УДК 616-036.22:616-07

https://doi.org/10.47526/YJoHS-2025.1-06

ANALYSIS OF ASSESSMENT METHODS AND THE ROLE OF PHYSICAL ACTIVITY IN THE DEVELOPMENT OF METABOLIC SYNDROME (LITERARY REVIEW)

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Abstract: The global spread of noncommunicable diseases (NCDs) has become a major public health concern. The incidence and mortality from cardiovascular diseases has increased significantly over the past three decades worldwide. According to forecasts of the World Health Organization, by 2030, up to 30% of deaths worldwide will be associated with a sedentary lifestyle and its negative consequences. The main strategy for preventing these conditions is to correct lifestyle and increase physical activity levels. Observational and interventional studies confirm the important role of physical activity and a healthy lifestyle in reducing the manifestations of metabolic syndrome. Factors such as physical activity and the MedDiet diet contribute to reducing the likelihood of developing it. Each component of the metabolic syndrome is more or less related to the level of physical activity. Although physical activity does not have a direct effect on insulin resistance, lipid metabolism disorders, or obesity, it has been proven that increasing activity levels significantly reduces these risk factors, having a positive effect on health. The review of scientific literature examines the impact of physical activity and a healthy lifestyle on metabolic syndrome, as well as clarifies the mechanism underlying their benefits in its prevention and treatment.

Keywords: metabolic syndrome, obesity, hypodynamia, healthy lifestyle, physical activity, diabetes mellitus.

Физикалық белсенділіктің бағалау әдістерін және метаболикалық синдромның дамуындағы рөлін талдау (әдеби шолу)

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Аңдатпа. Жұқпалы емес аурулардың (Жқа) жаһандық таралуы денсаулық сақтаудың басты мәселесіне айналды. Соңғы үш онжылдықта бүкіл әлемде жүрек-қан тамырлары ауруларынан болатын ауру мен өлім-жітім айтарлықтай өсті. Дүниежүзілік Денсаулық сақтау Ұйымының болжамына сәйкес, 2030 жылға қарай дүние жүзінде өлім-жітімнің 30% - ға дейіні отырықшы өмір салтымен және оның жағымсыз салдарымен байланысты болады. Бұл жағдайлардың алдын алудың негізгі стратегиясы-өмір салтын түзету және физикалық белсенділік деңгейін арттыру. Бақылау және интервенциялық зерттеулер метаболикалық синдромның көріністерін төмендетудегі физикалық белсенділік пен салауатты өмір салтының маңызды рөлін растайды. Физикалық белсенділік және MedDiet диетасы сияқты факторлар оның даму ықтималдығын төмендетуге ықпал етеді. Метаболикалық синдромның әрбір құрамдас бөлігі физикалық белсенділік деңгейімен азды-көпті байланысты. Дене белсенділігі инсулинге төзімділікке, липидтер алмасуының бұзылуына немесе семіздікке тікелей әсер етпесе де, белсенділік деңгейінің жоғарылауы денсаулыққа оң әсер ететін осы қауіп факторларын айтарлықтай төмендететіні дәлелденді. Ғылыми әдебиеттерге шолу

физикалық белсенділік пен салауатты өмір салтының метаболикалық синдромға әсерін зерттейді, сонымен қатар олардың алдын алу мен емдеудегі артықшылықтарының негізінде жатқан механизмді түсіндіреді.

Түйін сөздер: метаболикалық синдром, семіздік, физикалық белсенділік, салауатты өмір салты, дене белсенділігі, қант диабеті.

Анализ методов оценки и роли физической активности в развитии метаболического синдрома (обзор литературы)

