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Dietary Energy Density in the Australian Adult Population from National Nutrition Surveys 1995 to 2012

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ABSTRACT

Background It is hypothesized that the observed proliferation of energy-dense, nutrient-poor foods globally is an important contributing factor to the development of the obesity epidemic. However, evidence that the population's dietary energy density has increased is sparse. The World Cancer Research Fund recommends that dietary energy density be <1.25 kcal/g to prevent weight gain.

Objective The aim of this research was to determine whether the dietary energy density of the Australian population has changed between 1995 and 2012.

Design A secondary analysis of two cross-sectional Australian national nutrition surveys from 1995 and 2011/2012 was conducted.

Participants/setting Participants of the surveys included adults aged 18 years and older (1995 n=10,986 and 2011/2012 n=9,435) completing 24-hour dietary recalls, including a second recall for a subset of the population (10.4% in 1995 and 64.6% in 2011/2012).

Main outcome measures Outcome measures included the change in dietary energy density (calculated as energy/weight of food [kcal/g] for food only) between surveys.

Statistical analysis The National Cancer Institute method for "estimating ratios of two dietary components that are consumed nearly every day" was used to determine the usual distribution and the percentage of participants reporting energy density <1.25 kcal/g.

Results The mean (standard deviation) dietary energy density was 1.59 (0.26) kcal/g and 1.64 (0.32) kcal/g ($P<0.0001$) in 1995 and 2011/2012, respectively, with 13% and 5% ($P<0.0001$) of the population meeting dietary energy-density recommendations. For those aged 70 years and older, the percentage with energy density <1.25 kcal/g decreased from 22% to 6% ($P<0.0001$) for men and from 33% to 11% ($P<0.0001$) for women in 1995 and 2011/2012, respectively. Among those aged 18 to 29 years, 1% of men in both surveys ($P=0.8$) and 4% of women in 1995 and 2% in 2011/2012 ($P=0.01$) reported energy density <1.25 kcal/g.

Conclusions Dietary energy density has increased between the two surveys and few people consumed low energy-dense diets in line with recommendations. The change was largely due to increased energy density of older adult's diets, while young adults had high dietary energy density at both time points. These data suggest efforts now focus on the evaluation of the role of modifying energy density of the diet to reduce the risk of weight gain in adults.
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THE GLOBAL OBESITY EPIDEMIC IS RECOGNIZED AS one of the most pressing health concerns of modern society, affecting half a billion people globally.[1,2] Obesity contributes to the increased risk of mortality due to non-communicable disease,[3] including cardiovascular disease,[4] type 2 diabetes,[5] and some cancers.[6] The causes of obesity are complex, but at a fundamental level, weight gain is due to energy imbalance created by greater intake of energy than is expended.[7] In addition to more sedentary lifestyles and less energy expenditure throughout the day because of the automation of daily activities, one of

the dietary factors that is thought to favor population weight gain is a proliferation of widely marketed, palatable, energy-dense foods.[8,9] As such, the World Health Organization has labeled the obesity epidemic "a social and environmental disease."[10] Despite being frequently cited as a cause of obesity,[8,9] evidence that the dietary energy density of populations has increased is limited.

Appetite and satiety regulation are complex and there are many physiological mechanisms to regulate how much food is consumed to match the amount of energy expended during the day.[11] The obesity epidemic has demonstrated that biological mechanisms to defend a normal body weight have limitations. Dietary energy density (kcal/g) is thought to be important in weight regulation, as people tend to eat a constant volume of food and, therefore, the energy content per gram of food is an important determinant of the overall energy consumed.[12] Energy-dense foods tend to be dry foods and/or have a high-fat content, such as oils, candies, or cakes, while low energy-dense foods are higher in fiber and/or water content, such as vegetables, fruit, and yogurt.[13] Increasing the energy density of a meal can lead to passive consumption of a higher energy intake.[12,14] Similarly, increasing and decreasing dietary energy density has been demonstrated to increase and decrease body weight.[15] As such, authors of a systematic review to inform the Dietary Guidelines for Americans and the World Cancer Research Fund (WCRF) recommend consuming lower energy-dense diets as an effective strategy for weight maintenance.[15,16] The WCRF recommends that dietary energy density be $<$1.25 kcal per gram of food.[17]

