Sigerist, 1946; Kumar & Preetha, 2012). *Health promotion* is defined by (Green &Kreuter ,1999) as a comprehensive approach with an intentional integration of educational, political regulatory, and institutional supports for behaviors and lifestyle choices that promote well-being at the individual and population levels, including social and environmental interventions (Kumar & Preetha, 2012; Sharma, 2022). According to the Ottawa Charter, health promotion is the practice of giving people more control over their health and its determinants to promote health (World Health Organization [WHO], 1986).

Addressing the social determinants of health requires a deep understanding of the institutions, culture, customs, practices, and social structures (Sharma, 2022). As a strategy, health promotion has shifted the focus of public health beyond the typical biomedical approach, which primarily focuses on the causation of diseases, to a more psychosocial approach to help identify disease causes (Saranya & Kathirvel, 2023). In addition, health promotion helps public health professionals understand diseases through people's lenses and design multidisciplinary approaches for prevention (Saranya & Kathirvel, 2023). Furthermore, health promotion programs are vital to cutting healthcare costs (Bodkin & Hakimi, 2020). Nevertheless, the resources required to implement these programs are limited, whereas the expectations for producing results continue to be high (Bodkin & Hakimi, 2020; Patja et al., 2022). Due to these reasons, the health promotion field faces a challenge: delivering high-quality services that decrease the burden of diseases and enhancing quality of life while meeting financial restrictions. This urges the necessity for health promotion programs to be sustained to ensure that health benefits continue when the program ends (Bodkin & Hakimi, 2020).

Sustainability is frequently considered only to be related to funding. However, sustainability is more complicated than this belief (Bodkin & Hakimi, 2020). Health promotion sustainability encompasses the continuing operation of a program within an organization and the capability to carry out the program by itself while providing health benefits to individuals (Bodkin & Hakimi, 2020). Unfortunately, evidence has shown that only a little over 50% of health promotion initiatives are sustained due to changes in priorities or short cycles of funding (Quinn et al., 2018; Vitale et al., 2018). However, researchers and founders have started to recognize the importance of sustainability when discussing health promotion interventions. One of the reasons is that public health professionals have noticed that with sustainability, examining the implementation of interventions and programs is easier (Walugembe et al., 2019).

Walugembe et al. discussed some main reasons why sustainability should be a top priority for public health professionals (Walugembe et al., 2019). First, changes in community health are not detectable within a few months of implementation. The changes start to be noticed around three years after the beginning of the interventions (Walugembe et al., 2019). Second, the long-term effects of the programs are more accessible to study after being sustained for an extended period (Michie et al., 2018). Finally, stopping interventions abruptly without much thought lets down participants and creates barriers to subsequent community mobilization initiatives (Pluye et al., 2004). Therefore, the sustainability of health promotion is crucial to improving population health because sustainable innovations in public and behavioral health integrate eco-

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conscious practices with community's well-being. Telehealth platforms reduce travel emissions while expanding access to mental health services. Community-based programs using biodegradable materials promote healthy behaviors with minimal environmental impact. Wearable devices powered by renewable energy encourage self-monitoring of stress and activity levels. Moreover, AI-driven campaigns optimize public health outreach, reducing waste of resources. Green spaces and sustainable urban designs further support mental wellness, fostering healthier communities while preserving the planet for future generations. It is against this backdrop that this study aimed to evaluate how MTM-based interventions predict and sustain health behavior changes compared to other models or baseline measures.

Methods

Protocol

This systematic review adheres to the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist (Page et al., 2021). The study's approach incorporates the majority of the 27 key reporting elements recommended by PRISMA to systematically highlight essential concepts and identify gaps in knowledge. Supplementary Table 1 provides detailed information about the checklist and the specific sections assessed. The review protocol was then registered within the Open Science Framework (OSF) which can be accessed by the protocol number.

Eligibility criteria

The inclusion criteria for this review consisted of original peer-reviewed studies published between 2016 and October 2024 that exclusively applied the Multi-theory Model (MTM) to promote health behavior change. Since the MTM was introduced in 2015, selecting 2016 as the starting point for data collection was appropriate to capture evidence of its application. The review considered experimental studies conducted globally, and published in English, while excluding works based on other theoretical frameworks, gray literature, non-peer-reviewed articles, reviews, abstracts, editorials, commentaries, letters, opinion pieces, case reports, dissertations, presentations, and studies involving biochemistry or animals. Articles that were inaccessible were also excluded. The guiding research question for the literature search was, "Among diverse populations in various settings, how effective is the MTMof health behavior change compared to other theoretical models or baseline measures in predicting and sustaining health behavior changes?" These criteria ensured the inclusion of relevant and methodologically rigorous studies for systematic review.

Information Sources and Search

The search strategy for this review utilized a range of key terms, such as 'MTM,' 'multi-theory model,' 'multitheory model,' 'multi theory model,' 'Initiation,' 'Sustenance,' and 'Health behaviors,' including both 'Obesogenic behaviors' and 'Human behavior.' To ensure a comprehensive and inclusive search, Boolean operators (AND, OR), truncation, and MeSH terms were applied. This broad approach, without restricting specific health behaviors, was designed to capture a diverse set of studies utilizing the MTM. Searches were conducted across several databases, including MEDLINE (PubMed), CINAHL, APA PsycINFO, and Academic Search Premier, to ensure thorough coverage of relevant literature.

