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Foods E-KINDEX: A Dietary Index Associated with Reduced Blood Pressure Levels among Young Children: The CYKIDS Study

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ABSTRACT

Dietary modification is, in general, the preferred method when attempting reductions in blood pressure (BP) among adults. In children, however, few studies, have examined the relationship between dietary patterns and levels of BP, and the reported results are conflicting. The objective of this study was to investigate the association between levels of Foods E-KINDEX score and levels of BP in children. Measurements included BP, height, weight, and waist circumference. Diet quality was assessed by the Foods E-KINDEX diet score. The index includes 13 components that assess consumption frequency of 11 major food groups or foods, as well as two cooking techniques (fried and grilled foods). Its score ranges between 0 and 37. A subsample of 622 Cypriot children (mean age=11.7±0.83 years) from the CYKIDS national cross-sectional study was used. Logistic regression analysis was performed in order to examine the relationship of systolic BP, diastolic BP, and BP with diet quality (as assessed by the Foods E-KINDEX score). The median systolic BP and diastolic BP were 110 mm Hg (interquartile range [IQR]=100 to 120 mm Hg) and 68 mm Hg (IQR=60 to 70 mm Hg) for boys and 110 mm Hg (IQR=100 to 120 mm Hg) and 63 mm Hg (IQR=60 to 70 mm Hg) for girls, respectively. Mean Foods E-KINDEX score was 23.4±4.9 in boys and 24.3±4.8 in girls (P=0.487). Compared with children with a low diet score, those with at least an average Foods E-KINDEX score were 57% (odds ratio=0.43; 95% confidence interval: 0.19 to 0.98) less likely to have elevated systolic BP levels, regardless of various potential confounders. The Foods E-KINDEX score is independently associated with lower BP among healthy children. This finding might have implications in public health and should be further explored.
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Atherosclerosis begins in childhood and its progression is influenced by the same risk factors identified in adults (1,2). One of the most potent antecedents of atherosclerotic diseases is hypertension (1). As it has been well-documented, blood pressure (BP) tracks with age from childhood into the adult years (1) and elevated BP levels at a young age are a predictor of BP elevation later in life (3). Prevention should begin as early as possible and, according to current recommendations, be based on lifestyle modifications that include management of body weight; physical activity; and a diet that is limited in sodium but rich in fresh fruit and vegetables; fiber; and lowfat dairy (4).

With regard to the role of diet, a large body of evidence supports the notion that the intake of certain nutrients exerts a considerable influence on BP levels (1-3). However, as it has been shown by the Dietary Approaches to Stop Hypertension trial (4), the most substantial reductions in BP levels have been achieved through dietary modifications that promote changes in the intake of several nutrients, ie, high intakes of potassium, calcium, and magnesium, and low intakes of fat and sodium. A Dietary Approaches to Stop Hypertension–type diet, which is rich in fruits, vegetables, low-fat dairy, fish, and high in potassium, calcium, fiber, and n-3 fatty acids, is currently recommended for prevention and treatment of elevated BP in both adults and children (2,5-7).

A methodological approach that permits a broad assessment of the diet is that of dietary indices. Although there are some dietary indices that have been evaluated against their association with BP status in adult populations (8-11), none has been identified in children. Particularly, although there are several available dietary indices that were developed for children, to the best of our knowledge none of them has been developed to evaluate children's dietary behavior against BP levels. Dietary indices that assess dietary behaviors in relation to BP levels in children, therefore, represent a valuable preventive and monitoring tool for potential use in the front line of the fast-paced primary health care setting and in public health education and intervention programs. Thus, the objective of this work was to evaluate the relationship between diet quality, as assessed by the Foods E-KINDEX (a subindex of the E-KINDEX that assesses dietary habits, behaviors and practices in relation to children's obesity status [12]) and BP levels.

METHODS

Study Sample

The study was conducted during the 2004-2005 school year and covered all the freely accessed districts of the

Republic of Cyprus. Sampling was multistage and stratified by the number of students in each of the five provinces, as provided by the Ministry of Education (data not published, printed data available on request from the Department of Primary Education) and by place of residence (place of school was used as a proxy), urban or rural, as provided by the Cyprus Statistical Service (13).

