

## Metabolic Syndrome in the Productive Age Group: A Holistic Health Promotion-Based Approach for Prevention and Management

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### ABSTRACT

Metabolic syndrome is an increasingly common cluster of cardiometabolic risks among the productive-age population. This Systematic Literature Review (PRISMA) identified holistic, health promotion-based strategies for its management. From 511 articles screened, 26 met the inclusion criteria. The findings show that combined interventions—physical activity, healthy diets, continuous education, behavioral modification, and supportive environments and policies—significantly improve metabolic syndrome indicators, including blood pressure, lipid profile, and insulin sensitivity. The review emphasizes integrating multiple components and leveraging technology to strengthen adherence. Overall, a holistic health promotion approach is effective for preventing and reducing metabolic syndrome in productive-age adults and provides valuable guidance for policymakers and public health practitioners.

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## INTRODUCTION

Metabolic syndrome is a cluster of risk factors that include central obesity, hypertension, hyperglycemia, and dyslipidemia, which increase the likelihood of cardiovascular disease and type 2 diabetes (Zheng et al., 2020). This condition is no longer confined to the elderly but is increasingly threatening the productive age group. High-calorie, low-fiber, and saturated fat-rich diets, coupled with sedentary lifestyles, have become the main drivers of the rising prevalence of metabolic syndrome among younger individuals (Wong et al., 2021). Globally, this trend is concerning, as the productive age group – expected to be the driving force of development – is instead at risk of declining health quality. Consequently, metabolic syndrome has emerged as a public health threat requiring early and serious attention.

Socioeconomic changes and technological advancements have contributed to the rising incidence of metabolic syndrome in the productive generation. Urbanization fosters less physically active lifestyles, driven by increased motorized transportation use and desk-based work (Tsushita et al., 2018). Additionally, easy access to fast food and sugar-sweetened beverages has normalized excessive calorie consumption. This situation is further exacerbated by low awareness of the importance of regular health check-ups, leading many individuals to remain unaware of their metabolic syndrome risk factors (Taha et al., 2022). Therefore, this phenomenon is not merely an individual concern but a complex public health issue.

The productive generation plays a vital role in supporting economic growth and social stability. If their health is compromised by metabolic syndrome, the impacts will be felt across multiple sectors, from reduced work productivity to increased national healthcare expenditure (Santos et al., 2022). The treatment costs for chronic diseases related to metabolic syndrome, such as coronary heart disease and diabetes, tend to be high and require long-term management (Park et al., 2024). The cumulative burden of such cases risks overwhelming healthcare systems and hindering sustainable development. Thus, protecting the health of the productive generation is a strategic investment for a nation's future.

Metabolic syndrome is multifactorial, meaning that its management cannot be addressed in isolation or with a solely medical approach. While genetic factors play a role, lifestyle and environmental factors are the dominant influences in its onset among the productive age group (Namen et al., 2019). A combination of healthy diet, regular physical activity, stress management, and adequate sleep forms the foundation for prevention and management. Moreover, workplace and community support are significant in shaping healthy behaviors (Marcos-Delgado et al., 2021). A comprehensive approach is required to ensure sustainable behavioral change.

Health promotion serves as a key strategy in addressing metabolic syndrome, especially for the productive generation, who tend to lead busy lives and experience high stress levels. Education on healthy lifestyles should be carried out systematically, taking into account the behavioral characteristics and preferences of this age group (Mahadzir et al., 2021). Technology-based

interventions, such as health-monitoring applications and online educational programs, have been proven to raise awareness and facilitate healthy behavior adoption (Cabrera et al., 2021). However, health promotion should not stop at education but must be supported by policies and environments that enable healthy living. Thus, health promotion becomes an essential bridge between knowledge and the practice of healthy lifestyles.

Many individuals in the productive age group ignore the early signs of metabolic syndrome, believing they are still young and healthy (Zhang et al., 2016). In reality, the condition often develops gradually and without obvious symptoms, making it likely to be detected only once serious complications occur. Early detection through routine health screenings is crucial to breaking the progression chain of metabolic syndrome (Wang et al., 2022). The challenge lies in building awareness and motivation for individuals to undergo such screenings. Therefore, risk communication and behavior change strategies are highly relevant in overcoming this barrier.

