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Nutritional profile among vegetarians and non-vegetarians in Denpasar, Indonesia

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ABSTRACT

Introduction: Despite the many health benefits of a well-balanced vegetarian or vegan diet providing, vegetarians are at increased risk of deficiency in certain nutrients, such as calcium and iron, which could lead to health issues. Our study aimed to assess nutrient intakes and nutritional status between dietary patterns that include or do not include meat consumption. **Methods**: This cross-sectional study was conducted in Denpasar, Bali, Indonesia. One hundred sixty respondents (80 vegetarians and 80 non-vegetarians) participated. Data were collected from interviews, a semi-quantitative food frequency questionnaire, and Nutrisurvey tools. Nutrient intakes were also assessed, including energy, carbohydrates, fat, protein, calcium, iron, zinc, and vitamin C. Body mass index (BMI) was used to determine nutritional status. **Results:** There were no appreciable difference (p>0.05) in carbohydrate intake between vegetarian and non-vegetarian groups. In contrast, the vegetarian group's energy, protein, and fat intakes significantly differed from that of non-vegetarians (p<0.05). No significant differences (p>0.05) were found in calcium, zinc, vitamin C, vitamin D, vitamin B12, folic acid, and magnesium between the two groups. However, it was discovered that the two groups' iron intake and BMI were significantly different (p<0.05). **Conclusion:** Vegetarians and non-vegetarians demonstrated differences in BMI, energy intake, protein consumption, fat consumption, and iron consumption. With a well-curated variety of food options and efficient administration of vegetarian meal plans, it is possible to effectively meet the nutritional requirements of individuals in terms of both essential vitamins and minerals, as well as carbohydrates, protein, and fats.

Keywords: non-vegetarian, nutrient intake, nutritional status, vegetarian

INTRODUCTION

Vegetarian diets have become more popular as more people become aware of the advantages of a plant-based diet for lowering the risk of degenerative diseases. However, the fulfilment of nutritional requirements could be affected by the removal of animal products from the daily diet. A poor diet correlates with several chronic diseases, including cancer, diabetes mellitus, cardiovascular disease, and others (Rizzo *et al.,* 2013).

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Based on the most recent data from the World Health Organization (WHO) in 2021, it is clear that 39% of adults aged 18 years and above are considered overweight, while 13% are categorised as obese. The data provided by WHO gives rise to substantial concerns regarding the prevalence of overweight and obesity among adolescents. Obesity is affected by multiple risk factors, including socioeconomic circumstances, inadequate participation in outdoor physical activity, prolonged periods of watching television, intake of fast food and sugary drinks, and insufficient time for play. During the COVID-19 epidemic, there was a large rise in fast food consumption among adolescents in Indonesia, with a notable increase of 17.8% (Zaida, 2021). The age range of 17-25 years is classified as late adolescence by the Ministry of Health of the Republic of Indonesia.

The practice of vegetarianism has a close relationship with several religious traditions worldwide. In order to show respect for all living things and uphold the ideal of non-violence, some religions, such as Adventism and Hinduism, have been practising plant-based diets (Hargreaves *et al.,* 2020). Findings on several health advantages of limiting meat consumption also added to the increase in the practice of this vegetarian lifestyle. The idea that using animals for human food is immoral is further supported by ethical considerations (American Dietetic Association, 2009; Hargreaves *et al.,* 2020).

In general, vegetarian diets have both adverse and advantageous effects on health. Low animal protein intake is linked to insufficient iron, which is necessary for growth and bodily functions, and even increases the risk of anaemia. Deficits in other macronutrients or micronutrients are also common in vegetarian diets (Lea & Worsley, 2003; Pawlak, Berger & Hines, 2018). A previous study demonstrated a significant difference in plasma amino acid concentrations between vegans and those who consumed meat (Schmidt *et al.,* 2016). Similar to this, it was discovered that micronutrient intakes, such as vitamins B2, niacin (B3), B12, D, iodine, zinc, calcium, potassium, and selenium, in vegans were reduced when compared to other vegetarian dietary patterns (Bakaloudi *et al.,* 2021). Nutritional deficiencies are a severe threat to public health since they can lead to a variety of serious health issues. According to several studies, a well-planned, health-conscious vegetarian diet with supplements can help the body fulfil its nutrient requirements.

