



Review article

Emerging health problems among women: Inactivity, obesity, and metabolic syndrome

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ABSTRACT

The increase in obesity and metabolic syndrome has been documented worldwide. However, few studies have investigated the risk of inactivity, obesity, and metabolic syndrome specifically in women. Hormone balance plays a crucial role in regulating metabolism and helps to maintain optimal health. It is likely that the sex difference in obesity may be due to the variation in hormone concentration throughout a woman's life, which predisposes them to weight gain. This paper reviews previous literature and discusses factors that influence the risk of adiposity-related health consequences among women for three critical biological transitions throughout a woman's life: puberty, menopause, and pregnancy. To improve quality of life and metabolic health for women, interventions are needed to target women at different transition stages and provide tailored health education programs. Interventions should raise awareness of physical inactivity, obesity, and metabolic syndrome, and promote healthy behavioral change in women.

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Introduction

During the past two decades, there have been dramatic shifts in human environment, behavior, and lifestyle. These transitions have resulted in a global epidemic of overweight for pediatric and adults populations. According to the World Health Organization (WHO), overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health.

Overweight and obesity is a worldwide problem

Obesity-related risk factors, for example, physical inactivity and high blood pressure, account for approximately 57% of cardiovascular mortality and morbidity, which are the major non-communicable diseases worldwide.¹ Although sex differences in

determinants of obesity and the prevalence of weight-related diseases (for example, metabolic syndrome) have been documented in previous studies, few studies have explored if there are specific physiological changes during women's lives that increase their risks of inactivity, obesity, and metabolic syndrome. Hence, the goal of this paper is to review previous literature and discuss why inactivity and obesity-related chronic diseases are emerging health problems among women.

Sex differences in overweight and obesity

To date, findings regarding significant sex differences in overweight and obesity prevalence have been inconsistent worldwide. Sex differences in prevalence rates seem to be confounded by factors such as age, body mass index (BMI), race, and ethnicity. Moreover, the conclusions regarding sex difference in overweight and obesity prevalence are inconsistent because the results differ between age groups, even in the same nationally representative data set, National Health and Nutrition Examination Survey (NHANES), and Behavioral Risk Factor Surveillance System (BRFSS).^{2,3} Among adults in the USA, overweight has been more prevalent among male adults (female: 61.7%; male: 69.3%),

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whereas obesity has been more prevalent among females (female: 33.3%; male: 28.9%) from 1999–2004.⁴ In pediatric populations, however, overweight (girls: 29.7%; boys: 31.4%) and obesity (girls: 14.7%; boys: 16.2%) were both more common among boys than girls.⁴ In Taiwan, the prevalence of obesity (based on the Department of Health in Taiwan: BMI ≥ 27 kg/m²) was 19.2% in men and 13.4% in women in 2002.⁵ According to previous research, although women are not particularly at higher risk for developing overweight and obesity, their biological, psychosocial, and behavioral transitions during puberty and menopause may put them at greater risk of inactivity and further increase their risk for weight-related chronic diseases, including pulmonary problems, for example, obstructive sleep apnea, orthopedic complications, certain types of cancer, type 2 diabetes, metabolic syndrome, and cardiovascular disease.

Insulin-resistance is the central role in overweight and obesity

In line with the rising prevalence of overweight and obesity, metabolic syndrome is also increasing in adult and pediatric populations worldwide. Insulin resistance is the most accepted underlying pathophysiological mechanism linking obesity to metabolic syndrome and other chronic diseases. Insulin resistance results from adipose-tissue-released nonesterified fatty acids, glycerol, hormones, proinflammatory cytokines, and other factors.⁶ Metabolic syndrome, also known as syndrome X and insulin resistance syndrome, was first described by Reaven in 1988.⁷ A decade later, WHO proposed the first definition for adults in 2001. The Adult Treatment Panel III of the National Cholesterol Program established their clinical criteria for defining the metabolic syndrome, that is, the presence of three or more out of the following five risk factors: elevated triglycerides (≥ 150 mg/dL); low high-density lipoprotein-cholesterol (men: ≤ 40 mg/dL; women: ≤ 50 mg/dL); abdominal adiposity (men: waist circumference > 102 cm; women: > 88 cm); hyperglycemia (fasting glucose ≥ 110 mg/dL); and elevated blood pressure $\geq 130/85$ mmHg. The Adult Treatment Panel III definition is one of the most commonly adopted standards. Previous research has conclusively shown that metabolic syndrome is predictive of subsequent cardiovascular disease and type 2 diabetes in adults.⁸ Laaksonen et al⁸ tested whether metabolic syndrome predisposes to diabetes mellitus after a 4-year follow-up in a total of 1005 middle-aged men by using two different adult definitions for metabolic syndrome, proposed by WHO and the National Cholesterol Education Program. They found that individuals with metabolic syndrome had a higher risk of developing diabetes mellitus, odds ratio of 5.0–8.8. Additionally, other organizations have also proposed different diagnostic criteria for adults.⁹ According to the scientific report with an attempt to unify the definitions from the International Diabetes Federation and the American Heart Association/National Heart, Lung, and Blood Institute, reported that abdominal obesity is only one out of five components, and not a prerequisite component for the diagnosis of metabolic syndrome.¹⁰ In children and adolescents, several criteria for metabolic syndrome have been proposed and there is no standardized pediatric definition.¹¹ This lack of consensus may be due to the puberty-related physiological changes that affect metabolic profiles.¹² There have been criticisms against the clinical application of metabolic syndrome, and the idea of the circulatory syndrome was proposed. Circulatory syndrome is an attempt to refine the concept of metabolic syndrome by adding additional markers of cardiovascular disease such as renal impairment, microalbuminuria, arterial stiffness, ventricular dysfunction, and anemia.¹³ More epidemiological studies are needed to assess the usefulness and clinical validity of the associations between the circulatory syndrome and cardiovascular outcomes.