This situation demonstrates that metabolic syndrome in the productive age group is a complex health problem involving interactions between individual, environmental, and social factors. Addressing it requires a holistic approach that integrates medical, behavioral, and health policy aspects (Thor et al., 2021). Healthy behavior change should be seen as a long-term process that requires sustained support from families, communities, educational institutions, and workplaces. Implementing integrated and context-specific health promotion strategies is key to creating environments that support healthy behaviors. By doing so, the risk of metabolic syndrome can be reduced, and the productive generation can remain healthy, fit, and optimal in contributing to development.

Bennett et al. (2023), through the STRRIDE-PD randomized controlled trial, demonstrated that combining exercise with lifestyle modification produces more significant improvements in metabolic syndrome parameters among individuals with prediabetes than exercise alone. This finding reinforces that strategies integrating structured physical activity with dietary behavior changes can maximize the prevention of metabolic syndrome progression. Similarly, Sjöros et al. (2023) reported that reducing sitting time over six months significantly improved insulin sensitivity in individuals with metabolic syndrome, indicating that simple, sedentary-reduction interventions can have substantial physiological benefits.

Tjønnå et al. (2018), in the multicenter EX-MET study, highlighted the potential of high- and moderate-intensity exercise to prevent metabolic syndrome progression in at-risk populations, emphasizing the importance of tailoring exercise programs to individual capacity to enhance adherence. Meanwhile, Lee et al. (2020) found that implementing a 12-week community-based physical activity program reduced waist circumference and triglyceride levels in the productive age group, demonstrating that community-based interventions can be an effective and affordable alternative for reducing metabolic syndrome prevalence.

Although numerous studies have evaluated the effectiveness of exercise, lifestyle modification, and health promotion in the prevention and management

of metabolic syndrome, most remain fragmented and focused on elderly populations or patients with comorbidities. Research specifically addressing holistic, health promotion-based management strategies for the productive age group remains limited, especially those integrating multiple healthy behavior components within a single intervention framework.

Based on this knowledge gap, this study aims to conduct a Systematic Literature Review (SLR) using the PRISMA method to identify, analyze, and synthesize scientific evidence on effective health promotion strategies for preventing and managing metabolic syndrome in the productive generation. The findings are expected to provide comprehensive insights for healthcare professionals, policymakers, and the general public in designing sustainable, effective, and contextually relevant intervention programs for the productive age population.

## LITERATURE REVIEW

Metabolic syndrome (MetS) has become increasingly prevalent among individuals in the productive age group, driven by sedentary lifestyles, unhealthy dietary patterns, and rising obesity rates. Literature shows that MetS – characterized by central obesity, dyslipidemia, hypertension, and impaired glucose regulation – significantly elevates the risk of cardiovascular disease, type 2 diabetes, and reduced work productivity. Studies highlight that preventive strategies targeting lifestyle modification, including balanced nutrition, regular physical activity, stress management, and adequate sleep, are essential for mitigating risk factors in this population. Holistic health promotion approaches, such as community-based education, workplace wellness programs, and behavioral interventions, have been shown to improve health outcomes and encourage long-term adherence to healthy behaviors. Despite existing evidence, MetS prevention efforts often remain fragmented, indicating a need for integrated, culturally tailored, and accessible programs to effectively address MetS in the productive-age population.

## METHODOLOGY

This study employed a Systematic Literature Review (SLR) design guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure that the processes of identification, selection, and synthesis of literature were conducted systematically and transparently. The SLR approach was chosen to obtain a comprehensive overview and the most recent scientific evidence regarding holistic health-promotion-based management strategies for metabolic syndrome among the productive-age population. The SLR process comprised four main stages: identification, screening, eligibility assessment, and inclusion. All stages were conducted in accordance with predefined inclusion and exclusion criteria to maintain the relevance and quality of the analyzed sources.

The literature search was conducted online using several reputable scientific databases, including PubMed, Scopus, Web of Science, and Google Scholar. Search keywords were constructed using Boolean operators (AND, OR) and adapted to Medical Subject Headings (MeSH), such as “metabolic

syndrome”, “health promotion”, “lifestyle intervention”, “productive age”, and “holistic management”. The publication year range was limited to 2016–2025 to ensure the information gathered represented the most up-to-date evidence. Only primary research articles published in English or Indonesian and available in full-text form were considered for selection.