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Аннотация: Глобальное распространение неинфекционных заболеваний (НИЗ) стало серьезной проблемой общественного здравоохранения. За последние три десятилетия во всем мире значительно возросли заболеваемость и смертность от сердечно-сосудистых заболеваний. По прогнозам Всемирной организации здравоохранения, к 2030 году до 30% смертей во всем мире будут связаны с малоподвижным образом жизни и его негативными последствиями. Основной стратегией профилактики этих состояний является коррекция образа жизни и повышение уровня физической активности. Наблюдательные и интервенционные исследования подтверждают важную роль физической активности и здорового образа жизни в снижении проявлений метаболического синдрома. Такие факторы, как физическая активность и диета MedDiet, способствуют снижению вероятности его развития. Каждый компонент метаболического синдрома в большей или меньшей степени связан с уровнем физической активности. Хотя физическая активность не оказывает прямого влияния на резистентность к инсулину, нарушения липидного обмена или ожирение, было доказано, что повышение уровня физической активности значительно снижает эти факторы риска, оказывая положительное влияние на здоровье. В обзоре научной литературы рассматривается влияние физической активности и здорового образа жизни на метаболический синдром, а также разъясняется механизм, лежащий в основе их преимуществ при его профилактике и лечении.

Ключевые слова: метаболический синдром, ожирение, гиподинамия, здоровый образ жизни, физическая активность, сахарный диабет.

Introduction

Metabolic syndrome (MetS) is a global health problem encompassing key cardiovascular risk factors such as abdominal obesity, dyslipidemia, disorders of carbohydrate metabolism and high blood pressure. It is a precursor to cardiovascular disease (CVD) and its complications [1].

Diseases leading to the development of cardiovascular complications are closely related to lifestyle, including smoking, diet and physical activity level [1]. According to WHO, more than 3/4 of all cardiovascular disease (CVD) deaths can be prevented by lifestyle changes. The global incidence of MetS is increasing, making it crucial to identify factors leading to both its development and progression [2]. More specifically, it is estimated that between 20 and 25% of the world's adult population demonstrates a combination of risk factors associated with MS. In 2000, about 32% of adults in the United States were diagnosed with MetS, and in Iran, the prevalence of MetS in adults is 32% overall, with 27% in men and 36% in women [3].

Globally, nearly one third of adults were insufficiently physically active in 2022 (age-standardized prevalence of 31.3 percent, or 1.8 billion). The high-income Asia-Pacific region was

most affected by low levels of physical activity, followed by South Asia. Oceania had the lowest rate of physical inactivity, followed by sub-Saharan Africa. The prevalence of low motor activity was lowest among low-income countries and highest in lower-middle-income countries. The United Arab Emirates had the highest prevalence of low motor activity at 66.1 per cent; Malawi had the lowest prevalence at 2.7 per cent [4].

Physical activity in the Concept of Development of Physical Culture and Sports of the Republic of Kazakhstan until 2025 is considered "as the main source of health of the nation". The concept of a healthy nation includes the promotion of physical activity and systematic sports activities, as well as a wide range of measures and conditions, the most important of which is physical activity. According to the ISS data, in 2019 in Kazakhstan 5.7 million people were engaged in sports, which is 30.6% of the total population, in 2016 27.4% of the population, it is planned to increase the number to 7.3 million people by 2025, i.e. 40% of the total population. According to the WHO assessment of the level of morbidity in the world, Kazakhstan is a leader in mortality from non-communicable diseases compared to European countries. In Kazakhstan, the mortality rate at the age of 30 to 69 years is 82%, in other countries this indicator is 71% [WHO, 2018]. Four main categories of non-communicable diseases - CVD, cancer, obstructive pulmonary disease and DM2, make up the majority of diseases of national scale, leading to premature mortality, the probability of death from one of them is equal to 19.28% [5].

The purpose of the study: to conduct a literature review to analyse current methods of assessing physical activity and its role in the development of metabolic syndrome

Search strategy. The literature review analyzed articles published from the scientific databases PubMed, Medline, Google Scholar, Embase, and Web of Science from 2019 to 2024. The keywords "metabolic syndrome", "obesity", "hypodynamia", "healthy lifestyle", "physical activity", "diabetes mellitus" were used for the search.

For the literature review, articles that met the following criteria were considered:

1. full-text articles;
2. application of widely recognized MetS diagnostic criteria;
3. Conduct research on the role and relationship of physical activity, lifestyle in the development of MetS.The main reasons for exclusion criteria in studies are: repetitive data; availability of only brief abstracts, editorials; lack of sufficient data.

Metabolic syndrome and physical activity.