Puberty, menopause, and pregnancy: critical transition stages

Hormones play a major part in a woman's life, and there are three transitions when the female body goes through major hormonal transitions: puberty, pregnancy, and menopause. At these three transitional stages, women may face different disease risks related to obesity and metabolic syndrome. Puberty is a critical period of development marked by dynamic biological changes. Increasing body fat and insulin resistance during puberty may increase the risk of developing a metabolic syndrome. Insulin resistance is a physiological condition in which the body cells become less sensitive to the effect of insulin, and high blood sugar levels, as well as increased secretion of insulin, try to maintain normal blood glucose levels. Insulin resistance may be the initiating factor for obesity, diabetes, hypertension, and cardiovascular complications. It had been found that pubertal insulin resistance tends to be more severe in women than in men,¹⁴ which puts women at greater disease risk. Moran et al¹⁴ found that a cohort of girls ($n = 159$) was significantly more insulin resistant than a cohort of boys ($n = 198$) (8.1 ± 0.2 mg/kg/min vs. 9.9 ± 0.3 mg/kg/min, $p < 0.001$). During menopause, biological and psychosocial effects accompanied by changes in hormonal production may affect women's daily activities and wellbeing. Menopause transition is associated with weight gain and a shift to abdominal fat distribution.¹⁵ This indicates the association between elevated risk of a metabolic syndrome and breast cancer among older women. Sex hormone binding globulin declines during menopause transition,¹⁶ which is related to a greater BMI, larger waist circumference, dyslipidemia, and increased fasting glucose in the menopause.¹⁷ In addition, insomnia is one of the commonly reported symptoms among midlife women. Sleep deprivation is associated with weight gain and a greater risk of metabolic syndrome for midlife women.¹⁸ Pregnancy is another stage marked with greater weight gain. Pregnancy weight gain is inevitable, and postpartum weight retention contributes to the development of overweight and obesity in women of childbearing age.¹⁹ Health education programs on maintaining a healthy weight for women during both pregnancy and menopause are needed to prevent future health risks.

Interventions at different transition stages

Increasing physical activity and decreasing sedentary behavior are essential in preventing weight gain and obesity. Sex differences in physical activity levels have been documented worldwide and this trend holds. Overall, women are less active than men in adulthood and childhood.²⁰ Moreover, women in ethnic minorities tend to have the least activity levels, for example, Latina and African American female adolescents have the most pronounced pubertal decline in physical activity, compared to other ethnic groups,²¹ and higher levels of sedentary behavior.²² Based on the objectively assessed activity levels from the NHANES study during 2003–2006, Belcher et al²³ showed that women spent about 20 minutes less in moderate-to-vigorous physical activity ($p < 0.05$) and about 21 minutes more in sedentary behavior ($p < 0.05$) daily than men. Behavior acquired during adolescence tends to prevail into adulthood, thus, more studies are needed to understand correlates of activity among women in order to encourage them to be active and improve their metabolic health.

Conclusion

In summary, behavioral and biological changes during puberty, pregnancy, and menopause may result in greater risks of inactivity, obesity, and metabolic syndrome for women. From a public health perspective, it is important to identify modifiable weight-related correlates, as well as to target these correlates for change in

women, in order to prevent overweight and metabolic syndrome. Thus, interventions that aim to promote physical activity and raise awareness of obesity and metabolic syndrome are imperative. To enhance the effectiveness of these programs, the strategies should be customized and taken into account that physical activity and obesity are important for women.

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