Selection of studies

The articles were gathered and screened in accordance with the PRISMA flow diagram (Figure 1; PRISMA Checklist Appendix 1). The screening process involved a step-by-step evaluation of titles, abstracts, and full texts to assess their eligibility for inclusion or exclusion. Articles focusing on the application of the MTM to examine different aspects of human health behavior were selected for further analysis. The review process was independently conducted by

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reviewers SK and ADG, with both agreeing on the inclusion of seven out of eight articles. The disagreement regarding the final eighth article was resolved by MS.

Data extraction

The selected articles proceeded to the data extraction phase, conducted independently by two reviewers (SK and ADG). This systematic review includes eight experimental studies. Key data points were extracted and summarized, including the authors and publication year, study location, type of behavior examined, sample characteristics, study design, and main findings. The primary outcomes from the experimental studies are highlighted in the main findings section. The results of the selected studies and their comprehensive characteristics are presented as study type, design, sample, interventions, and salient findings (Table 1 and Table 2).

Study risk of bias assessment

The risk of bias in experimental studies was assessed using methodologies tailored to the study design. Randomized controlled trials (RCTs) were evaluated with the Cochrane risk-of-bias tool for randomized trials (Sterne, et al., 2019). Meanwhile, quasi-experimental and non-randomized control trial studies were assessed using the Cochrane risk-of-bias tool for non-randomized studies of interventions (Sterne et al., 2016). SK conducted the comprehensive assessment process. The results of these comprehensive evaluations have been presented based on the criteria of the authorship, randomization process, intervention criteria, measurement outcomes and reported results. (Table 3a and Table 3b).

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Table 1. Characteristics of included studies (n=8)

Authors, Year	Country	Population and sample	Design	Intervention description	Intervention duration	Salient findings
Bashirian et al., 2019	Iran	94 male adolescent students (47 each in intervention and control groups)	Randomized controlled trial	Five 45-minute sessions based on MTM constructs (e.g., participatory dialogue, behavioral confidence)	3 months	**MTM constructs:** Significant improvements in participatory dialogue, behavioral confidence, emotional transformation, and practice for change (**p < 0.001**). **Frequency of Water Pipe Smoking (WPS):** Decreased significantly from 14.9% to 4.3% in the intervention group compared to no significant change in the control group (**p < 0.001**). **Reduction in WPS:** Effect size not provided; **p-value: < 0.001**. These results highlight the intervention's success in reducing WPS among adolescent males.
Hayes et al., 2019	USA	48 African American women (25 intervention, 23 control)	Randomized controlled trial	Three 60-minute sessions promoting physical activity using MTM	6 weeks follow-up	**Physical Activity:** Mean weekly physical activity increased significantly in the intervention group from 37 minutes at baseline to 172 minutes at follow-up (mean difference: 135.08 minutes; 95% CI: 106.04–164.13; **p < 0.0001**). **Waist circumference:** Reduced significantly from 39 inches to 38 inches (mean difference: -1.12 inches; 95% CI: -1.70– -0.55; **p < 0.001**). **MTM constructs:** Significant improvement and changes in physical environment construct (mean difference: 2.08; 95% CI: 0.73–3.43; **p = 0.004**).
Brown et al., 2020	USA	54 African American women (26 intervention, 28 control)	Randomized controlled trial	Three-week dietary behavior intervention using MTM	8 weeks follow-up	**Overall fruit and vegetable consumption:** The mean consumption in the intervention group increased from 2.78 servings/day (pre-test) to 4.77 servings/day (post-test) and 5.04 servings/day (follow-up). **Effect size:** Partial eta squared for overall consumption: 0.193. **p-value: <0.0001**. **MTM Constructs:** Significant improvements noted for all constructs except participatory dialogue (**p < 0.05**).
Kumar et al., 2021	India	100 tobacco users; 64 completed follow-up	Non-randomized trial	Standardized counseling sessions focusing on tobacco cessation	12 weeks	**MTM behavior change Scores:** Increased significantly from 32.78 at baseline to 48.7 at 12 weeks (**p < 0.001**). **Effectiveness of constructs:** Improvements in participatory dialogue, behavioral confidence, and changes in the physical environment were most impactful. **Statistical significance: p < 0.001** for all major behavioral improvements.

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Table 1. Characteristics of included studies (n=8)

Authors, Year	Country	Population and sample	Design	Intervention description	Intervention duration	Salient findings
Yoshany et al., 2021	Iran	80 postmenopausal women (40 intervention, 40 control)	Randomized controlled trial	Five 45-minute sessions using MTM to improve quality of life	3 months follow-up	**Quality of Life Scores (MENQOL):** Improved significantly across all domains in the intervention group from baseline to post-intervention and three-month follow-up (**p < 0.05**). **MTM constructs:** Significant increases were observed in emotional transformation, practice for change, and changes in the social environment constructs (**p < 0.05**). Detailed numerical scores were not provided.
Gupta et al., 2023	India	300 college students (150 intervention, 150 control)	Quasi-experimental	Motivational counseling, educational sessions on portion size behavior using MTM	1 year	**Proportion of large portion-sized meal consumption:** Reduced significantly in the intervention group from 46% to 11% (**p < 0.001**). **MTM constructs:** Significant improvements in participatory dialogue, behavioral confidence, and emotional transformation (**p < 0.05**). Specific effect sizes were not reported.
Joveini et al., 2023	Iran	128 middle-aged women (65 intervention, 63 control)	Quasi-experimental	Five 60-minute group sessions focusing on reducing sugar consumption using MTM	6 months	**BMI:** Decreased significantly in the intervention group compared to controls (**p < 0.05**). **Waist circumference:** Reduced significantly (**p < 0.05**). **Sugar Consumption:** Reduced significantly in the intervention group (specific reductions not quantified). **MTM constructs:** Improvements in participatory dialogue, behavioral confidence, and emotional transformation (**p < 0.05**). Detailed numerical scores and effect sizes were not reported.
Calvert et al., 2024	USA	Stroke patients in rural Georgia counties	Quasi-experimental	Community paramedicine program with home visits, telemedicine and care coordination	90 days	**Stroke mortality and readmissions:** Mortality and readmissions were significantly reduced at 30-, 60-, and 90-days post-intervention. **Risk factor management:** Improvements were observed in managing hypertension, diabetes, and medication adherence. Specific statistical measures or effect sizes were not reported in the document.