Low physical activity is a major factor that increases the risk of mortality from non-communicable diseases, contributing to 830,000 deaths and 15.75 million disability-adjusted life years worldwide in 2019 [6]. Metabolic syndrome (MetS) has become a global epidemic due to sedentary lifestyles and increased consumption of high-calorie foods. These negative factors contribute to the rise of obesity in both developed and developing countries, although its prevalence is somewhat lower in the latter [7]. According to the World Health Organization (WHO), more than 75% of deaths from cardiovascular disease (CVD) can be prevented through lifestyle changes [8].

Obesity is considered a key public health problem and ranks fifth among the leading causes of death worldwide. Overweight and obesity are among the major lifestyle diseases that lead to further health complications and contribute to a host of chronic diseases, including cancer, diabetes mellitus, metabolic syndrome and cardiovascular disease. Metabolic syndrome (MetS) contributes to an increased risk of developing diabetes mellitus and cardiovascular disease (CVD) both in patients with and without a history of cardiovascular disease [9]. Therefore, its early detection may be an important strategy to reduce cardiometabolic risk in patients in the future. Physical activity has been shown to reduce cardiovascular disease risk factors by improving cardiorespiratory fitness, and dietary interventions are effective in reducing obesity [10]. In addition, measures to increase physical activity have been found to be effective in improving cardiometabolic parameters [11].

A number of studies have identified the relationship between hypodynamia and nutrition, focusing primarily on the development of obesity, energy expenditure, adipogenesis, and polymorphisms of genes related to eating behavior and appetite control. Such studies are of great

interest because they open new possibilities for individualized prevention and therapy of metabolic syndrome (MetS). Optimization of nutrition in combination with physical activity and weight loss may have a beneficial effect on overall risk, contributing to the prevention and treatment of metabolic syndrome [12].

Total time spent in sedentary behavior has been found to be significantly associated with an increased risk of metabolic syndrome. This study showed that prolonged sedentary behavior is associated with an increased risk of metabolic syndrome regardless of the level of physical activity. In this case, the nature of the relationship varies by gender rather than by age [13-14].

The World Health Organization (WHO) recommends at least 150 minutes of moderate-intensity FA or 75 minutes of high-intensity FA per week for adults [15]. Failure to follow these recommendations is associated with an increased risk of coronary heart disease, cancer, diabetes, anxiety, depression, cognitive impairment and shortened life expectancy [16].

The potential impact of promoting physical activity is substantial, and it is estimated that 20% of deaths could be prevented if people followed the minimum recommendations for healthy lifestyle. Despite this, the inclusion of physical activity in MetS prevention strategies remains underutilized. The prevalence of MetS increases with age, is higher in men than in women, and varies by race and ethnicity. There is an inverse relationship between physical activity and MetS, more pronounced in men, and it is known that a physically active lifestyle can prevent or delay the onset of MetS in young adults [17].

Recent evidence emphasizes the importance of a gender-specific approach to better promote physical activity and increase our understanding of gender differences in the development and impact of MetS and cardiovascular disease (CVD). Such an approach may lead to improved health outcomes and more tailored health strategies [18].

Physical inactivity is a significant and modifiable risk factor that is more prevalent and stronger in female populations worldwide for all age groups. The gender gap in physical activity starts at an early age and leads to significant short- and long-term adverse health outcomes, especially cardiovascular health [19].

According to a study by Spanish scientists in 2025, it has been shown that women lead a more sedentary lifestyle than men (OR = 1.35; 95% CI = 1.10-1.65), so they may particularly benefit from increasing physical activity levels. Regarding physical activity and sports, men appear to be more active than women. The results of several studies show that men's attitudes are more positive than women's, with significant differences [20].

According to a study by Gallardo-Alfaro et al (2021), regular exercise reduces sympathetic activity and plasma catecholamine concentrations at rest and improves renal homeostasis by reducing vascular resistance, which helps to lower blood pressure. High blood pressure is one of the key independent risk factors for cardiovascular disease [21].