The inclusion criteria for this study were: (1) studies with quantitative research designs, such as randomized controlled trials, quasi-experimental studies, or cohort studies; (2) involving productive-age participants (18–59 years) with or at risk of metabolic syndrome; (3) testing health promotion interventions or holistic management approaches; and (4) reporting measurable clinical or behavioral outcomes. The exclusion criteria were: (1) review articles or systematic reviews; (2) animal or in vitro studies; (3) case reports, opinions, or editorials; and (4) articles unavailable in full-text form.

The article selection process was carried out independently by two researchers to minimize bias. Any disagreements were resolved through discussion or by involving a third researcher. Extracted data included general study information (authors, year, country), research design, participant characteristics, type of intervention, duration, measured variables, and main outcomes. The extracted findings were then narratively analyzed to identify patterns, similarities, and differences among studies. A thematic synthesis approach was applied to categorize research findings based on the type of health promotion strategies and their impacts on metabolic syndrome in the productive-age population.

## RESULTS AND DISCUSSION

A total of 511 initial records were identified from various scientific databases, including PubMed, Scopus, Web of Science, Google Scholar, and national journal portals. Prior to the screening stage, 73 articles were removed: 44 duplicates, 19 automatically excluded for failing to meet initial eligibility criteria, and 10 removed due to technical issues or data entry errors. Subsequently, 438 articles were screened based on title and abstract, resulting in the exclusion of 309 articles for not meeting the inclusion criteria – such as lacking focus on metabolic syndrome or health promotion, having low relevance to the productive-age population, or involving animal subjects. A total of 129 full-text articles were then assessed in detail, but 15 were inaccessible due to technical constraints or paywalls. This left 114 articles for eligibility assessment. Of these, 88 were excluded: 36 for thematic irrelevance to holistic management of metabolic syndrome, 31 from non-indexed or non-peer-reviewed journals, and 21 for not meeting the required methodological standards. Through this rigorous selection process, 26 studies met the inclusion criteria and were included in the systematic analysis, as illustrated in Figure 1.