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Table 2. Characteristics of studies that reported evaluation (n=8)

Authors, Year	Outcome measures	Number of Measurements	Whether the sample size was estimated	Whether measurement scales were validated	Whether process evaluation was done; if yes, consider salient findings
Bashirian et al., 2019	Reduction in water pipe smoking frequency; improvements in MTM constructs (e.g., participatory dialogue, behavioral confidence)	Pre-test, post-test, and 3-month follow-up (3 measurements)	Yes; sample size was calculated based on study power requirements	Yes; validated questionnaire for MTM constructs (e.g., participatory dialogue and behavioral confidence)	Yes; evaluation included participant feedback on session relevance, and fidelity checks showed 100% adherence to planned intervention protocols
Hayes et al., 2019	Minutes of physical activity per week, waist circumference, and MTM constructs	Pre-test, post-test, and 6-week follow-up (3 measurements)	Yes; estimated based on expected effect sizes and statistical power	Yes; validated MTM constructs and self-reported physical activity tracking	Yes; participants highly rated satisfaction with sessions, reporting improved access to fitness centers and adherence to protocols
Brown et al., 2020	Fruit and vegetable consumption (24-hour recall), MTM constructs (behavioral confidence, participatory dialogue)	Pre-test, post-test, and 8-week follow-up (3 measurements)	Yes; sample size determined using G*Power analysis with 80% power	Yes; 38-item validated questionnaire for dietary behavior and MTM constructs	Yes; satisfaction surveys showed high ratings for session relevance and engagement. Observations confirmed 100% fidelity in activity completion
Kumar et al., 2021	MTM behavior change scores, tobacco cessation rates, and initiation constructs	Baseline, 2 weeks, 6 weeks, and 12 weeks (4 measurements)	Yes; sample size calculation based on MTM intervention studies	Yes; validated MTM questionnaire with high reliability (Cronbach's alpha > 0.80)	Yes; process evaluation highlighted participant satisfaction and alignment of intervention delivery with planned objectives
Yoshany et al., 2021	Quality of life (MENQOL questionnaire) and MTM constructs	Baseline, immediately post-intervention, and 3-month follow-up (3 measurements)	Yes; sample size calculated for statistical significance in MENQOL scores	Yes; MENQOL is a validated instrument for menopausal quality of life assessment	Yes; process evaluation indicated high session adherence, and participants reported improvements in adaptation behaviors
Gupta et al., 2023	Proportion of large portion-size consumption, BMI, and MTM constructs	Baseline and endline (2 measurements)	Yes; sample size estimation accounted for attrition rates	Yes; validated questionnaire for portion size consumption and MTM constructs	Yes; high participant engagement was noted, and facilitators reported successful adaptation of content to participant needs
Joveini et al., 2023	BMI, waist circumference, sugar consumption, and MTM constructs	Baseline, 1 month, 3 months, and 6 months post-intervention (4 measurements)	Yes; calculated to achieve sufficient statistical power for intervention effects	Yes; validated anthropometric tools and MTM-based questionnaire	Yes; fidelity checks confirmed full adherence to educational content delivery, with positive participant feedback

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Table 2. Characteristics of studies that reported evaluation (n=8)

Authors, Year	Outcome measures	Number of Measurements	Whether the sample size was estimated	Whether measurement scales were validated	Whether process evaluation was done; if yes, consider salient findings
Calvert et al., 2024	Stroke mortality, readmissions, medication adherence, and chronic disease management	30-, 60-, and 90-days post-discharge (3 measurements)	No; sample size was determined by pilot program participation	No; relied on medical records and healthcare provider reports	Yes; process evaluation revealed successful integration of home visits and telemedicine, with high patient satisfaction

Table 3a. RCTs evaluated using RoB 2 (n=4)

Authors, year	D1: Randomization process	D2: Deviations from intended interventions	D3: Missing outcome data	D4: Measurement of outcome	D5: Selection of the reported result	Overall
Bashirian et al., 2019	Low risk	Low risk	Low risk	Low risk	Low risk	*Low risk*
Hayes et al., 2019	Low risk	Low risk	Low risk	Low risk	Low risk	*Low risk*
Brown et al., 2020	Low risk	Some concerns	Low risk	Low risk	Some concerns	*Some concerns*
Yoshany et al., 2021	Low risk	Low risk	Low risk	Low risk	Low risk	*Low risk*

Table 3b. Non-RCTs evaluated using ROBINS-I (n=4)

Authors, year	Bias due to confounding	Bias in selection of participants	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall
Kumar et al., 2021	Moderate risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	*Low risk*
Gupta et al., 2023	Moderate risk	Some concerns	Low risk	Low risk	Some concerns	Low risk	Low risk	*Moderate risk*
Joveini et al., 2023	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	*Low risk*
Calvert et al., 2024	Moderate risk	Some concerns	Some concerns	Some concerns	Low risk	Some concerns	Some concerns	*Moderate risk*