Physical activity reduces SBP by an average of 6.9 mm Hg in people with hypertension. Cordero et al . report an average reduction of 6 to 7 mm Hg in patients with hypertension compared with 3 mm Hg in patients with normal blood pressure. Cornelissen et al . in a systematic review with healthy adults, found a significant reduction in MAP in patients who completed an exercise program, regardless of the type of training; but they found no reduction in SBP in patients who completed combined strength and endurance training. Regarding gender, they found that men with an exercise program achieved more than twice this reduction in SBP and DBP than women. Our results also show sex differences, but in this case, women had a more pronounced reduction in blood pressure than men [22].

One direct effect of physical activity is to reduce insulin resistance because muscle tissue increases glucose uptake. Regular physical activity reduces the risk of type 2 diabetes mellitus (T2DM), and observational studies suggest that in patients with T2DM, women may require greater frequency and intensity of physical activity than men to reduce cardiovascular events [23]. In this sense, aerobic physical activity leads to an increase in the biological efficacy of insulin, and it has

been reported that even after exercise, insulin receptor sensitivity and number are increased by 36% [24].

In a prospective study by Jung WS et al conducted on healthy patients, a decrease in blood glucose levels was observed. In contrast to the other studies reviewed, the results showed significant differences. Noticeable differences between men and women were observed only at the lowest level of physical activity, while no sex differences were observed in other studies [25].

According to the results of a study by Di pietro L and others, as well as other scientific papers, an increase in physical activity contributes to a decrease in waist circumference. This effect is more pronounced in men than in women, which is confirmed by data from previous studies. Regular physical exercise plays a key role in the prevention of overweight and the treatment of diseases related to obesity. Thus, physical activity helps to reduce cardiovascular risk by effectively controlling body weight [26].

Ethiopian researchers have found that insufficient attention is paid to physical activity and its role in reducing the severity of diabetes symptoms, as well as its assessment as a preventive factor according to Global Physical Activity Questionnaire (GPAQ) indicators. In addition, the relationship between a sedentary lifestyle and the risk of metabolic syndrome remains poorly understood, indicating a lack of important knowledge in the field of public health [27].

Analysis of methods for assessing physical activity

The International Physical Activity Questionnaire (IPAQ) was developed to standardize the monitoring of activity at the population level around the world [28]. This is an easy-to-use, self-reporting, 7-day questionnaire (or interview). It collects information about time spent in vigorous, moderate, walking, and sedentary activities. The overall score evaluates metabolic expenditure and has been developed to categorize people with low, moderate, or high activity. Early studies have shown satisfactory reliability and validity in the general population [29].

Since the IPAQ is used to estimate the level of physical activity based on the MET (MET-minutes/week) accumulated over the last seven days, the calculated values must be multiplied by the duration of activity in minutes per day and the number of days per week during which it was performed (MET-minutes/week) [30]. The IPAQ evaluates the frequency, duration, and intensity of physical activity during the previous week [31].

He Y. et al. analysed the associations between physical activity (PA), sitting time (ST) and metabolic syndrome (MetS). The study included 957 adults aged 40-65 years living in Hangzhou, China. Exercise data were collected using the International Physical Activity Questionnaire Short Form (IPAQ-SF), a tool designed to measure walking, moderate, and vigorous physical activity. Participants were requested to report the duration and frequency of each activity, and the total physical activity volume was calculated in MET-min/week. The MET values assigned to each activity were as follows: walking = 3.3, moderate PA = 4.0, and vigorous PA = 8.0. The participants were then categorised into low, moderate, or high activity levels based on the following criteria: duration, frequency, and overall activity. Additionally, sitting time was recorded, with categories of ≤3 hours/day, 3–6 hours/day, and >6 hours/day. The results showed that high levels of PA were associated with a lower risk of cardiovascular disease (CVD), especially in people with central obesity (visceral fat). In contrast, sitting for more than 3 hours per day was associated with an increased risk of CVD, especially in people with central obesity. Thus, moderate to vigorous physical activity is beneficial for CVD prevention, while prolonged sitting increases the risk, especially in central obesity [32].

