## Original Research

# Higher dietary diversity score is associated with obesity: a case–control study

R. Karimbeiki [a], M. Pourmasoumi [b], A. Feizi [c], B. Abbasi [a], A. Hadi [a],
N. Rafie [a], S.M. Safavi [a,*]

[a] Department of Clinical Nutrition, School of Nutrition & Food Science, Isfahan University of Medical Sciences, Isfahan, Iran
[b] Gastrointestinal and Liver Diseases Research Center (GLDRC), Guilan University of Medical Sciences, Rasht, Iran
[c] Department of Epidemiology and Biostatistics, School of Public Health, Endocrinology and Metabolism Research Center and Cardiac Rehabilitation Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran

### ARTICLE INFO

### ABSTRACT

Objective: The present study was carried out to compare dietary diversity score (DDS) among overweight, obese, and normal-weight adults.

Study Design: This case–control study was conducted with a total of 200 cases (100 participants with obesity and 100 participants with overweight) and 300 controls (normal weight) matched by socio-economic status (SES), older than 18 years.

Methods: Dietary intakes were assessed using a self-administered Food Frequency Questionnaire. Data regarding physical activity and sociodemographic variables were gathered. DDS was computed based on the scoring of the five food groups emphasized in the United States Department of Agriculture Food Guide Pyramid. Anthropometric measurements were measured, and the body mass index and waist-to-hip ratio were calculated.

Results: The mean ± standard deviation of DDS was higher in participants with obesity (5.65 ± 1.32) than that in overweight participants (5.23 ± 1.23), while the lowest score was reported among normal-weight individuals (4.97 ± 1.42) ($P < 0.001$). The odds of obesity increased with each unit increase in DDS (odds ratio [OR]: 1.46; 95% confidence interval [CI]: 1.22, 1.74). However, the association became slightly weaker after adjusting for potential confounding factors (OR: 1.34; 95% CI: 1.07, 1.68).

Conclusion: It was concluded that there was a significant positive association between DDS and obesity. However, additional investigations are warranted.

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## Introduction

Obesity is a major public health problem worldwide. According to the World Health Organization report, the global prevalence of obesity has doubled between 1980 and 2014. In 2016, more than 1.9 billion adults were overweight, with more than 650 million being obese.[1] If present trends continue unabated, by 2030, 1.12 and 2.16 billion adults will suffer from obesity and overweight, respectively.[2] Obesity is a major risk factor for several diseases[3,4] with significant economic impacts on global healthcare systems.[5]

Obesity is a complex multifactorial chronic disease developing from an interaction between diet, genetics, physical activity, medication, and other factors.[6] Until now, studies have mainly investigated the role of single nutrients in obesity.[7] Although these investigations are important, dietary pattern analysis has recently emerged as a novel approach for assessing the relationship between diet and the risk of chronic diseases, including obesity. Pattern analysis examines the effects of the overall diet rather than looking at individual nutrients or foods and may thus be more indicative of disease risk than individual foods or nutrients.[8,9] Dietary diversity score (DDS) is one of the indicators used for assessing overall diet and has been associated with the nutrient adequacy ratio of some nutrients and quality of diet in previous studies.[10–12]

In this regard, Azadbakht et al. indicated that a higher DDS was positively associated with higher intakes of fruits, vegetables, and whole grains and total intake of dietary fiber, calcium, and vitamin C, which were inversely correlated to obesity among female students.[13] In addition, Oldewage-Theron et al.[14] showed that a higher DDS was associated with lower intakes of fatty acids and cholesterol and subsequently a healthier diet and lower body mass index (BMI) in women from the Vaal Region, South Africa. However, a recent systematic review and meta-analysis showed that there was no significant association between DDS and BMI status, although between-study heterogeneity was high.[15]

To the authors' knowledge, this is the first case–control study examining the association between DDS and obesity. Studies regarding this association have reported inconsistent results, with most of them being cross sectional in design. The DDS–obesity relationship still remains an unresolved question; because an answer to this question is key to informing and guiding public health initiatives to ameliorate obesity by lifestyle interventions, it was decided to conduct this study to clarify the association between DDS and obesity.

## Methods

### Study design and participants

This was an observational case–control study that was conducted from April to January 2015, comparing DDS among overweight, obese, and normal-weight Iranian adults (>18 years). The study population comprised 500 adults studied in three groups. The case groups included 100 obese and 100 overweight individuals randomly chosen from those attending the 'Baraka' obesity treatment group in Tehran,

Iran. The control group consisted of 300 normal-weight participants who were randomly selected using multistage cluster sampling method from volunteers living in different areas of Tehran. Controls were matched in a 1.5-to-1 ratio to obese and overweight adults by socio-economic status (SES).[16]

A written informed consent was obtained from all participants, and the study was approved by the Ethics Committee of Isfahan University of Medical Sciences (code: IR.MUI.REC.3.198).

The inclusion criteria were as follows (for both cases and controls): age above 18 years, being literate and interested in participating in this study. Pregnant and lactating women, people with special diets, people diagnosed with diseases (such as diabetes, cardiovascular diseases and eating disorders) that could affect their dietary intake, and people who consumed medications affecting their appetite or weight (some of these drugs included fluoxetine, sulfasalazine, and topiramate that cause anorexia and corticosteroids and antidepressants drugs that increase appetite and weight) were excluded. Participants with reported energy intakes not falling between 800 kcal/day (3347 KJ/day) and 4200 kcal/day (17,537 KJ/day) or those who did not complete the questionnaires appropriately (participants who did not complete all three questionnaires or who did not answer more than 40 items of the 168-item semi-quantitative Food Frequency Questionnaire [FFQ]) were also excluded.

### Procedure and data collection

The following variables were collected for each participant: DDS, age, sex, marital status, educational level, occupational status, physical activity, smoking, and economic status.

### Dietary assessment

Usual dietary intake was assessed by a validated and reliable self-administered 168-item semi-quantitative FFQ.[17] In the first visit, an expert dietitian explained the participants how to complete the FFQ. The FFQ consisted of a list of foods commonly consumed by Iranians with a standard serving size. Participants were asked to write their frequency of consumption and common portion sizes of each food item during the last year on a daily, weekly, or monthly basis, and they were asked to deliver the questionnaires after a week. Portion sizes of consumed foods were converted to grams using household measures. All items were then coded according to the prescribed protocol and analyzed for energy content and other nutrients by Nutritionist IV software (version 3.5.2; N-squared computing, USA), modified for Iranian foods.

### Dietary diversity score

Five groups were used to calculate DDS:[18] bread grains, vegetables, fruits, meats and their substitutes, and dairy products, according to the United States Department of Agriculture (USDA) Food Guide Pyramid. The main groups were then divided into 23 subgroups according to Kant et al.[19] The bread-grain group was divided into seven subgroups (refined bread/grain, whole wheat biscuits, macaroni, whole bread, corn flakes, rice, and refined flour). Vegetables were divided into