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Results

Experimental studies

The systematic review process and searches resulted in identifying studies on sustainable public and behavioral health innovations. From 883 records sourced via Medline/PubMed (n=8485), CINAHL (n=95), and Academic Search Premier (n=23), duplicates (n=100) were removed, yielding 8739 for abstract screening. This excluded 8716 records, leading to 23 full-text assessments; 11 were ineligible (editorials n=4, letters n=2, protocols n=5), and 4 unretrieved, resulting in 8 studies included. Finally, a total of eight experimental studies were identified that employed the MTM to address health behavior change. Among these, four used RCT designs (Bashirian et al., 2019; Hayes et al., 2019; Brown et al., 2020; Yoshany et al., 2021), while four utilized quasi-experimental or non-randomized designs (Kumar et al., 2021; Gupta et al., 2023; Joveini et al., 2023; Calvert et al., 2024). These studies targeted a wide range of health behaviors across various populations and geographic regions, as detailed in Tables 1 and 2.

The RCTs included interventions focused on reducing water pipe smoking among adolescent males in Iran, increasing physical activity among African American women in the United States, improving fruit and vegetable consumption in African American women, and enhancing the quality of life among postmenopausal women in Iran (Brown et al., 2020; Yoshany et al., 2021). All four RCTs demonstrated significant improvements in the targeted health behaviors and related MTM constructs. For example, a few studies reported a significant reduction in water pipe smoking prevalence in the intervention group from 14.9% to 4.3% ($p < 0.001$) (Bashirian et al., 2019). Hayes et al. documented a substantial increase in physical activity, from 37 minutes per week at baseline to 172 minutes at follow-up ($p < 0.0001$) (Hayes et al., 2019).

The quasi-experimental and non-randomized studies further highlighted the versatility of MTM-based interventions (Kumar et al., 2021). They conducted a tobacco cessation intervention in India, reporting significant improvements in MTM behavior change scores from 32.78 at baseline to 48.7 at 12 weeks ($p < 0.001$) (Kumar et al., 2021). Gupta et al. (2023) achieved a significant reduction in large portion-size meal consumption among Indian college students, from 46% to 11% ($p < 0.001$).(Joveini et al.,2023) observed reductions in BMI and waist circumference, alongside improvements in MTM constructs, among middle-aged women in Iran ($p < 0.05$). Lastly, Calvert et al. (2024) implemented a community paramedicine program for stroke patients in Georgia, reporting significant reductions in mortality and readmissions at 30-, 60-, and 90-days post-discharge.

Process evaluations consistently highlighted the high fidelity of intervention delivery and positive participant feedback across studies. For instance, (Hayes et al. ,2019) reported improved access to fitness resources, while Gupta et al. noted high participant engagement and successful content adaptation. These findings collectively reinforce MTM's efficacy in driving meaningful health behavior changes across diverse populations and settings.

Risk of bias assessment

The risk of bias for the included experimental studies, as presented in Table 3a and Table 3b, was evaluated using the Cochrane risk-of-bias tool for randomized trials (RoB 2) and the Cochrane risk-of-bias tool for non-randomized studies of interventions (ROBINS-I).

For the four RCTs, the overall risk of bias was generally low. Some studies demonstrated low risk across all assessed domains, including the randomization process, deviations from intended interventions, and outcome measurement (Bashirian et al., 2019; Hayes et al., 2019). However, (Brown et al.,2020) showed some concerns related to the selection of reported results, reflecting potential reporting bias. (Yoshany et al. ,2021) reported having low risk in all domains, further supporting the reliability of its findings.

The risk of bias in quasi-experimental and non-randomized studies was assessed as moderate

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overall.(Kumar et al., 2021) exhibited low risk across most domains, including confounding factors and measurement of outcomes, enhancing the robustness of their results. In contrast, studies by(Gupta et al.,2023;Calvert et al., 2024) reported moderate risk due to concerns such as bias in the selection of participants and deviations from intended interventions, which are inherent to their study designs. These limitations, while important to consider, do not negate the valuable insights offered by these studies.

The rigorous risk-of-bias assessment underscores the methodological quality of the included studies. While recognizing some limitations, the assessment confirms that the findings provide a reliable evidence for interpreting the effectiveness of MTM-based interventions. This robust evaluation ensures confidence in the applicability and relevance of the reported health behavior changes facilitated by the MTM

