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ASSESSMENT OF METABOLIC SYNDROME AND ITS RISK FACTORS IN WOMEN BY AGE, SOCIOECONOMIC STATUS, AND LIFESTYLE FACTORS

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Abstract:
Metabolic syndrome (MetS) is a complex condition that elevates the risk of cardiovascular disease, type 2 diabetes, and other chronic disorders in women. This study examines the prevalence of MetS and its associated risk factors, with particular attention to age, socioeconomic status, and lifestyle behaviors. Evidence shows that the prevalence of MetS rises with age, especially during perimenopause and postmenopause. Key lifestyle determinants, including unhealthy diet, physical inactivity, and obesity, are strongly linked to MetS development. Socioeconomic factors, such as education, income level, and access to healthcare, further modify the risk. Reproductive health aspects, including polycystic ovary syndrome and pregnancy-related complications, also contribute to metabolic abnormalities. Understanding the interactions between these factors can guide effective prevention and intervention strategies. Overall, integrated approaches that combine lifestyle modification, health education, and regular screening are essential to mitigate the burden of MetS among women across different age groups and social settings.

Keywords: Metabolic syndrome, women, risk factors, lifestyle, socioeconomic status, age, obesity, reproductive health.

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Introduction

Metabolic health is characterized by optimal blood glucose, lipids, cholesterol, blood pressure, and adiposity. Alterations in these characteristics may lead to the development of type 2 diabetes mellitus or dyslipidemia. Recent evidence suggests that female reproductive characteristics may be overlooked as risk factors that contribute to later metabolic dysfunction. These reproductive traits include the age at menarche, menstrual irregularity, the development of polycystic ovary syndrome, gestational weight change, gestational dysglycemia and dyslipidemia, and the severity and timing of menopausal symptoms. These risk factors may themselves be markers of future dysfunction or may be explained by shared underlying etiologies that promote long-term disease development. Disentangling underlying relationships and identifying potentially modifiable characteristics have an important bearing on therapeutic lifestyle modifications that could ease long-term metabolic burden. Further research that better characterizes associations between reproductive characteristics and metabolic health, clarifies underlying etiologies, and identifies indicators for clinical application is warranted in the prevention and management of metabolic dysfunction [14].

Metabolic syndrome (MetS), a cluster of metabolic dysregulations, is recognized as a significant risk factor for the development of heart failure (HF). The pathophysiological mechanisms linking MetS to HF are complex and multifaceted, with the components of MetS contributing to cardiac deterioration through impaired myocardial energy metabolism, increased inflammation, and endothelial dysfunction. Numerous clinical studies have confirmed the relationship between MetS and HF. Multiple studies have demonstrated that the impact of MetS on HF varies by sex and age. Metabolic disorders, including MetS, have a greater impact on HF incidence in younger adults compared to the elderly population and in women compared to men. Although the reasons for these differences are not yet fully understood, recognizing the sex- and age-

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related variations is crucial for developing targeted strategies to prevent HF in individuals with MetS. Future research should continue to investigate the underlying mechanisms behind these variations and identify optimal management approaches that account for both sex and age in reducing HF risk [10].

Cardiovascular disease (CVD) is a leading cause of death in women and risk of development is greatly increased following menopause. Menopause occurs over several years and is associated with hormonal changes, including a reduction in estradiol and an increase in follicle-stimulating hormone. This hormonal shift may result in an increased risk of developing abdominal adiposity, insulin resistance, dyslipidemia, vascular dysfunction, hypertension, type 2 diabetes mellitus (T2DM), metabolic dysfunction-associated fatty liver disease (MAFLD), and metabolic syndrome (MetS). Furthermore, with the onset of menopause, there is an increase in oxidative stress that is associated with impaired vascular function, inflammation, and thrombosis, further increasing the risk of CVD development. Despite the harmful consequences of the menopause transition being well known, women in premenopausal, perimenopausal, and postmenopausal stages are unlikely to be enrolled in research studies. Therefore, investigations on the prevention and treatment of cardiovascular and metabolic disease in middle-aged women are still relatively limited. Whilst lifestyle interventions are associated with reduced CVD risk in this population sample, the evidence still remains inconclusive. Therefore, it is important to explore the effectiveness of early intervention and potential therapeutic approaches to maintain cellular redox balance, preserve endothelium, and reduce inflammation. Glycine, N-acetylcysteine, and L-theanine are amino acids with potential antioxidant and anti-inflammatory activity and are identified as therapeutic interventions in the management of age-related and metabolic diseases. The benefits of the intake of these amino acids for improving factors associated with cardiovascular health are discussed in this review. Future studies using these

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amino acids are warranted to investigate their effect on maintaining the vascular health and cardiovascular outcomes of postmenopausal women [11].