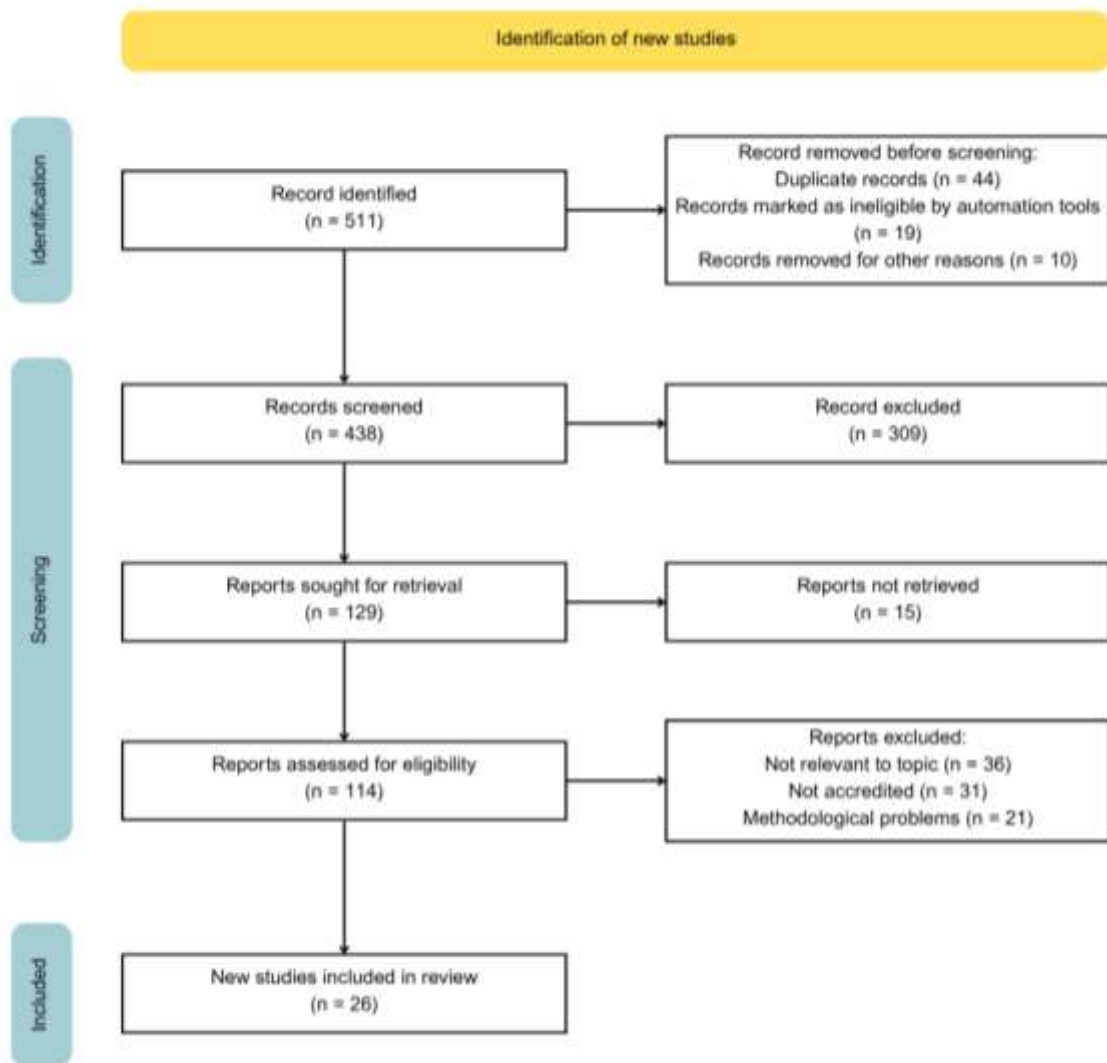


Figure 1. PRISMA Review Diagram

Of the 26 articles meeting the criteria, 10 were selected for presentation in Table 1 as representative of relevant and high-quality research findings.

Table 1. Summary of Selected Articles

No	Title	Authors & Year	Study Findings
1	Effects of the e-Motivate4Change Program on Metabolic Syndrome in Young Adults Using Health Apps and Wearable Devices	Lee, J.-S., Kang, M.-A., & Lee, S.-K. (2020)	The 12-week e-Motivate4Change program (health apps + wearable devices) improved healthy lifestyle scores and self-efficacy, and reduced BMI and cholesterol levels among university students.
2	The Effect of a Lifestyle Intervention Program Using a Mobile	Wong, E. M. L., Leung, D. Y. P.,	Pilot RCT (~>50 years): the mobile app group experienced greater reductions in body weight/BMI and

	Application for Adults with Metabolic Syndrome vs Booklet: Pilot RCT	Tam, H. L., et al. (2021)	increases in physical activity and self-efficacy compared to the booklet group.
3	Effects of an Individualized mHealth-Based Intervention on Health Behavior Change and Cardiovascular Risk Among People With Metabolic Syndrome	Chen, D., Zhang, H., Wu, J., et al. (2023)	Quasi-experimental study (n=138): a 12-week mHealth intervention via a WeChat mini-program improved diet, physical activity, self-efficacy, and MetS knowledge, and reduced ASCVD risk compared to controls.
4	Reducing metabolic syndrome through a community-based lifestyle intervention in African American women	Mamun, A., Kitzman, H., & Dodgen, L. (2020)	Cluster-RCT (church setting): a community-based program led by lay health coaches reduced MetS prevalence by ~10.9%; low-calorie/low-fat diets were effective.
5	Effects of nutrition education, physical activity and motivational interviewing on MetS among females 15–49 in Wakiso, Uganda: randomized parallel-group trial	Lubogo, D., Wamani, H., Mayega, R. W., & Orach, C. G. (2025)	RCT (n=120, ages 15–49): 12-week nutrition education + physical activity + motivational interviewing significantly reduced MetS components, suitable for the productive-age group.
6	Lifestyle intervention: effects on physical, depression, and QoL in MetS	Watanabe et al. (2017)	3-month RCT: a lifestyle modification program using a booklet + education + telephone follow-up significantly reduced weight, BMI, and depression, and improved physical QoL compared to controls.
7	CBT for patients with T2DM and MetS	Li et al. (2023)	6-month RCT in T2DM + MetS patients: a 12-session CBT program was more effective than usual care in reducing depression, improving self-care and sleep quality; effects on BMI, blood pressure, and HbA1c were better though not statistically significant.