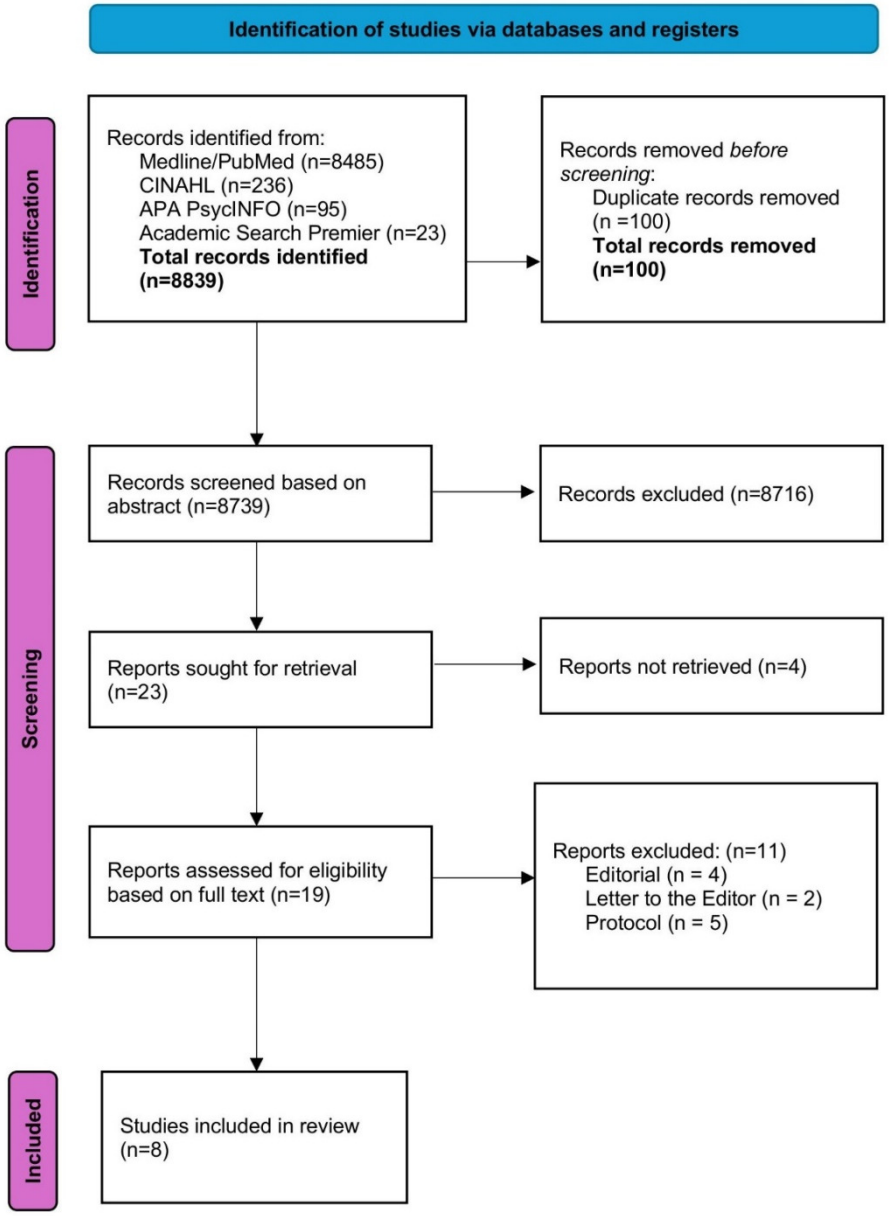

Figure 1. PRISMA 2020 flow diagram for selection of studies

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Discussion

The purpose of the study was to examine the efficacy of MTM-based interventions using experimental designs in sustaining health behavior changes. Health behavior change is increasingly recognized as a vital strategy for sustainable health promotion, particularly in community settings where diverse barriers and facilitators impact the effectiveness of interventions. The implementation of evidence-based interventions (EBIs) in these settings requires a nuanced understanding of the contextual factors that influence health behaviors. The newer theoretical generation of models like MTM demonstrates a comprehensive framework that encompasses various domains, including innovation, contextual settings, individuals, and the implementation process, which are crucial for identifying the determinants of successful health behavior change initiatives (Sharma, 2022).

As explained in the findings of this review, one of the primary areas in sustainable health promotion are the strategies in community settings and the need to tailor these to the specific barriers and facilitators present in those environments. Previous research indicated that community settings often lack the resources, expertise, and support systems that are more readily available in clinical settings, thus making the application of traditional implementation strategies less effective (Balis & Houghtaling, 2023). One comparative output from this review is the barriers to implementing policy and environmental changes recaptured at improving nutrition and physical activity can be multifaceted, including issues related to local politics, community engagement, and resource availability (Hayes et al., 2019). Therefore, it is essential to adopt a strength-based approach that not only identifies needs but also leverages existing community resources to facilitate sustainable health behavior change.

This research has explained that the process of selecting and tailoring sustainable health promotion and implementing strategies can be informed by various tools and methodologies which are more tangible and practical with MTM for a change in human behavior. However, the effectiveness of these tools is contingent upon the users' understanding of the contextual factors at play in their specific community settings. For example, the recommendations may not be directly applicable without adaptation to the unique dynamics of a community, which often differ significantly from clinical environments (Balis & Houghtaling, 2023; Kangasniemi et al., 2014). On the other hand, this necessitates a collaborative approach at the population level, rather than just the clinical processes, where the social and physical components of the environment and community can be actively involved in the decision-making process (Gupta et al., 2023). This can be re-structured with the selection of suitable health promotion, implementation strategies, and simultaneous utilization of the MTM framework.

Moreover, this study emphasized the importance of building individual participation and dialogue-based models within communities to enhance the implementation of health behavior change strategies. The social and physical contexts of individuals and communities can serve as both facilitators and barriers to the integration of interventions, highlighting the need for tailored strategies that capitalize on existing community strengths while addressing potential challenges (Calvert et al., 2024).

For instance, providing stroke patient management and coaching can empower community members to take ownership of health promotion initiatives, thereby fostering a more sustainable approach to health behavior change to care for people with disabilities in the wider context. This participatory approach not only enhances the relevance of the interventions but also increases community buy-in, which is critical for long-term success.

In addition to behavioral change, the selection of intervention strategies should also consider the specific characteristics of the target population. Understanding the demographics, cultural contexts, and health literacy levels of community members can inform the design of interventions that resonate

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with their needs and preferences (Bashirian et al., 2019). Tailoring interventions to align with the values and behaviors of the community can significantly enhance engagement and adherence to sustainable health promotion activities. For example, interventions that incorporate local cultural practices or leverage student leaders as advocates can improve the acceptance and effectiveness of sustainable health behavior change initiatives in young adults for substance use within the framework of MTM.