Obesity is considered a 21st-century epidemic and it is a metabolic risk factor for Non-Communicable Diseases such as cardiovascular diseases, type 2 diabetes, metabolic syndrome, hypertension, some types of cancer, among others. Thus, its prevention and treatment are important public health concerns. Obesity within the context of food insecurity adds an additional layer of complexity to the current obesity epidemic. Efficient policies and interventions ought to take into consideration the effects of food insecurity on the risks of developing obesity among food insecure households. This review aims to analyze the recent available evidence around the obesity – food insecurity paradox. Most of the literature has consistently shown that there is a significant association between food insecurity and obesity, specifically in women of high-income countries. However, mechanisms explaining the paradox are still lacking. Even though researchers have tried to analyze the issue using different individual and societal variables, these studies have failed to explain the mediatory mechanisms of the food insecurity – obesity relationship since the proposed mechanisms usually lack strength or are purely theoretical. The research focus should shift from cross-sectional models to other research designs that allow the exploration of pathways and mechanisms underlying the food insecurity and obesity relationship, such as longitudinal studies, which will hopefully lead to consecutive research testing the effectiveness of different approaches and scale up such interventions into diverse contexts among those affected by obesity and the different degrees of food insecurity [4].

Rheumatoid arthritis (RA) due to systemic inflammation and insulin resistance increases the risk of cardiovascular disease and reduces life expectancy. In order to develop cardiac death prevention strategies, it is necessary to estimate the prevalence of metabolic syndrome (MetS) in these patients. Methods: This systematic review and meta-analysis was performed to estimate the prevalence of

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MetS among patients with RA. International databases (i.e., Scopus, PubMed, Web of Science, and Google Scholar) were searched during the period of October 1 and October 10, 20121. Heterogeneity among the included studies was assessed through the Cochrane Q test statistics and I2 test. Finally, a random-effects meta-analysis model was computed to estimate the pooled prevalence of MetS. Results: Sixty-one articles with 96 groups and a sample size of 13,644 people were analyzed. The pooled prevalence of MetS was 32% (95% CI: 29.6–34.4). The highest prevalence of MetS is related to studies conducted in Asia (32.7%, 95% CI: 29–36.3) and Europe (32.7%, 95% CI: 27.5.37.9) and the lowest Prevalence was also related to studies conducted in Africa (28%, 95% CI: 28.8–32.2). The prevalence of MetS in men was 33% (95% CI: 26–39) and 34% (95% CI: 29–40) in women. Findings by diagnostic criteria showed that the highest and lowest prevalence of MetS was related to ATP III (37.5%, 95% CI: 30.9–44.2) and EGIR (14.4%, 95% CI: 10.5–18.5), respectively. Conclusions: MetS is highly prevalent in patients with RA and identification of high-risk patients is necessary to prevent cardiovascular mortality [3].

Metabolic syndrome (MetS) is characterized by a cluster of metabolic abnormalities, including abdominal obesity, hyperglycemia, insulin resistance, dyslipidemia, and hypertension. Growing evidence suggests that these components may contribute to the development of gastrointestinal (GI) malignancies. This review aims to explore the association between MetS and GI cancers, including esophageal, gastric, pancreatic, and colorectal cancers. Materials and Methods: A narrative literature review was conducted using PubMed, incorporating 22 sources published between 1991 and 2024. Search terms included “gastrointestinal malignant tumors”, “metabolic syndrome”, “diabetes mellitus”, and “obesity”. Priority was given to large-scale studies from Europe, America, and Asia. Case reports, commentaries, and conference abstracts were excluded. Results: By analyzing the available literature data, this study determined that hyperinsulinemia (IGF-1 pathway), hyperglycemia, and obesity

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(>102 cm in men and >88 cm in women) are highly associated with the development of esophageal cancer (primarily with Barret's long and short segment as precancerosis), gastric cancer (through reactive oxygen species), and both pancreatic (1.5–2.4 higher risk) and colorectal cancer (30% higher risk). Patients with a high BMI (>40 kg/m2) show a 20%- or 1.18-times greater risk of developing colorectal cancer and a 1.72-times higher risk of developing pancreatic cancer. There is not enough evidence on the specific influence of hypertriglyceridemia, low HDL cholesterol, and high blood pressure on the development of gastrointestinal malignancy. However, those three conditions have shown a low to moderate association (from 6% to 12%) with the development of colorectal cancer. Conclusions: Metabolic syndrome (MetS) is increasingly being recognized as a significant risk factor for the development and progression of gastrointestinal cancers. Key components such as obesity, hyperglycemia, insulin resistance, and type 2 diabetes mellitus appear to contribute to carcinogenesis through mechanisms involving chronic inflammation, oxidative stress, and immune dysregulation. Further research is needed to clarify the biological pathways linking MetS to gastrointestinal malignancies and to inform effective prevention strategies [2].