Although a vegetarian diet offers many health benefits, it is important to recognise that vegetarians have limited options when it comes to animal protein. Both animal-based and plant-based foods are rich in different nutrients, but certain nutrients are more abundant in animal-based foods. Due to this, it is believed that vegetarians are more likely to experience nutritional deficits than non-vegetarians. The need to examine the nutritional status and micronutrient intakes of vegetarians, and compare them to non-vegetarians, is driven by the vegetarian groups dispersed throughout Denpasar in Bali that are closely associated with particular religious beliefs (Nebl *et al.,* 2019).

MATERIALS AND METHODS

Study design and participants

This cross-sectional study was carried out at Warmadewa University, Denpasar, from January to June 2022. The study population consisted of Warmadewa University students aged 18-25 years who satisfied the specified inclusion and exclusion criteria. Warmadewa University was deliberately chosen due to the presence of both vegetarian and

non-vegetarian followers, as indicated by earlier surveys. The university expressed willingness to participate in the study and accommodate data gathering even throughout the COVID-19 outbreak. Vegetarian participants strictly adhered to and have followed specific vegetarian practices for at least one year at the time of data collection. They willingly volunteered to participate and had no health issues during the data collection procedure. Non-vegetarian participants were individuals who did not adhere to or followed any specific vegetarian dietary patterns, were willing to participate, and did not have any health conditions during the study. Further inclusion criteria encompassed the absence of any medications that may influence body weight, particularly among female participants, as well as the exclusion of those who were menstruating, pregnant, or breastfeeding.

Sample size was determined using the formula derived from the weight of each population (Robb, 1963). Given the presence of two distinct sample groups, namely vegetarians and non-vegetarians, each group was assigned a weight to achieve a combined sample size of 160 individuals. The sample size comprised 160 individuals, with 80 participants in the vegetarian group and an equal number in the non-vegetarian group. The sampling procedure employed the simple random sampling technique, utilising random numbers generated through Microsoft Excel, until a sample size of 80 individuals was obtained for both the vegetarian and non-vegetarian groups. The study received approval from the Ethics Committee of the Faculty of Medicine and Health Sciences, Warmadewa University for Research Involving Human Subjects [Ref. No. 220/Unwar/FKIK/EC-KEPK/I/2022]. All participants willingly supplied written informed consent to participate in the study.

Data collection and measurement

Information on 1) subject's name, age, gender, residential address, vegetarian status, and the duration of their vegetarianism; 2) nutritional status, such as body mass index; 3) energy and nutrient intakes, such as protein, fat, and carbohydrates; 4) micronutrient intakes, such as vitamin and mineral intakes, were collected. Micronutrients calcium, iron, zinc, and vitamin C were all examined.

Data on subject characteristics

Enumerators who had received training in conducting interviews, filling out questionnaires, and measuring body mass index assisted with data collection for this study. Data on subject characteristics and food consumption were collected using structured interview techniques. Body mass index, calculated using a formula based on height and weight, was used to determine data on nutritional status. Height and weight data were obtained by directly measuring respondents using the SMIC/GEA ZT-120 height and weight scales.

$$\text{BMI} = \text{weight (kg)}/\text{height (m}^2\text{)}$$

According to the Ministry of Health of the Republic of Indonesia, BMI is categorised into five classes, which consist of underweight (BMI <18.5 kg/m^2), normal (BMI 18.5 to 22.9 kg/m^2), overweight (BMI 23 and 24.9 kg/m^2), obesity grade I (BMI 25 to 29.9 kg/m^2), and obesity grade II (BMI ≥30 kg/m^2). The selection of the 17-25 years age group was derived from this study, which specifically targeted the late teenage demographic. This population was then categorised into four groups: 18 years, 19-21 years, 22-23 years, and 24-25 years. The level of education we used was the last level of education completed by the respondent, based on the diploma obtained. Regarding educational