A prospective study was conducted in Korea, which involved 3,910 adults (1,890 men and 2,020 women) without MetS, examined in 2001-2002. The condition of the participants was monitored from 2013 to 2014. To assess the level of physical activity, energy expenditure within leisure physical activity was measured using the metabolic equivalent of a task (MET) in hours per week. All participants were divided into five groups. The average follow-up period was 11.8 years. During the study, 482 men (25.5%) and 541 women (26.8%) were diagnosed with MetS for the first time. Multifactorial logistic analysis showed that people who performed physical activity 2-3 times

higher than the recommended minimum had a 4.4% lower risk of MetS [HR = 0.956; 95% CI: 0.654–1.398]. With an activity level exceeding at least 3-4 times, the risk reduction was 21.9% [HR = 0.781; 95% CI: 0.574–1.063] [33].

A study was conducted in Zora, Marrakech, to explore the relationship between physical activity and metabolic syndrome (MetS). The International Physical Activity Questionnaire (IPAQ) was utilised as a research instrument. The research involved 300 participants, with 57.3% of the participants being female and 42.7% of the participants being male, yielding a sex ratio of 0.74. The findings of the study indicated a substantial correlation between physical activity levels and the presence of MetS ($p = 0.002$). The study also highlighted a connection between obesity, MetS, and physical activity levels among the population of Marrakech [34].

In Hangzhou, China, in 2010, a cross-sectional study was conducted using the International Standard Physical Activity Questionnaire (IPAQ) and classified into three levels. The prevalence rates of MetS in the general sample, among men and women, were 16.4%, 25.4% and 10.3%, respectively. Patients with MetS smoked more, consumed more alcohol and tea, slept longer, and were older than patients without MetS. Low physical activity was more common in patients with MetS than without it (29.9% vs. 20.9%); more participants without MetS engaged in high FA compared to patients with MetS (29.9% vs. 19.7%) [35].

Another study by Xu and others found that high physical activity was significantly inversely associated with MetS after adjusting for age, gender, ethnicity, and current smoking in obese older adults. It is important to note that these studies used questionnaires, namely the International Physical Activity Questionnaire (IPAQ) or the Global Physical Activity Questionnaire (GPAQ), to assess the level of physical activity and another index of MetS criteria [36].

In a cohort study in Iran, stricter adherence to a healthy lifestyle was associated with a reduced risk of six-year incidence of MetS [37].

A similar cross-sectional study of adults aged >60 years with a BMI > 30 kg/m2 showed that those who engaged in high physical activity had a lower risk of MetS [38].

Low- and moderate-intensity physical activity has beneficial effects on endothelial function, insulin resistance, cardiac remodeling, and lipid metabolism [39].

A chronic, mild inflammatory condition has also been associated in many studies with the presence of components of the MetS, which can be partially explained by changes in adipose tissue and which can be compensated by adequate physical activity [40].

Lifestyle change strategies, which primarily include regular physical activity and dietary changes, play a crucial role in the treatment of MetS. A healthy lifestyle is defined as regular physical activity, quitting smoking, having healthy eating patterns, and avoiding obesity [39]. According to the US Preventive Services Task Force Recommendation Statement, adults with cardiovascular disease (CVD) risk factors should be offered or referred to behavioural counselling interventions that focus on the promotion of a healthy diet and the increase of physical activity. These interventions have been demonstrated to facilitate long-term lifestyle modifications that reduce the risk of developing CVD, manage existing risk factors, and enhance overall heart health [41].

Conclusion:

Treatment of MetS is based on lifestyle changes. The key aspects of therapy are weight loss, a balanced diet and sufficient physical activity. Therapeutic strategies should be applied in accordance with established clinical guidelines to correct modifiable risk factors such as high blood pressure and dyslipidemia. Early detection of the syndrome and timely intervention play an important role in reducing the likelihood of developing cardiovascular complications.

Health professionals should develop and apply prevention strategies tailored to individual risk profiles, taking into account factors such as age, gender, socioeconomic status, and lifestyle. Personalized interventions play a key role in addressing various factors contributing to the development of MetS. In addition, public health initiatives should aim to raise awareness about MetS, its consequences, and the benefits of a healthy lifestyle to prevent it. Health professionals

should encourage inactive adults to be physically active in their free time to take advantage of the health benefits.

Conflict of interest. The authors declare no conflict of interest.

Acknowledgments: Parts of the manuscript were translated from kazakh language to English using artificial intelligence (ChatGPT, OpenAI, GPT-4). The translation was subsequently reviewed and edited for accuracy by the authors.

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