Endometrial cancer (EC) is the second gynecological cancer with the highest global incidence. Among many associated risk factors, metabolic syndrome (MetS) is an important and preventable one. It comprises a group of conditions that often occur together: central adiposity, hyperglycemia, arterial hypertension, and atherogenic dyslipidemia. This review aimed to describe the epidemiological and biological relationship between MetS and EC, focusing on the role of lifestyle in prevention. A literature search was carried out in the PubMed database. 4824 publications were screened, and 123 were included for this review. The association between MetS and EC has been described. Chronic adipose tissue inflammation and insulin resistance are involved in the development of obesity, particularly visceral adiposity. These changes promote the ideal environment for

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the development of EC. Strategies based on lifestyle modifications may be effective for the prevention of MetS and consequently EC. Some of these modifications include adopting a diet rich in fruits, vegetables, whole grains, and legumes, depending to the accessibility of these foods for each region. Avoiding ultra-processed foods and increasing daily physical activity were also some suggested modifications. We propose that women be screened for MetS to establish early treatment and to possibly prevent EC. Clinical trials designed to prove the effect of lifestyle modifications on the prevention of EC are needed [15].

Metabolic syndrome (MetS) is an extremely prevalent complex trait and it can originate in early life. This concept is now being termed the developmental origins of health and disease (DOHaD). Increasing evidence supports that disturbance of gut microbiota influences various risk factors of MetS. The DOHaD theory provides an innovative strategy to prevent MetS through early intervention (i.e., reprogramming). In this review, we summarize the existing literature that supports how environmental cues induced MetS of developmental origins and the interplay between gut microbiota and other fundamental underlying mechanisms. We also present an overview of experimental animal models addressing implementation of gut microbiota-targeted reprogramming interventions to avert the programming of MetS. Even with growing evidence from animal studies supporting the uses of gut microbiota-targeted therapies start before birth to protect against MetS of developmental origins, their effects on pregnant women are still unknown and these results require further clinical translation [9].

Both small for gestational age and large for gestational age (LGA) size at birth are associated with metabolic complications throughout life. The long-term consequences of LGA have been investigated in only a few studies. LGA is thought to be associated with early obesity and metabolic risk. Understanding how LGA can influence later obesity risk is important for pediatric obesity

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interventions. Pregnant women who are overweight or obese are at high risk of having LGA babies. Infants born LGA are at increased risk of becoming overweight or obese children, adolescents, and young adults and can have an increased risk of metabolic syndrome later in life and giving birth to LGA offspring. Education and intervention for weight control before and during pregnancy should be conducted to prevent LGA births. Particular attention is needed for women of childbearing age who are diabetic and obese, which could be the starting point for lifelong management of obesity [8].

Purpose of review Accommodating fetal growth and development, women undergo multiple physiological changes during pregnancy. In recent years, several studies contributed to the accumulating evidence about the impact of gestational hyperlipidemia on cardiovascular risk for mother and child. This review aims to provide a comprehensive overview of the current research on lipid profile alterations during pregnancy and its associated (cardiovascular) outcomes for mother and child from a clinical perspective. Recent findings In a normal pregnancy, total and LDL-cholesterol levels increase by approximately 30-50%, HDL-cholesterol by 20-40%, and triglycerides by 50-100%. In some women, for example, with familial hypercholesterolemia (FH), a more atherogenic lipid profile is observed. Dyslipidemia during pregnancy is found to be associated with adverse (cardiovascular) outcomes for the mother (e.g. preeclampsia, gestational diabetes, metabolic syndrome, unfavorable lipid profile) and for the child (e.g. preterm birth, large for gestational age, preatherosclerotic lesions, and unfavorable lipid profile). Summary The lipid profile of women during pregnancy provides a unique window of opportunity into the potential future cardiovascular risk for mother and child. Better knowledge about adverse outcomes and specific risk groups could lead to better risk assessment and earlier cardiovascular prevention. Future research should investigate implementation of gestational screening possibilities [12].

