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Original Research

High compliance with dietary recommendations in a cohort of meat eaters, fish eaters, vegetarians, and vegans: results from the European Prospective Investigation into Cancer and Nutrition–Oxford study☆,☆☆

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ABSTRACT

The aim of this study was to investigate differences in dietary intakes between 30251 participants in the European Prospective Investigation into Cancer and Nutrition–Oxford study, comprising 18 244 meat eaters, 4 531 fish eaters, 6 673 vegetarians, and 803 vegans aged 30 to 90 years who completed semiquantitative food frequency questionnaires. We hypothesized that these groups characterized by varying degrees of animal product exclusion have significantly different intakes of many nutrients, with possible implications for dietary adequacy and compliance with population dietary goals. Nutrient intakes were estimated including fortification in foods, but excluding dietary supplements. Dietary supplementation practices were also evaluated. Highly significant differences were found in estimated nutrient intakes between meat eaters and vegans, with fish eaters and vegetarians usually having intermediate values. Meat eaters had the highest energy intakes, followed by fish eaters and vegetarians, whereas vegans had the lowest intakes. Vegans had the highest intakes of polyunsaturated fatty acids, dietary fiber, vitamins C and

Abbreviations: AHS2, Adventist Health Study 2; AOAC, Association of Official Analytical Chemists International; BMR, basal metabolic rate; EAR, Estimated Average Requirement; EI, energy intake; EPIC, European Prospective Investigation into Cancer and Nutrition; FAO, Food and Agriculture Organization of the United Nations; FFQ, food frequency questionnaire; IHD, ischemic heart disease; IOM, Institute of Medicine; NSP, nonstarch polysaccharides; PUFA, polyunsaturated fatty acids; RE, Retinol Equivalents; RAE, Retinol Activity Equivalents; SFA, saturated fatty acids; WHO, World Health Organization.

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E, folate, magnesium, iron, and copper. Meat eaters had the highest intake of saturated fatty acids, protein, vitamin B_2, vitamin B_{12}, vitamin D, zinc, and iodine. Fish eaters had the highest intakes of calcium and selenium. There were no statistically significant differences in sodium and potassium intakes between dietary groups. With the exception of sodium intake, compliance with population dietary goals was high across diet groups. The results suggested a high prevalence of inadequacy for dietary vitamin B_{12} and iodine in vegans. The diet groups under study showed striking differences in dietary intakes, with possible implications for compliance with dietary recommendations, as well as cardiometabolic diseases risk.

1. Introduction

According to a joint Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) expert consultation from the year 2004, "households across all regions should select predominantly plant-based diets rich in a variety of vegetables and fruits, pulses or legumes, and minimally processed starchy staple foods. The evidence that such diets will prevent or delay a significant proportion of non-communicable chronic diseases is consistent" [1]. This recommendation was reflected in recent dietary guidelines. For example, the 2010 Dietary Guidelines for Americans advised to "shift food intake patterns to a more plant-based diet that emphasizes vegetables, cooked dry beans and peas, fruits, grains, nuts, and seeds" [2].

However, the FAO/WHO consultation adds: "This [diet] should not exclude small amounts of animal foods, which make an important nutritional contribution to plant-food-based diets" [1]. Establishing the optimal balance between plant and animal foods for obtaining health benefits and nutrient adequacy of diets at a population level is an important goal for public health nutrition, and assessing the adequacy of habitual dietary intakes in vegetarians can prove valuable in accomplishing this task.

Vegetarians in Western countries have a lower risk of some noncommunicable chronic diseases compared with otherwise similar nonvegetarians, which may partially stem from the differences between their dietary intakes and those of the general population. A recent meta-analysis concluded that vegetarians have a significantly lower ischemic heart disease (IHD) mortality (29%) and overall cancer incidence (18%) than do nonvegetarians [3]. Previous studies in the European Prospective Investigation into Cancer and Nutrition (EPIC)–Oxford cohort showed associations between the vegetarian dietary pattern and lower risk of IHD [4], diverticular disease [5], cataract [6], hypertension [7], kidney stones [8], and some types of cancer [9].

Although it is generally accepted that appropriately planned vegetarian diets are nutritionally adequate for individuals during all stages of the life cycle and across all physical activity levels, concerns exist about their potential inadequacy in regard to some nutrients, especially in vegans [10]. This study aims to describe dietary intakes, dietary supplementation practices, and differences in dietary patterns of meat eaters, fish eaters, vegetarians, and vegans who were participants in a large cohort study. We hypothesized that these groups characterized by varying degrees of animal product exclusion have significantly different intakes of many nutrients, with possible implications for dietary adequacy and compliance with population dietary goals. Therefore, the objectives of the present study were to estimate and compare mean daily nutrient intakes between the 4 diet groups, estimate the prevalence of inadequate intakes based on food intakes alone, and compare the mean daily nutrient intakes with recommended group-level dietary targets.

2. Methods and materials

2.1. *Study population*

The EPIC-Oxford cohort study recruited more than 65 000 participants 20 years or older between 1993 and 1999. The participants are a cohort of generally health-conscious British residents adhering to 4 distinct dietary patterns: meat eaters, fish eaters, vegetarians, and vegans. A detailed description of the recruitment process and socioeconomic and lifestyle characteristics has been published elsewhere [11]. This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by a multicenter research ethics committee. Written informed consent was obtained from all participants. Briefly, the EPIC-Oxford study is part of the EPIC study that aimed to recruit more than 400 000 men and women across European countries (equating to national cohorts in the range of 35 000-50 000 participants), based on sample size calculations suggesting sufficient power to detect statistically significant relative risks of at least 1.2 for all major cancer sites at this sample size [12]. The EPIC-Oxford cohort was designed to recruit as many vegetarians as possible and a similar number of meat eaters [11]. Participants were recruited through general practices in Oxfordshire, Buckinghamshire, and Greater Manchester, and by postal methods that aimed to recruit health-conscious people throughout the United Kingdom. Participants were categorized into 1 of 4 diet groups based on their response to questions asking whether they ate any meat, fish, eggs, and dairy products. Participants were categorized as those who eat meat ("meat eaters"), those who do not eat meat but eat fish ("fish eaters"), those who do not eat meat or fish but eat