Furthermore, the iterative nature of sustainable health promotion in alignment with MTM underscores the necessity for ongoing evaluation and adaptation of health behavior change strategies. As sustainable health behavior contexts evolve, so too must the strategies employed to promote sustainable health outcomes. Continuous feedback loops, involving the sustenance constructs of the MTM, can provide valuable insights into the effectiveness of interventions and highlight areas for improvement (Brown et al., 2020). This dynamic approach not only fosters resilience in sustainable health promotion efforts but also ensures that interventions remain relevant and impactful over time.

The integration of health behavior changes strategizes the broader public health initiatives and requires a systems-level perspective. Recognizing that health behaviors are influenced by a complex interplay of social determinants, such as economic stability, education, and access to healthcare, is crucial for developing comprehensive health promotion strategies (Balis & Houghtaling, 2023). By addressing these underlying determinants, health behavior change initiatives can contribute to more equitable health outcomes across diverse populations.

Sustainable health promotion is an emerging field that integrates health promotion strategies with environmental sustainability principles. This approach recognizes the interconnectedness of human health and the health of the environment, emphasizing that sustainable practices can lead to improved health outcomes. The literature indicates that health promotion must evolve to address the pressing environmental challenges of the 21st Century, particularly in the context of climate change, food insecurity, and urbanization. Integration of environmental sustainability into health promotion is not merely an additive process but requires a fundamental shift in how health practitioners conceptualize their role. For instance, there is a necessity for nursing practices to incorporate environmental considerations, arguing that healthcare professionals should engage in activities that minimize adverse health impacts on both local and global scales (Kangasniemi et al., 2014). This perspective aligns with the findings from the interventions in this review so that environmental sustainability principles can enhance health promotion efforts, particularly in addressing food consumption by utilizing MTM (Gupta et al., 2023; Nuttman et al., 2020). By embedding sustainability into health promotion frameworks, practitioners can create more resilient health systems and promote eating habits that are better equipped to handle environmental stressors.

The concept of sustainable diets is pivotal in addressing both obesity and environmental degradation. Li emphasized that current dietary trends contribute to the obesity epidemic while simultaneously exerting pressure on environmental resources (Li, 2016). This dual challenge necessitates a health promotion approach that advocates for sustainable dietary practices, which can mitigate health risks while promoting environmental stewardship. There are useful frameworks for understanding the multifaceted relationship between health and environmental factors, suggesting that capacity building is essential for adapting health promotion strategies to the anthropocene (Langmaid et al., 2021). In the same way, MTM is the 4th generation model that can connect human behavior for sustainable environmental resources by taking into account the anthropometric measures together with transformation for a dietary behavior change (Brown et al., 2020; Joveini et al., 2023).

In addition to dietary considerations, the role of

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community health is central and important in promoting environmental health literacy. Healthcare professionals must adopt a thinking approach to effectively address the complexities of health problems and promote sustainable healthcare practices (Ebadifar et al., 2018). This approach is echoed by (Patrick et al., 2011) who advocate for community-based healthcare practices that prioritize sustainability. By fostering environmental health literacy and practice for change, health promotion practitioners can empower communities to make informed decisions that enhance personal health, particularly if MTM-based interventions are designed for community paramedicine, chronic disease care, and cautious prescription of certain medications (Calvert et al., 2024; Kapukotuwa et al., 2024).

Furthermore, the importance of partnerships in health promotion cannot be overstated. There is always a high potential for collaboration between academic researchers and employers to design effective workplace health promotion programs that consider environmental factors (Brehm et al., 2011). Such partnerships can facilitate the development of interventions that not only improve employees' health but also promote sustainable health practices within organizations based on introspective meditations (Sharma, 2022). This simple, collaborative approach is essential for addressing the broader social determinants of health, as emphasized in many health initiatives (Green & Allegrante, 2011).

The socio-ecological model of health promotion provides a valuable framework for understanding the interplay between individual behaviors and environmental factors. Simons-Morton notes that effective health promotion programs must consider the environmental conditions that influence health behaviors, advocating for multilevel interventions that target both individual and systemic factors (Simons-Morton, 2013). This perspective has supported the integration of health promotion and environmental sustainability initiatives to identify barriers and facilitators of effective program evaluation (Patrick & Kingsley, 2016).

Moreover, the role of policy in shaping health promotion practices is critical. A robust framework for comprehensive research, policy, and advocacy agenda that may address environmental health inequalities can also emphasize the interim need for policies that promote health equity alongside the sustainability of health (Masuda et al., 2010). Findings of (Kay and Livingstone ,2020) also call for an integrated health promotion approach that addresses both environmental sustainability and health equity (Kay & Livingstone,2020). By aligning health promotion strategies with sustainable development goals and comprehending the sustainable health paradigm of MTM, practitioners can contribute to a more equitable and healthy society (Kapukotuwa et al., 2024).

The educational needs of health promotion practitioners are also paramount in this context. Patrick et al. emphasize the necessity for higher education institutions to prepare future health promoters to tackle environmental challenges effectively (Patrick & Kingsley, 2016). This preparation includes equipping students with the knowledge and skills to integrate sustainability into health promotion practices, in the context of constructs of MTM; this would thereby foster a new generation of practitioners who are adept at addressing the complexities of health and environmental issues. Sustainable health promotion is increasingly recognized as a critical component of public health strategies, integrating principles of environmental sustainability with health promotion practices. The theoretical frameworks like MTM that guide this integration emphasize the importance of equity, resource conservation, and community engagement, which are foundational to both health promotion and sustainability efforts.