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During pregnancy, the fetoplacental unit is key in the pronounced physiological endocrine changes which support pregnancy, fetal development and survival, birth and lactation. In healthy women, pregnancy is characterized by changes in insulin sensitivity and increased maternal androgen levels. These are accompanied by a suite of mechanisms that support fetal growth, maintain glucose homeostasis and protect both mother and fetus from adverse effects of pregnancy induced insulin and androgen excess. In pregnancies affected by endocrine, metabolic disorders such as polycystic ovary syndrome (PCOS), diabetes and obesity, there is an imbalance of beneficial and adverse impacts of pregnancy induced endocrine changes. These inter-related conditions are characterized by an interplay of hyperinsulinemia and hyperandrogenism which influence fetoplacental function and are associated with adverse pregnancy outcomes including hypertensive disorders of pregnancy, macrosomia, preterm delivery and caesarean section. However, the exact underlying mechanisms and relationships of the endocrine and metabolic milieu in these disorders and the impact they have on the prenatal endocrine environment and developing fetus remain poorly understood. Here we aim to review the complex endocrine and metabolic interactions in healthy women during normal pregnancies and those in pregnancies complicated by hyperinsulinemic disorders (PCOS, diabetes and obesity). We also explore the relationships between these endocrine and metabolic differences and the fetoplacental unit, pregnancy outcomes and the developing fetus [13].

Gestational diabetes mellitus (GDM) emerges worldwide and is closely associated with short- and long-term health issues in women and their offspring, such as pregnancy and birth complications respectively comorbidities, Type 2 Diabetes (T2D), metabolic syndrome as well as cardiovascular diseases. Against this background, mobile health applications (mHealth-Apps) do open up new possibilities to improve the management of GDM. Therefore, we analyzed the clinical effectiveness of specific mHealth-Apps on clinical health-related short

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and long-term outcomes in mother and child. Methods: A systematic literature search in Medline (PubMed), Cochrane Library, Embase, CINAHL and Web of Science Core Collection databases as well as Google Scholar was performed. We selected studies published 2008 to 2020 analyzing women diagnosed with GDM using specific mHealth-Apps. Controlled clinical trials (CCT) and randomized controlled trials (RCT) were included. Study quality was assessed using the Effective Public Health Practice Project (EPHPP) tool. Results: In total, n = 6 publications (n = 5 RCTs, n = 1 CCT; and n = 4 moderate, n = 2 weak quality), analyzing n = 408 GDM patients in the intervention and n = 405 in the control groups, were included. Compared to control groups, fasting blood glucose, 2-h postprandial blood glucose, off target blood glucose measurements, delivery mode (more vaginal deliveries and fewer (emergency) caesarean sections) and patient compliance showed improving trends. Conclusion: mHealth-Apps might improve health-related outcomes, particularly glycemic control, in the management of GDM. Further studies need to be done in more detail [6].

Gestational diabetes mellitus (GDM) is one of the most common pregnancy complications. Understanding the pathogenesis and appropriate diagnosis of GDM enables the implementation of early interventions during pregnancy that reduce the risk of maternal and fetal complications. At the same time, it provides opportunities to prevent diabetes, metabolic syndrome, and cardiovascular diseases in women with GDM and their offspring in the future. Fibroblast growth factors (FGFs) represent a heterogeneous family of signaling proteins which play a vital role in cell proliferation and differentiation, repair of damaged tissues, wound healing, angiogenesis, and mitogenesis and also affect the regulation of carbohydrate, lipid, and hormone metabolism. Abnormalities in the signaling function of FGFs may lead to numerous pathological conditions, including metabolic diseases. The FGF19 subfamily, also known as atypical FGFs, which includes FGF19, FGF21, and FGF23, is essential in regulating metabolic homeostasis and acts as a hormone while entering the systemic circulation. Many

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studies have pointed to the involvement of the FGF19 subfamily in the pathogenesis of metabolic diseases, including GDM, although the results are inconclusive. FGF19 and FGF21 are thought to be associated with insulin resistance, an essential element in the pathogenesis of GDM. FGF21 may influence placental metabolism and thus contribute to fetal growth and metabolism regulation. The observed relationship between FGF21 and increased birth weight could suggest a potential role for FGF21 in predicting future metabolic abnormalities in children born to women with GDM. In this group of patients, different mechanisms may contribute to an increased risk of cardiovascular diseases in women in later life, and FGF23 appears to be their promising early predictor. This study aims to present a comprehensive review of the FGF19 subfamily, emphasizing its role in GDM and predicting its long-term metabolic consequences for mothers and their offspring [16].

