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Assessment of the relationship of pre- and postnatal stress with body composition and obesity risk

Abstract

Introduction: Obesity is a multifactorial condition influenced by both genetic and environmental factors. In its pathogenesis, genetic factors such as FTO and MC4R gene polymorphisms play a role, while environmental factors include familial factors, perinatal factors, lifestyle-related factors, and experiencing adverse life events during the pre- and postnatal periods. The mutual interactions of the mentioned factors and their significance in the etiology of obesity require further research.

Research Objective: The aim of this study was to comprehensive evaluation of the association between pre- and postnatal stress and the risk of overweight and obesity in children, as well as potential modifiers of body composition and proportions in children, with particular emphasis on the significance of experiencing adverse life events and their interaction with FTO (rs9939609) and MC4R (rs17782313) gene polymorphisms.

Materials and Methods: As part of the research for the PhD thesis, 530 children attending 11 randomly selected primary schools in Poznań and its vicinity were examined. The study group consisted of 254 girls and 276 boys, ranging in age from 6 to 12 years. Pre- and postnatal stress experiences were assessed using a questionnaire method. Parents or guardians of the children answered questions about the occurrence of adverse life events with potential stress-inducing effects in mothers during pregnancy and in children. The questionnaire also included questions regarding socio-economic status, perinatal factors, and children's lifestyles. Body weight and height were measured, and children's body composition was assessed using the bioelectrical impedance method. BMI (Body Mass Index), FMI (Fat Mass Index), and FFMI (Fat-Free Mass Index) were calculated. Underweight, overweight, and obesity were determined based on BMI according to the International Obesity Task Force criteria and based on fat tissue content according to McCarthy's criteria. FTO and MC4R gene polymorphisms were determined by collecting saliva samples from the children. Genotyping of selected polymorphisms was performed using allele discrimination (SNP) with TaqMan probes. Parental BMI was calculated based on self-reported weight and height measurements.

Results: Overweight and obesity, diagnosed based on fat tissue content, were more common in boys than in girls. There were no differences in the frequency of overweight and obesity diagnosed based on BMI in children who experienced prenatal stress compared to children who did not experience stress. Prenatal stress was associated with overweight but not with obesity or underweight diagnosed based on fat tissue content. Post-hoc analyses in the boys' group confirmed the relationship between prenatal stress and overweight, while in the girls' group, the results were not statistically significant. Detailed analysis revealed that obesity was more common in children who experienced at least one adverse life event in their postnatal life. Among the studied stressor types, significant associations with obesity were observed for witnessing violence, family conflicts, prolonged separation from a parent, and the death of a close family member. In the study group, the presence of risk alleles of the FTO (allele A) and MC4R (allele C) genes was not associated with the frequency of underweight, overweight, or obesity. In separate gender-specific analyses, it was observed that in the girls' group, obesity diagnosed based on BMI was more common among heterozygotes AT compared to homozygotes TT of the FTO gene. Similarly, BMI z scores and FatM z scores were significantly higher in heterozygotes compared to homozygotes for the FTO gene TT genotype. In the group of girls, CC homozygotes had a higher FatM z scores compared to MC4R gene TT homozygotes. Furthermore, interaction effects of FTO with adverse childhood experiences were observed for BMI, and interaction effects of MC4R with adverse childhood experiences were observed for FMI and FatM. Regression models indicated a significant and dominant role of parental factors related to body size and education, as well as genetic factors, in explaining the variability of children's body composition and proportions. Higher child BMI values were associated with higher paternal BMI and younger maternal age at the child's birth. Higher FMI values were associated with higher paternal BMI, greater maternal weight during pregnancy, lower maternal education, and the presence of the FTO risk allele. Higher fat tissue content (FatM) was associated with lower maternal education, younger maternal age at the child's birth, greater maternal weight gain during pregnancy, higher paternal BMI, and the presence of the FTO gene risk allele.

Conclusions: Overweight and obesity, diagnosed based on fat tissue content, were more common in boys than in girls. The analysis of the relationship between prenatal stress and children's anthropometric indicators revealed that boys may also be more susceptible to the development of excessive adiposity as a consequence of experiencing prenatal stress than girls. The occurrence of adverse experiences with traumatizing potential during the postnatal phase

of development was also a significant predictor of obesity, with the type of experience significantly differing in the level of body adiposity among children. In single-factor analyses, the examined FTO and MC4R polymorphisms were associated with body composition and proportion indices in girls but not in boys. Therefore, the regulation of adipose tissue levels appears to be under greater genetic control in girls, while in boys, a larger modifying influence of stress can be observed. The study also demonstrated a dominant influence on the variability of anthropometric indicators by factors with well-documented significance in the ethology of obesity. Gene polymorphisms of FTO and MC4R were found to be involved in various interactions with adverse, stress-inducing childhood experiences related to BMI and adiposity indicators, highlighting the need for further research into the determinants of childhood obesity, taking into account epigenetic mechanisms.