Implications for practice

A key aspect of sustainable health promotion is the alignment of its principles with those of environmental sustainability.(Nuttman et al., 2020) highlighted that both fields advocate equity across generations, sustainable resource use, and empowerment, suggesting that health promotion

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can benefit from adopting environmental sustainability principles. This is further supported by sustainable development strategies based on MTM which must be integrated with health promotion strategies to avoid creating new health or environmental issues (Sharma, 2022; Kapukotuwa et al., 2024). Such integration is essential for fostering a holistic approach to health that considers the socio-ecological context of health behaviors and outcomes.

Frameworks for understanding sustainability in health promotion are also critical. It is paramount to establish a shared understanding of sustainability among practitioners, funders, and researchers, emphasizing that programs capable of sustaining themselves are more likely to yield lasting health outcomes (Schell et al., 2013). MTM also provides a structured approach that can guide the development and evaluation of health promotion initiatives. The authors also propose the integration of MTM with other frameworks. MTM has been integrated with the Menopause-Specific Quality of Life questionnaire (MENQOL) for the improvement of quality of life in postmenopausal women and the Perceived Stress Scale (PSS) in intentional outdoor nature contact behavior (Sharma, 2022; Yoshany, et al., 2022). Similarly, the Dynamic Sustainability Framework (DSF) which encourages the use of diverse methods for planning sustainability, including simulation modeling and pilot testing, to adapt health promotion interventions to local contexts can be integrated with MTM for sustainable health promotion (Chambers et al., 2013).

Community engagement is another vital component of sustainable health promotion. Patrick et al. emphasized the importance of locally defined indicators, such as the Happy Planet Index, which can enhance community involvement in health and sustainability issues (Patrick et al., 2022). This participatory approach aligns with the Health-Promoting School framework, which integrates environmental, organizational, and personal factors to improve health outcomes in educational settings (Langford et al., 2014). By fostering community engagement, health promotion initiatives can better address local needs and leverage existing resources for sustainability which has also been emphasized in the SAVOR intervention of MTM (Brown et al., 2020).

Moreover, the financial sustainability of health promotion programs is crucial for their long-term viability. (Javadinasab et al., 2019) discuss various sustainable financing methods that can enhance health promotion services, particularly in developing countries, suggesting that effective funding strategies can significantly reduce disease burdens and healthcare costs. This financial aspect is complemented by the need for health promotion practitioners to be trained in sustainability principles, as highlighted by (Weber et al. 2022) who advocate for planetary health literacy among future educators and decision-makers who voiced the study's MTM intervention to reduce sugar consumption (Joveini et al., 2023).

Community health workers (CHWs) play a pivotal role in bridging the gap between healthcare services and underserved communities. CHWs are essential in equity-focused strategies, particularly in areas where access to health services is limited (Mhlongo et al., 2020). They are trained to diagnose and treat common ailments such as diarrhea, malaria, and pneumonia, thereby directly addressing health disparities exacerbated by environmental factors. The participatory dialogue approach of MTM can be utilized to build the capacity of CHWs for an integrated model of community case management, which can significantly improve health outcomes in vulnerable populations (Yoshany et al., 2022).

Furthermore, the implementation of environmental health programs within healthcare facilities is vital for promoting equitable access to care. A systematic implementation of environmental programs in a university teaching hospital emphasizes that best practices often stem from guidelines provided by international bodies like the World Health Organization (Ryan-Fogarty et al., 2016). However, the realization of these measures is contingent upon local regulations, stakeholder

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engagement, and the implementation of changes in the physical environment of the individuals and communities. Effective waste management and sustainable practices within healthcare settings not only enhance environmental performance but also contribute to the overall health of the community. The authors propose that MTM can be an effective evidence-based model in utilizing environmental resources to bring changes in behaviors to manage and dispose of environmental waste.

The concept of One Health, which emphasizes the interconnectedness of human, animal, and environmental health, is increasingly recognized as a framework for addressing environmental health issues. The advocacy for enhanced environmental representation in One Health initiatives suggests that collaboration with Eco health practitioners can lead to more comprehensive approaches to public health challenges (Barrett & Bouley, 2015). MTM can utilize this integrative perspective as the evidence-based framework for a self-management intervention to resolve complex behavioral and environmental determinants of health that disproportionately affect different populations, e.g., cancer patients and hospital readmissions (Calvert et al., 2024; Sharma et al., 2020).

Sustainable health promotion with community and environmental health literacy is another critical factor in promoting sustainable access to care with the ability to understand and utilize information regarding environmental exposures and their health impacts (Lichtveld et al., 2019). Increasing environmental health literacy among communities can empower individuals to make informed decisions about their health and advocate for safer environments. This empowerment is particularly vital for the changes in the physical environment and practices for change – two of the dynamic constructs of MTM for vulnerable populations who may lack access to healthcare resources and information. For this reason , the MTM framework has been successfully adapted in Iran's public health system to promote obesity prevention among adolescents, incorporate nutrition among post-menopausal women, change in childbearing behavior, and initiate change in substance use relapse (Bagherniya et al., 2018; Mousali et al., 2020; Yoshany et al., 2021; Abbasi Shavazi et al., 2024).