Women are considered to have an irregular menstrual cycle if their cycle length is less than 21 days or more than 35 days, accompanied by less or very severe blood flow. The prevalence of menstrual cycle irregularities varies across countries. Irregular periods can occur due to changes in the body's levels of estrogen and progesterone hormones, which disrupt the normal pattern of the period. Menstrual irregularity has been found to be associated with various diseases and medical conditions, such as metabolic syndrome, coronary heart disease, type 2 diabetes mellitus, and rheumatoid arthritis. Anemia, osteoporosis, psychological problems, impaired quality of life, and infertility have also been recorded. Moreover, a significant correlation between irregular periods and the risk of developing pregnancy-related hypertensive disorders, as well as an increased risk of adverse obstetric and neonatal outcomes, has been proven. Therefore, irregular menstruation is considered an important health indicator among women. Physical, mental, social, psychological, and reproductive problems are often associated with menstrual irregularities. Thus, evaluating the factors associated with irregular menstruation is necessary to determine

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appropriate preventive and treatment strategies and to decrease the associated health problems. The aim of this review was to define normal and irregular menstruation, their types, and prevalence, to recognize the risk factors and causes of irregular menstruation, and to understand their impact on women's health [1].

Polycystic ovarian syndrome (PCOS) is one of the most common heterogeneous endocrine and metabolic disorders in premenopausal women. It is a complex multifactorial disorder with strong epigenetic and environmental influences, including factors related to eating habits and lifestyle. There is a close relationship between obesity and PCOS. Weight gain and obesity are often clinical symptoms manifested by biochemical markers. Moreover, abdominal obesity in women with PCOS is involved in the development of inflammatory changes. A significant share of balanced therapies correcting the lifestyle of patients is suggested, e.g., with the implementation of appropriate diets to minimize exposure to inflammatory factors and prevent abnormal immune system stimulation. In the case of obese patients with PCOS, planning a diet program and supporting the motivation to change eating habits play an important role to lose weight and lower BMI. Probiotics/synbiotic supplementation may enhance weight loss during the diet program and additionally positively affect metabolic and inflammatory factors by improving the intestinal microbiome [5].

Intermittent energy restricted diets are used amongst women with overweight and obesity and a healthy weight. For those with overweight and obesity weight control is typically achieved through daily energy restriction (DER) which has reduced adherence and attenuated metabolic benefits over time. Several intermittent energy restriction (IER) regimens have been developed aiming to promote maintained weight loss and additional weight independent metabolic benefits including the 5:2 diet, alternate day fasting (ADF) and time restricted eating (TRE). This review summarises the potential benefits or harms of these regimens for managing women's health. 5:2 and ADF diets have equivalent long term (≥6-month) adherence, weight loss and metabolic benefits to DER. Current

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limited evidence suggests IER is a safe weight loss intervention for women which does not affect reproductive or bone health, increase eating disorders or disturb sleep. Adherence and weight loss with both IER and DER are lower amongst younger women compared to older women and men. Weight loss with ADF and TRE have respectively improved symptoms of polycystic ovarian syndrome and premenstrual syndrome but there is no evidence of weight independent effects of IER on these conditions. There is little evidence of the benefits and/or harms of IER amongst healthy weight women in whom there is a greater potential for adverse effects on reproductive and bone health, fat free mass, eating disorders and sleep. Further research benefits of IER for weight control and metabolic health as well as harms is required [7].

Conclusion:

Metabolic syndrome represents a significant public health challenge for women, shaped by age, lifestyle habits, socioeconomic factors, and reproductive health conditions. Identifying individuals at elevated risk early allows for timely preventive measures, reducing the likelihood of long-term complications such as cardiovascular disease and type 2 diabetes. Promoting healthy dietary patterns, regular physical activity, and maintaining a healthy body weight are central strategies for prevention. Additionally, addressing socioeconomic barriers and improving health literacy can enhance access to care and support behavior change. Monitoring reproductive health, including conditions like polycystic ovary syndrome and pregnancy-related metabolic complications, offers further opportunities for intervention. A coordinated, multi-level approach that integrates lifestyle modification, education, and medical monitoring is essential to lessen the burden of metabolic syndrome among women of different ages and social backgrounds. Implementing such strategies can ultimately improve metabolic health outcomes and overall quality of life for women.

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