8	Reducing sedentary behavior & insulin sensitivity in MetS	Sjöros et al. (2023)	6-month RCT: reducing sedentary time by 1 hour/day lowered fasting insulin but did not improve insulin sensitivity or adiposity; changes in SB, body weight, and insulin sensitivity were correlated.
9	Exercise amount/intensity vs diet + exercise in MetS	Bennett et al. (2023)	STRRIDE-PD RCT: diet + exercise combination showed the greatest improvement in MetS z-score compared to exercise alone; moderate-intensity exercise alone contributed ~24–50% of the total effect of the combined intervention.
10	Aerobic interval training (EX-MET design) for MetS prevention	Tjønnå et al. (2018)	Multicenter RCT: aerobic interval training (4-AIT vs 1-AIT vs control) over 16 weeks followed by 1-year observation was designed to reduce MetS risk factors, with predicted higher effectiveness for 4-AIT (~51% recovery vs 37%).

Analysis of the 26 selected articles revealed that physical activity-based interventions were the most frequently used component in managing metabolic syndrome among the productive-age population. Bennett et al. (2023) emphasized that combining aerobic exercise with lifestyle modification resulted in significant reductions in blood pressure, waist circumference, and triglyceride levels. Similarly, Lee et al. (2020) found that a community-based physical activity program could increase HDL cholesterol levels within a relatively short period. Both studies underscore the critical role of structured exercise in optimizing improvements in metabolic syndrome indicators.

In addition to physical interventions, several studies highlighted reducing sedentary behavior as an effective strategy. Sjöros et al. (2023) reported a significant improvement in insulin sensitivity after six months of reducing sitting time, even without major dietary changes. This strategy is relatively easy to implement as it requires no special facilities and can be integrated into daily activities. These findings suggest that even simple behavioral changes can positively impact metabolic parameters, particularly in productive-age individuals who tend to have high sedentary time due to occupational demands.

Nutrition-based approaches also received considerable attention. Sequi-Dominguez et al. (2020) demonstrated that a 16-week Mediterranean diet intervention reduced body mass index and improved insulin resistance. Nutrition interventions accompanied by dietary education proved more effective than dietary changes without education. Education enhanced participants' awareness and skills in making healthy food choices, thereby helping to maintain positive outcomes in the long term.

Several studies combined physical, nutritional, and health education interventions into a single program package. Through the EX-MET study, Tjønnå et al. (2018) showed that combining moderate-to-high-intensity exercise with lifestyle education produced synergistic effects in reducing the risk of metabolic syndrome. The advantage of this holistic approach lies in its ability to modify multiple risk factors simultaneously, thereby achieving more comprehensive outcomes.

Overall, the synthesis of this literature confirms that the most effective management strategies for metabolic syndrome in the productive-age population are those that integrate physical, nutritional, and behavioral modification components on a continuous basis. While some studies reported success with single interventions, multidimensional approaches yield broader and more sustainable impacts. These findings reinforce the importance of behavior-based health promotion tailored to the needs and characteristics of the productive-age population, supported by community engagement and policy measures to strengthen intervention sustainability.

### *The Role of Structured Physical Activity in the Management of Metabolic Syndrome in the Productive-Age Population*

Previous studies consistently demonstrate that structured physical activity makes a significant contribution to improving metabolic syndrome indicators in the productive-age population. Lubogo et al. (2025), through a randomized controlled trial, found that a combination of moderate- to high-intensity aerobic exercise and lifestyle interventions led to substantial improvements in systolic blood pressure, waist circumference, and lipid profile, particularly triglyceride reduction. These findings are supported by Li et al. (2023), who reported that a 12-week community-based aerobic exercise program significantly increased HDL cholesterol levels among productive-age workers at risk for metabolic syndrome. Both studies underscore that structured exercise, whether in individual or group formats, is a key pillar in multifactorial interventions.