Strengths and limitations of the interventions studied in the review

Sustainable health promotion frameworks are essential for integrating health promotion strategies with sustainability principles, ensuring that health initiatives are not only effective but also environmentally responsible and socially equitable. This review highlighted the MTM framework that can guide practitioners, researchers, and policymakers in developing sustainable health promotion practices. Moreover, addressing evaluation within the environmental health inequalities requires a concerted effort from multiple stakeholders, including healthcare providers, policymakers, and community organizations which have been conducted in these MTM-based interventions. These process evaluations reported fidelity, effectiveness, participant satisfaction, intervention adherence, intervention content adaptation, and quality measures (Bashirian et al., 2019; Hayes et al., 2019; Brown et al., 2020; Kumar et al., 2021; Yoshany et al., 2021; Gupta et al., 2023; Joveini et al., 2023; Calvert et al., 2024). The consistently high scores of the process evaluation indicators emphasized the collective high efficacy of MTM of all of its constructs to bring about a health promotion change.

The integration of environmental health education into sustainable health promotion is also crucial for preparing future healthcare professionals to address these challenges. To address the paradox of sustainment amid ongoing change, there is a need for advocacy for a flexible approach to planning for sustainability (Chambers et al., 2013). MTM framework encourages the use of role-playing, simulation modeling, and pilot testing to evaluate the impact of different decisions on sustainability outcomes. By promoting continuous experimentation and adaptation, this framework supports the long-term viability of health promotion initiatives (Hayes et al., 2019).

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Important factors related to the limitations of behavioral interventions that have been considered in the MTM-based interventions were the lack of comprehensive data due to access and reach to populations of interest and to collect biometric tests and measurements (Bashirian et al., 2019). Similarly, other MTM interventions explained that overestimation of interventions' effects, accuracy and brevity of survey, and non-randomized trial without control have limited the probing of constructs and introduced bias (Hayes et al., 2019; Calvert et al., 2024). There were also reported limitations secondary to acquiescence bias and/or social desirability and lack of sub-group analysis (Brown et al., 2020).

Strengths and limitations of the review

The intersection of environmental health and equitable access to care is a multifaceted issue that requires a comprehensive approach. This review has taken into account the leveraging of communities, environmental health programs, and cross-sectoral collaboration, to address the behavioral, social, and environmental determinants of sustainable health and equitable access to care. This comprehensive review underscores the importance of integrating evidence-based sustainable health considerations into public health strategies to ensure that all individuals, particularly those in underserved communities, can achieve optimal health outcomes. This project has also comprehensively synthesized existing research on the MTM framework and emphasized the importance of public health program capacity for sustainability. Another strength is providing a structured approach to understanding sustainability in public health, addressing chronic diseases, and the delivery of healthcare. By focusing on capacity building, this review will help ensure that health programs can adapt to changing environmental and social contexts, ultimately leading to more sustainable outcomes.

In addition, findings from the risk of bias assessment underscored the importance of such studies that address various dimensions of sustainability. By understanding the factors that contribute to or hinder sustainability, health promoters can design more effective programs that are resilient to challenges and can identify knowledge gaps. To the authors' knowledge, this is the first comprehensive review to describe the MTM-based interventions. The authors have also given a holistic perspective and systematic critical analysis of the MTM-based sustainable interventions that can be considered for the future social and environmental contexts of sustainable health.

Of the limitations of this study is that there are a very limited number of studies themselves that were considered for the review; there was also a lack of new data on interventions based on MTM. Another limitation was the retrospective nature of the review which might have affected the causal conclusions drawn from the included studies. In addition, there was limited generalizability and heterogeneity in studies which have been challenging to synthesize accurate data from the studies.

Conclusions

Health behavior change serves as a critical strategy for sustainable health promotion, particularly in community settings where contextual factors significantly influence the success of interventions. By fostering collaboration, leveraging community strengths, and adopting a systems-level approach, sustainable health promotion efforts can achieve greater sustainability and effectiveness in improving health behaviors among diverse populations. Sustainable health promotion represents a critical evolution in public health practice, necessitating a comprehensive understanding of the interconnections between health and the environment. By integrating sustainability principles into health promotion strategies, practitioners can enhance health outcomes while fostering environmental stewardship. Sustainable health promotion requires a multifaceted approach that incorporates theoretical frameworks, community engagement, and sustainable financing. By aligning health promotion practices with environmental sustainability principles and fostering local involvement, public health initiatives can achieve more significant and lasting impacts on both

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health and the environment. It is also emphasized that by integrating sustainable health considerations into healthcare systems, we would ensure that all individuals, regardless of their socio-economic status, have access to quality care that mitigates environmental risks. In summary, sustainable health promotion frameworks are vital for integrating health promotion efforts with sustainability principles. The challenges of the integration of sustainable practices into health promotion will be essential for building resilient communities and promoting overall well-being. By adopting these frameworks, health promoters can enhance the effectiveness and sustainability of their initiatives, ultimately contributing to healthier communities and a more sustainable future.

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Conflicts of Interest

The authors declared no conflict of interest.

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Ethical considerations

This is a systematic review, and no direct human subject interaction has been undertaken. All the guidelines for undertaking systematic review followed the PRISMA statement.

Code of Ethics

This is a systematic review, so no research ethics committee approval was required. All relevant studies included in the review are publicly available, and extracted datasets from the articles can be presented on request.

Authors' Contributions

S.K and M.S conceptualized the study; S.K and A.D.G devised the methodology; S.K and A.A worked on the software; S.K., A.A., A.D.G, and M.S.A. validated the data; S.K curated the data and ran the formal analysis; all authors prepared, wrote, reviewed, and edited the draft and the final manuscript; S.K and A.A refined the visualizations, and M.S supervised the project. All authors have also read and agreed to the published version of the manuscript.

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