Development of a Korean Diet Score (KDS) and its application assessing adherence to Korean healthy diet based on the Korean Food Guide Wheels

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Abstract
The most critical point in the assessment of adherence to dietary guidelines is the development of a practical definition for adherence, such as a dietary pattern score. The purpose of this study was to develop the Korean Diet Score (KDS) based on the Korean Food Balance Wheel and to examine the association of KDS with various lifestyle characteristics and biochemical factors. The dietary data of 5,320 subjects from the 4th Korean National Health and Nutritional Examination Survey were used for the final analysis. The food guide was composed of six food group categories; ‘grain dishes’, ‘fish and meat dishes’, ‘vegetable dishes’, ‘fruits’, ‘milk’, and ‘oils and sugars’. Based on the recommended serving numbers for each group, the scores measuring adherence to this food guide were calculated from the dietary information from the 24-hour dietary recall questionnaire, and then its correlation with various characteristics was assessed. KDS was significantly associated with several clinical, lifestyle and socioeconomic factors as well as diagnosed disease history. The higher quintile group of KDS showed a significantly lower level in fasting blood glucose, systolic blood pressure, triglycerides, current smoking and drinking as well as higher leisure time activity, house income and education. Furthermore, the KDS quintile group of women was inversely associated with hypertension, osteoporosis and diabetes. A higher KDS quintile was characterized with a higher intake of several critical nutrients, such as Ca, Fe and vitamins as well as a desirable nutrition balance such as the ratio of macronutrients. Our results demonstrate that KDS is a beneficial tool in assessing the adherence to a healthy diet based on the Korean dietary guidelines. We suggest that KDS could be a useful indicator for evaluating the dietary balance of the Korean population.

Key Words: KDS, KNHANES, dietary guidelines, dietary patterns, Korea

Introduction
Dietary guidelines have been created to provide public education regarding healthy food choice for the promotion of healthy living and prevention of diseases. Many national governments and organizations have published dietary guidelines and often used to investigate the association between nutrient intakes with specific diseases such as cancer or chronic illnesses. The Korean Food Guidance System was introduced in 2010 by the Korean Nutrition Society (KNS). Its basic concept is planning a meal to satisfy the nutritional recommendation of major food groups, representative foods in each group and servings. Nutritional recommendations in the Food Guidance System are based on the Dietary Reference Intakes for Koreans (KDRIs) and Dietary Guidelines for Koreans. Furthermore, it includes the Food Balance Wheels (Fig. 1) developed to emphasize exercise which is excluded in a previous tower model. A backward big wheel consisted of the 6 major food groups to represent the servings of each food group and a front small wheel contains a glass of water. The six major food groups are ‘Grains’, ‘Meat, Fish, Eggs, and Beans’ (named as ‘Meats’), ‘Vegetables’, ‘Fruits’, ‘Milk and Dairy products’ (called as ‘Milks’) and ‘Oils, Fats,
Figure 1. The Korean Food Balance Wheels (Source: Dietary Reference Intakes for Koreans, First Revision, 2010. The Korean Nutrition Society)

Subjects and Methods

Study population

The Korea National Health and Nutrition Examination Survey (KNHANES) has been conducted as a series of surveys in a cross-sectional study of nationally representative samples of the non-institutionalized civilian Korean population aged ≥ 1 yr. Detailed information about the KNHANES is described elsewhere [17]. In brief, comprehensive information on health and nutrition was collected from a stratified multistage probability sample of South Korean households representing the civilian, non-institutionalized population. This national survey was set to monitor the trends of prevalence, awareness, treatment, and control of selected chronic diseases. In addition, it was also set to monitor the trends in nutritional status and risk behaviors, and to analyze risk factors for chronic diseases. For these purposes, with standardized high quality methods, extensive data on health and nutrition were collected through health interviews, health examinations (physical examination, clinical measurements, and tests), and dietary interviews. We used the data of KNHANES 2007 and 2008 with a total of 14,338 subjects (4,594 in 2007 and 9,744 in 2008). Among them, 11,956 individuals supplied 24-hour dietary recall data and data on health behavior and health examination. Individuals less than 30 years and more than 80 years of age (4,542 subjects) and individuals exhibiting extreme total energy intake with 500 kcal/day or less and 5,000 kcal/day or more (105 subjects), individuals having diet therapy (1,517 subjects), pregnant or lactating women (85 subjects), cancer patients (210 subjects), and individuals who have no data of blood pressure were excluded from the analysis. Finally, 5,320 individuals with complete diet survey, health examination data and health interview data were included for this analysis.

Data collection

A health examination was comprehensively conducted, which included measurement of blood pressure (BP), height, weight, waist circumference, triglyceride (TG), high-density lipoprotein (HDL)-cholesterol, and fasting blood glucose. Hypertension was identified in individuals who met; SBP ≥ 140 mmHg; DBP ≥ 90 mmHg (the average values of twice measurement). Waist circumference was measured according to the WHO guideline at the end of a normal expiration, with the arms relaxed at the sides, under the midline of the participant’s armpit, at the midpoint between the lower part of the last rib and the top of the hip. Trained interviewers conducted surveys in households and administered a structured questionnaire to obtain information on sociodemography, lifestyle, health characteristics and nutritional status including dietary supplement use for each respondent, smoking history, physical activity, alcohol consumption, and past medical history.