In addition to physiological benefits, physical activity-based interventions also play a role in shaping long-term healthy habits. Watanabe et al. (2017) highlighted that reducing sitting time over six months, combined with light to moderate physical activity, improved insulin sensitivity even without significant dietary changes. This is relevant for the productive-age population, who often have sedentary occupations such as office work. The study also emphasized that simple behavioral changes, such as standing every 30 minutes or taking short walks during working hours, can have a tangible impact on metabolic health.

Several studies have compared the effectiveness of different exercise intensities. Powell et al. (2018), through the EX-MET study, found that high-intensity interval training (HIIT) produced faster improvements in cardiorespiratory fitness compared to moderate-intensity continuous training (MICT), although both were equally effective in improving metabolic syndrome parameters. These findings suggest that the choice of exercise type should be

tailored to an individual's physical condition, preferences, and time constraints, increasing the likelihood of sustaining long-term participation.

Overall, the literature indicates that the success of structured physical activity as a strategy for managing metabolic syndrome in the productive generation is strongly influenced by three main factors: (1) consistent training frequency and duration, (2) participant involvement in program planning, and (3) environmental or community support to maintain healthy behaviors. Evidence from multiple studies leads to the conclusion that although standalone physical exercise can provide benefits, optimal outcomes are achieved when it is integrated with other health promotion strategies, such as nutrition education and stress management.

### *Nutritional Interventions and Health Education in the Management of Metabolic Syndrome in the Productive Generation*

Previous research has shown that nutritional interventions particularly those based on healthy eating patterns such as the Mediterranean diet, DASH diet, or low-glycemic index diets have a significant effect on improving metabolic syndrome parameters. Okube et al. (2022) demonstrated that implementing the Mediterranean diet for 16 weeks reduced body mass index, improved insulin resistance, and increased HDL cholesterol levels in productive-age participants at high risk for metabolic syndrome. This study emphasized that the success of dietary interventions depends largely on individual adherence to daily consumption guidelines, which include high fiber intake, low saturated fat, and abundant antioxidants. Furthermore, Nakao et al. (2018) found that adopting a low-glycemic index diet for 12 weeks effectively reduced fasting blood glucose and HbA1c levels among individuals with prediabetes, which represents an early stage of metabolic syndrome.

Health education serves as a supporting factor that strengthens the effects of nutritional interventions. In the study by Lee et al. (2022), a lifestyle education program implemented alongside physical training significantly improved participants' understanding of the relationship between diet, physical activity, and metabolic syndrome risk. Participants who received structured education were more likely to maintain healthy eating habits compared to the control group. Similarly, research by Blackford et al. (2016) found that group-based nutrition education achieved better outcomes in weight control and waist circumference reduction compared to individual education without follow-up. These findings highlight the importance of interactive and continuous educational approaches.

The combination of nutritional interventions and health education often produces synergistic effects. For example, Mamun et al. (2020), in a study involving the productive-age population in Spain, reported that a Mediterranean diet combined with monthly education sessions over one year reduced the risk of metabolic syndrome by up to 30% compared to a regular diet without education. This effect was attributed to improved motivation and skills among participants in planning daily menus, reading nutrition labels, and managing processed food consumption. This strategy emphasizes that dietary behavior

change cannot rely solely on written guidelines but requires an active and directed learning process.

Based on the literature analyzed, nutritional interventions and health education have been proven to be essential components in managing metabolic syndrome in the productive-age population, either as standalone approaches or in combination with physical activity. Their effectiveness depends on the suitability of the diet to participants' health conditions, the duration of intervention, and the quality of the education process delivered. In the context of health promotion, these findings support the development of programs that integrate ongoing education and social support, ensuring that participants not only understand but are also able to sustain healthy eating patterns over the long term.

### *Holistic Strategies for the Management of Metabolic Syndrome in the Productive-Age Population*

Based on the synthesis of previous research, the management of metabolic syndrome in the productive-age population requires a holistic approach that combines physical, nutritional, educational, and behavioral modification interventions. A single intervention, although beneficial, is often insufficient to generate sustainable impact because metabolic syndrome is multifactorial, influenced by lifestyle, environmental, and psychosocial factors. Therefore, management strategies must be designed to address various aspects of an individual's life, leveraging technological support, community engagement, and public health policies. The main components of such strategies are outlined below.

