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An Overweight Preventive Score associates with obesity and glycemic traits

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ABSTRACT

Purpose. To develop a multidimensional, simple index which incorporates targeted dietary and lifestyle behaviors for the prevention and evaluation of treatment of childhood and adolescent obesity.

Methods. A total of 1072 (53.8% females) healthy children and 857 (54.8% females) adolescents from GENDAI and TEENAGE studies respectively were included in the analysis. Both studies are cross-sectional, population-based studies. Dietary and lifestyle behaviors – either with negative or positive impact on obesity, based on the recommendations of Barlow and the Expert Committee – were assessed with use of two non-consecutive 24-h recalls and a dietary questionnaire. For each individual, cumulative exposures to 6 of these obesity-related behaviors, namely consumption of fruits and vegetables, breakfast and family meals, consumption of sugar sweetened beverages and fast-food meals, and screen time, were assessed through calculation of the Overweight Preventive Score. Obesity and glycemic control traits were also available for all individuals from both cohorts.

Results. Overweight Preventive Score was significantly associated ($P < 0.05$) with all obesity traits and with decreased likelihood of becoming overweight [OR (95% CI): 0.90 (0.84, 0.97), $P = 0.003$] in all individuals after adjustment for potential confounders and exclusion of low-energy reporters. Associations were also significant in stratified analyses by sex ($P < 0.05$). The score was also associated with glycemic control traits in all individuals independently of body mass index, but these associations remained significant ($P < 0.05$) only in males and after adjustment for potential confounders and exclusion of low-energy reporters.

Conclusions. The proposed Overweight Preventive Score is a simple index and could be proven as a useful tool for the assessment of preventive and therapeutic interventions in child and adolescent overweight and insulin resistance.

Abbreviations: BMI, body mass index; BMR, basal metabolic rate; EI, energy intake; GENDAI, GENe and Diet Attica investigation on childhood obesity; HOMA-IR, insulin resistance homeostasis model assessment; LER, low energy reporter; OPS, Overweight Preventive Score; TEENAGE, TEENs of Attica: Genes and Environment.

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1. Introduction

Prevalence of overweight and obesity in children and adolescents has increased over the last decades with direct effect on cardiovascular and metabolic risk factors [1–3]. Environmental factors disturbing the balance of energy intake and energy expenditure have been accused for the increased prevalence. The Expert Committee that was convened in 2005 by the American Medical Association in collaboration with the Health Resources and Service Administration and the Centres for Disease Control and Prevention proposed a series of recommendations for specific behaviors, including diet, physical activity and sedentary behaviors for the prevention and treatment of child and adolescent overweight and obesity. In detail, these behaviors include limiting consumption of sugar-sweetened beverages, increasing consumption of fruits and vegetables, limiting screen time, eating breakfast daily, limiting eating out especially at fast-food restaurants, encouraging family meals, and limiting portion size [4]. The Committee also highlighted the challenges the complex etiology of obesity poses for the scientific community and the need for tools to thoroughly assess factors associated with overweight and obesity [5].

During the last decade, dietary patterns have been widely used for the assessment of dietary intake and the evaluation of diet–disease associations. For example, a pattern including the consumption of vegetables, cooked meals, and dinner, and a pattern representing high consumption of whole-grain cereals, legumes, and low intake of sugar-sweetened beverages, were negatively associated with obesity indices in children [6], or an empirically derived lifestyle pattern characterized by higher eating frequency, breakfast consumption and higher adherence to Mediterranean diet was negatively associated with body mass index (BMI) in young people [7].

The use of dietary indexes may provide a useful tool for the evaluation of dietary patterns. Application of dietary indices in children, however, has been limited and mainly focused on the assessment of diet quality [8,9]. Moreover, the great majority of indices applied to children have mainly included dietary parameters without taking into account other lifestyle obesogenic behaviors. Under this perspective, we constructed an index comprising lifestyle factors including eating and leisure time behaviors, which were among the target behaviors proposed by the aforementioned Expert Committee for the prevention and treatment of child and adolescent overweight [4] and we investigated potential associations with overweight risk, anthropometric and adiposity traits and glycemic control indices in children and adolescents.

2. Methods

2.1. Study Populations

GENDAI (GENe and Diet Attica Investigation on childhood obesity) [10] and TEENAGE (TEENs of Attica: Genes and Environment) [11] are school-based cohorts including children and adolescents attending public schools in the Attica region of Greece. In the GENDAI cohort from the 3124 children who were invited to join the study, 1138 children participated (53% girls; mean age: 11.2 ± 0.7 years), whereas a total number of 857 adolescent students out of 1440 attending participating schools (participation rate: 59.5%) were recruited in TEENAGE study. Prior to recruitment, registered students of participating schools as well as their parents/guardians were fully informed about the aims of the studies, the voluntary nature, and the confidentiality of the data. Parents/guardians of interested students gave written consent, while participating students provided their verbal assent. Both studies were approved by the Ethics Committee of Harokopio University of Athens and the Greek Ministry of Education, Lifelong Learning and Religious Affairs.

2.2. Assessment of Dietary Intakes and Leisure Time Activities

In both studies, dietary intakes were assessed by two non-consecutive 24-hour recalls three to ten days apart. The type of foods consumed (including fat content, brand name, constituents of mixed dishes, etc.), as well as the quantity or volume were recorded in detail. Data from recalls were analyzed for their macro- and micro-nutrient content by the Nutritionist Pro, version 2.2 software (Axxya Systems-Nutritionist Pro, Stafford, TX). Food group intake (servings/day) was assessed from dietary recalls, namely fruits, vegetables, and sugar-sweetened beverages. Dietary recalls were also used to evaluate the types of meals consumed qualitatively [12]. Breakfast consumption (i.e. the first meal of the day, consisting of sandwich, breakfast cereals, juice, a dairy product, or some of them) as well as the consumption of cooked meals (i.e. the number of lunches or dinners, warm or cold, that include a combination of food items, going through some type of food preparation to constitute a more or less traditional meal, in contrast to sandwich meals, snacks or breakfast-like meals) were recorded. Participants completed a questionnaire about their meal patterns and eating behavior, which was a modified version of a set of questions about meal patterns used in the Health Behavior of School-Aged Children study [13]. For the evaluation of low energy reporting, the ratio of the reported energy intake/basal metabolic rate (EI/BMR) was calculated for each individual. The BMR was estimated using the Schofield equations [14]. Participants with EI/BMR $\leq$ 0.99 were classified as “low energy reporters” (LER) based on the cut-off limits developed by Goldberg *et al.* for 2-day dietary intake recalls [15]. “Non-low energy reporters” (non-LER) were participants with EI/BMR $\geq$ 1.00.

Students completed a physical activity checklist recall for two non-consecutive days [16]. This instrument inquired about students’ minutes spent on mild, moderate, and strenuous exercise and screen time (TV viewing and computer/video games playing) during the previous 24 hours.

2.3. Anthropometry and Clinical Assessment

Body weight (kg) and height (m) were measured with individuals barefoot and in light clothing. BMI was calculated as weight/height^2. Participants were classified as normal weight, overweight or obese, according to the BMI cut-off values adopted by the International Obesity Task Force [17]. A