To date, there is limited evidence that the overall energy density of population diets have increased over time. Evidence from several population surveys has demonstrated no temporal increases in dietary energy density, but it has relied on analysis of surveys with limited data-collection time frames.[18,19] Analysis of multiple National Health and Nutrition Examination Surveys demonstrated temporal increases in dietary energy density between the years 1971 and 2002.[20] However, the results need to be interpreted cautiously, as the surveys had methodological differences.[20] In Australia, the prevalence of adult overweight and obesity has increased from 56.3% in 1995 to 62.8% in 2011/2012.[21] Although research evaluating the Australian population's diet demonstrated that energy density was positively correlated with fat and negatively correlated with fiber and water intake,[22] there has been no known analysis to demonstrate whether the population's dietary energy density has increased.

The aim of this research was to determine whether the dietary energy density of the Australian population has changed over time by comparing the reported energy density in 1995 with that of 2011/2012. A secondary aim was to determine whether the proportion of the population estimated to meet the WCRF guidelines differed between these time points as well.

MATERIALS AND METHODS

This research consists of a secondary analysis of data from two cross-sectional national nutrition surveys designed to estimate the Australian population's usual food intake: the National Nutrition Survey 1995 and the National Nutrition and Physical Activity Survey 2011/2012. An analysis was conducted for all survey participants aged 18 years and older. This research used de-identified data and was deemed exempt from full review from the Institutional Review Board, in accordance with the National Statement on Ethical Conduct in Human Research.[23] The surveys were carried out under the Federal Census and Statistics Act 1905.[24,25] For an overview of the methodology used in both surveys, see Table 1. Full details of the survey design are published elsewhere.[24,25]

The National Nutrition Survey 1995 and the National Nutrition and Physical Activity Survey 2011/2012, conducted by the government agency, the Australian Bureau of Statistics (ABS), are multi-staged area samples of private dwellings, covering approximately 97% of Australia. Exclusions included non-private dwellings, such as correctional facilities, medical and aged care accommodation, and general accommodation (eg, hotels); households of foreign government diplomats; and non-Australian defense personnel stationed in Australia. In 2011/2012, very remote areas of Australia were not sampled, but the ABS reports that this is not expected to change estimates for the Australian population.[25] Both surveys were designed and powered to estimate dietary intakes by age and sex strata. Interview collection days were Monday to Sunday and collection periods were February 1995 through March 1996 for the National Nutrition Survey 1995 and May 2011 through June 2012 for the National Nutrition and Physical Activity Survey 2011/2012.

Dietary Assessment

The surveys each collected two 24-hour diet recalls to assess population diet. The 1995 and 2011/2012 surveys used adaptations of the multiple-pass recall method, the three-pass and five-pass method, respectively, which were originally developed by US Department of Agriculture's Agricultural Research Service.[26,27] For the 2011/2012 survey, the government agencies, Australia New Zealand Food Authority and Food Standards Australia and New Zealand in conjunction with the ABS modified the tool to reflect the Australian food supply.[25] In 1995, the three-pass method was modified for use with the Australian public by the Commonwealth Department of Health and Family Services in conjunction with the ABS.[24] For the National Nutrition Survey 1995 survey, both interviews were conducted by trained nutritionists in a face-to-face pen-and-paper interview, while the 2011/12 survey was collected by trained and experienced ABS staff in a face-to-face computer-assisted personal interview for the first interview and a computer-assisted telephone interview for the second interview.[25,27]

Two nutrient databases, AUSNUT 1999 created by Australia New Zealand Food Authority and AUSNUT 2011-2013 created by Food Standards Australia and New Zealand, were developed to estimate the foods, supplements, and nutrients reported in the National Nutrition Survey 1995 and the National Nutrition and Physical Activity Survey 2011/2012, respectively.[28,29] The databases contain information for food and beverages (AUSNUT 1999 n=3,920 and AUSNUT 2011/12 n=5,740) that each reflect the available foods, dietary supplements, measures, and nutrient profiles available in the time-period of the survey.[28,29] Differences, as stated by the ABS, that need to be considered when making comparisons