Table 1. Recommended nutritional requirements for Indonesians in 2019 (AKG, 2019)

Nutrient	*Men*		*Women*	
	16-18 years old	*19-29 years old*	*16-18 years old*	*19-29 years old*
Energy (kcal)	2650	2650	2100	2250
Protein (g)	75	65	65	60
Carbohydrate (g)	400	430	300	360
Fat (g)	85	75	70	65
Calcium (mg)	1200	1000	1200	1000
Magnesium (mg)	270	360	230	330
Vitamin C (mg)	90	90	75	75
Vitamin D (mcg)	15	15	15	15
Vitamin B12 (mcg)	4	4	4	4
Folic acid (mcg)	400	400	400	400
Iron (mg)	11	9	15	18
Zinc (mg)	11	11	9	8

achievement, participants were categorised into one of these subsequent groups: 'high school or lower'; 'trade school/college (partial or complete)'; or 'university (partial or complete)'. In order to evaluate the perceived sufficiency of income, participants were queried about the level of difficulty or ease they experienced in meeting their financial obligations, taking into account their overall monthly earnings ('low'; 'neither low nor high'; 'high'; 'very high'). There were three distinct categories of vegetarianism: lacto-vegetarian, lacto-ovo vegetarian, and vegan. Vegetarianism was categorised into two groups based on duration: three years or less and more than three years. For individuals under the three-year category, a minimum requirement of one year as a vegetarian was used.

Data on food consumption

The semi-quantitative food frequency questionnaire (SQFFQ) was employed during interviews to collect data on consumption of energy and additional nutrients, including protein, fat, and carbohydrates. SQFFQ is a prevailing and legitimate methodology employed in dietary research (Kowalkowska & Wadolowska, 2022). Data were collected by enumerators who had received training to complete the SQFFQ. The enumerators in this study consisted of paramedics, including nurses and midwives.

Furthermore, the acquired data regarding food consumption were thoroughly validated on two separate occasions to guarantee the precision of the information about foods or ingredients, frequency, and conversion of food ingredients into grams. The research team confirmed the accuracy and comprehensiveness of the consumption statistics. The acquired data were classified into three distinct categories: substandard, if it fulfilled less than 70% of the suggested nutritional standards for Indonesians; satisfactory, if it fulfilled 70-90% of the suggested nutritional standards for Indonesians; and excellent, if it fulfilled more than 90% of the suggested nutritional standards for Indonesians (AKG, 2019). Table 1 displays the recommended nutritional requirements for Indonesians, particularly adolescents.

Data on micronutrient consumption

Data collection on micronutrient intakes involved examining food consumption information, which had been quantified as grams of ingredient consumption. Enumerators interviewed each respondent's daily food intake (food recall). From the food data, the staple ingredients used were identified. For example, rice and eggs are the staple ingredients of fried rice with eggs. Each ingredient from each menu was then calculated in grams and entered into the Nutrisurvey application. The consumption data analysis was conducted using the Nutrisurvey for Windows 2007 application, which provides a comprehensive list of food ingredients in Indonesia and detailed information on their nutritional values and composition. Nutrisurvey's comprehensive list of food ingredients may not encompass all possible foods. However, if certain items were included, they were carefully added based on the composition as stated on the food labels.

Furthermore, should any food ingredients not be included in the Nutrisurvey list, suitable substitutes were determined by comparing their closeness to the existing ingredients. The study successfully summarised the daily nutrient values into micronutrient consumption data, which was then saved in Microsoft Excel. The acquired data were classified into three distinct categories: inadequate, if they fulfilled less than 70% of the recommended nutrient requirements for the Indonesian population; satisfactory, if they fulfilled 70-90% of the recommended nutrient requirements for the Indonesian population; and abundant, if they fulfilled more than 90% of the recommended nutrient requirements for the Indonesian population. The phases of data processing included editing, coding, cleaning, and processing.