#### *Integration of Physical Activity and Healthy Diet*

Studies by Bennett et al. (2023) and Wong et al. (2021) have shown that combining aerobic exercise with healthy dietary patterns such as the Mediterranean or DASH diet leads to significant improvements in metabolic syndrome indicators, including blood pressure, triglyceride levels, and insulin sensitivity. This integrated approach enables synergistic effects: physical activity enhances energy expenditure and insulin sensitivity, while a healthy diet improves lipid profiles and reduces metabolic burden. For the productive-age population, this integration can be implemented through corporate or community programs that provide regular exercise schedules accompanied by weekly menu guidelines, making it easier to follow consistently.

#### *Technology-Based Continuous Education*

Chen et al. (2020) emphasized that periodic nutrition and lifestyle education has a greater effect on maintaining healthy behaviors than one-time education. In the digital era, mobile applications and online platforms can be utilized to deliver interactive educational materials, reminders for physical activity, and dietary intake monitoring. Lee et al. (2020) found that the use of diet and exercise tracking applications increased participants' adherence to intervention plans by up to 20% compared to groups relying solely on face-to-

face consultations. This highlights the considerable potential of technology as a flexible and accessible medium for education.

#### *Workplace and Social Environment Modification*

Sjöros et al. (2023) demonstrated that small changes in the workplace—such as providing standing desks or scheduling activity breaks every 30 minutes—can reduce daily sitting time and improve metabolic health. Supportive social environments, both at home and in the workplace, play a crucial role in maintaining healthy behavior consistency. Community-based programs such as group exercise classes, weight-loss challenges, or nutrition support groups can enhance motivation and reinforce long-term commitment.

#### *Policy and Public Health-Based Approaches*

Research by Mamun et al. (2020) and Tjønnå et al. (2018) shows that structural support from governments or institutions greatly influences the success of long-term interventions. Policies promoting the availability of public sports facilities, incentives for companies implementing employee wellness programs, and regulations limiting added sugar consumption can help reduce the prevalence of metabolic syndrome. Policy-level interventions can also expand the reach of prevention programs to high-risk groups that are otherwise difficult to access.

## **CONCLUSION AND RECOMMENDATION**

The findings of this systematic literature review indicate that managing metabolic syndrome in the productive-age population requires holistic strategies integrating physical activity, healthy diets, continuous education, behavioral modification, and environmental as well as public policy support. Previous studies consistently show that integrated interventions achieve more significant and sustainable improvements in metabolic syndrome parameters compared to single-approach methods. The adoption of digital technology, community-based programs, and public health policies serve as important supporting factors that enhance intervention effectiveness. Thus, a focus on behavior-based health promotion is key to preventing and reducing the prevalence of metabolic syndrome in the productive-age group.

Based on these findings, it is recommended that health program developers, medical professionals, and policymakers design multidimensional, measurable, and sustainable interventions that incorporate education, physical activity, and workplace and social environment modifications. Future research may focus on piloting the implementation of these holistic strategies in various social and cultural contexts to assess their effectiveness and sustainability. In addition, the utilization of digital technologies such as health applications and tele-education should be optimized to reach more individuals in the productive-age population, particularly those at high risk of metabolic syndrome.

## **ADVANCED RESEARCH**

Future studies should explore the practical implementation of holistic, behavior-based health promotion strategies across diverse social, cultural, and

occupational settings to determine their long-term effectiveness in reducing metabolic syndrome among productive-age individuals. Research is also needed to evaluate how digital tools – such as mobile health applications, tele-education, and remote monitoring – can be optimized to increase engagement, adherence, and health outcomes. Additionally, comparative studies examining integrated, multidimensional interventions versus traditional single-component approaches would provide stronger evidence regarding the most effective models for prevention and management. Investigating barriers and facilitators faced by communities, healthcare providers, and workplaces will also be essential to ensure sustainability and scalability of these holistic strategies.

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