A total of 1,589 children of fourth, fifth, and sixth grade (9 to 13 years, mean=11±0.98 standard deviation) in 24 primary schools were identified for potential inclusion; 1,140 agreed to participate (72% participation rate), representing 3.7% of the total population. Diet quality was assessed in all children and the participating parents. Dietary assessment was based on a semi-quantitative food frequency questionnaire, consisting of 154 food items (including all of the commonly used foods in the local Greek-Cypriot cuisine) and three supplementary questionnaires that evaluated other aspects of dietary habits (14). Specifically, a Food Groups Frequency Questionnaire that evaluated the frequency of consumption of 15 food groups on a 4-point scale, a Short Eating Habits Behaviors and Beliefs Questionnaire, which evaluated eight psychological aspects of eating using a 4-point Likert-type scale, and a short Dietary Habits Questionnaire that evaluated 19 core eating habits on a 2-point (yes/no) scale (14). In addition, all children answered a semi-quantitative physical activity questionnaire while their parents responded to a short questionnaire that included sociodemographics and information on family cooking and child feeding practices. A detailed description of the study design and dietary assessment methodology has been published elsewhere (14,15).

Measurements of body weight, height, waist, and arterial BP were performed in a randomly selected subsample of 622 children (2.2% of the reference population) during the 2005-2006 school year, according to the protocol described elsewhere (16). BP measures were in accordance with the relevant recommendations (2). Children included in the present study were those of the original study's sample, who at the time that official permission was granted for anthropometric measurements to be performed were still attending primary school. Correlation and χ^2 tests did not show any substantial difference in the sociodemographic characteristics of the subsample used here and those of the original sample.

BP and anthropometric measurements on one hand, and assessment of diet and physical activity on the other, were performed on two different occasions about 10 months apart. As anthropometry and BP can be readily affected by changes in diet and physical activity, parents were asked to report any recent changes in their children's physical activity and dietary patterns during the BP measurement. The research protocol and all means used were approved by the Ministry of Education and Culture (Department of Primary Education) as the law in Cyprus provides for studies carried out in the school environment and during formal school hours. Informed consent was signed by the parent or the guardian of each participant.

Foods E-KINDEX Dietary Index and the Physical Activity Index

In order to evaluate the association between whole diet and BP levels, we used the Foods E-KINDEX, a component of the E-KINDEX (12), an index that has been developed to identify children whose dietary behaviors and choices can predispose them to obesity. E-KINDEX is an index that assesses and summarizes into a single score several dietary habits, behaviors, and practices that have been implicated in development of childhood obesity (12). The Foods E-KINDEX, a subindex of the E-KINDEX, aims to express the quality of the diet from the perspective of varied and balanced food choices by an arithmetic score, which ranges from 0 to 37. The index consists of 11 major food groups or foods (ie, bread, cereals, and grains [excluding bread], fruit and fruit juices, vegetables, legumes, milk, fish and seafood, meat [excluding delicatessen and processed meat], salted and smoked meat food, sweets and snacks, and soft drinks) that were included in the Food Groups Frequency Questionnaire (14,15); the subindex also comprises two components for cooking techniques (frying and grilling). Response categories were 0 times/week, 1 to 2 times/week, 3 to 5 times/week, and ≥6 times/week. Cronbach's α was .708 for the items used in the Foods E-KINDEX score, showing a good internal consistency (17). Repeatability (filling the same questionnaire twice, within 1 month apart) was good (as tested by Spearman ρ=0.234 to 0.569, with most items >0.450). This validation procedure in a child population of the same age and ethnic background has been used previously (18).

Scoring of dietary habits was performed by the same individual who was blind to BP measurements of the participants. Table 1 presents the components of the Foods E-KINDEX, along with the scoring system and the upper and lower cutoff points of each component.

A physical activity index was calculated based on two variables that measured frequency on a weekly basis of all running and walking activities. Further details about this index are provided elsewhere (16). A physical activity index has been validated against pedometer counts in a sample of 80 children. Results show that Spearman's correlation coefficients range from 0.280 for weekdays to 0.352 for weekends. In addition, a variable that assesses the daily average television viewing time (including weekends) was included (16).

Statistical Analysis

Continuous variables are presented as mean±standard deviation, whereas categorical variables are presented as absolute and relative frequencies. Normality of variables' distribution was tested by Q-Q plots and by Kolmogorov-Smirnov test. Systolic and diastolic BP values were not normally distributed, and thus their distribution is presented as median and interquartile range. Associations between continuous variables were tested by Kruskal-Wallis test, whereas associations between categorical variables were tested by χ^2. Mean differences of BP levels by sex were tested using Mann-Whitney test. Correlations between the Foods E-KINDEX score and BP levels were tested by Spearman ranked correlation coefficient. Two binary logistic regression analyses were applied, with the two levels of systolic BP (≤120 vs >120 mm Hg) and diastolic BP (≤80 vs >80 mm Hg) as dependent variables and the Foods E-KINDEX score as the independent variable. Finally, multinomial logistic regression analysis was applied with a new categorical variable de-