Data analysis

The Food Ingredients Composition List and Nutrisurvey software were used to analyse nutrient consumption data to determine the average daily intakes of energy, carbohydrates, protein, fat, calcium, iron, zinc, vitamin C, vitamin D, vitamin B12, folic acid, and magnesium. Data on age, gender, BMI, education, perceived income adequacy, vegetarian status, length of vegetarianism, type of vegetarianism, reasons for choosing vegetarianism, and micronutrient intakes were analysed univariately in the form of frequency distribution. At the same time, the macronutrient intakes of respondents were analysed univariately in the form of mean, standard deviation (SD), and percentage. Analysis of differences in age, gender, BMI, macronutrient and micronutrient intakes in vegetarian and non-vegetarian groups was carried out by chi-square test analysis. A p-value ≤ 0.05 was used to determine statistical significance for all analyses performed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corporation, Armonk, NY, USA).

RESULTS

Table 2 presents the characteristics of respondents in the vegetarian and non-vegetarian groups. Most vegetarians were 24-25 years old (28.7%), while non-vegetarians were predominantly 22-23 years old (33.7%). In both vegetarian and non-vegetarian groups, most of the respondents were females. The majority of vegetarians had normal BMI (57.5%), while non-vegetarians mainly had overweight BMI (40%).

Most participants (60.0%) in the vegetarian group had been a vegetarian for more than three years, as shown in Table 2. In this study, we found that 45.0% of vegetarian respondents were lacto-ovo vegetarians, vegetarians who

Table 2. Characteristics of respondents

Respondent characteristics	*Vegetarians*		*Non-vegetarians*	
	n	*%*	*n*	*%*
Age (years)				
18	21	26.3	15	18.7
19-21	15	18.7	21	26.3
22-23	21	26.3	27	33.7
24-25	23	28.7	17	21.3
Gender				
Male	33	41.3	39	48.7
Female	47	58.7	41	51.3
Body mass index (kg/m^2)				
Underweight	12	15.0	9	11.3
Normal weight	46	57.5	24	30.0
Overweight	13	16.2	32	40.0
Obesity grade I	5	6.3	8	10.0
Obesity grade II	4	5.0	7	8.7
Education completed				
High school or lower	21	26.3	15	18.7
Trade school/college (partial or complete)	31	38.7	25	31.3
University (partial or complete)	28	35.0	40	50.0
Perceived income adequacy				
Low	8	10.0	2	2.5
Neither low nor high	24	30.0	37	46.3
High	42	52.5	35	43.7
Very high	6	7.5	6	7.5
Vegetarian status	80	50.0	80	50.0
Duration of vegetarian/vegan diet (year)				
≤3	32	40.0		
>3	48	60.0		
Type of Vegetarian				
Vegan	17	21.3		
Lacto-vegetarian	27	33.7		
Lacto-ovo-vegetarian	36	45.0		
Reason for following a vegetarian diet				
Weight loss	16	20.0		
Vegetarian diet is healthier	15	18.7		
Not like eat meat	5	6.3		
Spiritual reasons	29	36.3		
My family is following a vegetarian diet	11	13.7		
Other	4	5.0		

avoided meat, fish, and poultry, while only consuming milk and eggs. Since lacto-ovo vegetarianism is often the initial step for many people transitioning to a vegetarian lifestyle, it is relatively easy to find individuals who follow this dietary pattern. Religion (36.3%) and the need to lose weight (20.0%) were the main reasons for individuals adopting vegetarianism.

Table 3 displays the average macronutrient consumption among

the vegan, lacto-vegetarian, lacto-ovo vegetarian, and non-vegetarian groups. According to the table, it was evident that the lacto-vegetarian group had the most excellent mean energy intake at 1827 kcal, followed closely by the lacto-ovo vegetarian group at 1800 kcal, and the vegan group at 1576 kcal. The mean values for protein, carbohydrate, and fat varied throughout the vegetarian groups, with the lacto-ovo vegetarian group achieving the highest means of 58.3 g, 340.9 g, and 61.8 g, respectively. Non-vegetarians had higher energy, protein, carbohydrate, and fat intakes than vegetarians.

Table 4 shows that the proportions of vegetarians who had low, moderate or high intakes of energy, protein, and fat intakes were significantly different from the proportions of non-vegetarians, while, consumption of carbohydrates did not differ significantly. Consumption of calcium, zinc, vitamin C, vitamin D, vitamin B12, folic acid, and magnesium between the vegetarian and non-vegetarian groups were not significantly different. Based on the findings, there were no significant differences in micronutrient intakes, except for iron.

DISCUSSION

Gender and dietary choices showed no significant differences in this study. Vegetarianism is often practised for religious and health reasons. The majority of the population in Denpasar is Hindu. Therefore, religious considerations are the main driver for becoming vegetarian. The health hazards of excessive meat intake, such as metabolic or cardiovascular diseases, have increased awareness of the need to reduce meat consumption. Moreover, most of the respondents in this study were women who tended to focus more on eating habits, physical appearance, and weight loss (Azhar *et al.,* 2023).

Table 3. Mean macronutrient intakes among vegans, lacto-vegetarians, lacto-ovo vegetarians, and non-vegetarians

Respondent characteristics	*Vegans (n=17)*			*Lactovegetarians (n=27)*			*Lacto-ovo vegetarians (n=36)*			*Vegetarians (n=80)*			*Non-vegetarians (n=80)*		
	Min	*Max*	*Mean±SD*	*Min*	*Min*	*Min*	*Min*	*Max*	*Mean±SD*	*Min*	*Max*	*Mean±SD*	*Min*	*Max*	*Mean±SD*
Energy (kcal)	745	2100	1576±395	745	715	715	715	2660	1800±467	745	2010	1432±306	715	2700	2016±499
Protein (g)	27.5	89.0	50.3±17.4	18.4	21.5	21.5	21.5	92.3	58.3±15.2	18.4	92.3	54.5±17.4	21.5	103.0	62.9±19.6
Carbohydrate (g)	152.0	490.0	334.7±82.6	116.0	137.0	137.0	137.0	500.0	340.9±76.3	116.0	500.0	324.6±82.2	137.0	578.0	328.2±83.3
Fat (g)	18.5	88.5	56.3±21.9	18.5	20.5	20.5	20.5	95.0	61.8±18.2	18.5	95.0	56.3±19.9	20.5	97.5	69.9±21.9

Table 4. Comparison of energy and nutrient intakes between vegetarians and non-vegetarians

Respondent characteristics	*Vegetarians*		*Non-Vegetarians*		*p-value*
	n	*%*	*n*	*%*	
Energy					0.012*
Low	14	17.5	12	15.0	
Moderate	39	48.7	23	28.7	
High	27	33.8	45	56.3	
Protein					0.044*
Low	14	17.5	11	13.7	
Moderate	46	57.5	34	42.5	
High	20	25.0	35	43.8	
Carbohydrate					0.237
Low	14	17.5	13	16.3	
Moderate	37	46.3	47	58.7	
High	29	36.2	20	25.0	
Fat					0.001*
Low	22	27.5	15	18.7	
Moderate	47	58.7	33	41.3	
High	11	13.8	32	40.0	
Calcium (Ca)					0.585
Low	28	35.0	23	28.8	
Moderate	40	50.0	41	51.2	
High	12	15.0	16	20.0	
Zinc (Zn)					0.266
Low	17	21.2	20	25.0	
Moderate	44	55.0	49	61.2	
High	19	23.8	11	13.8	
Iron (Fe)					0.011*
Low	14	17.5	20	25.0	
Moderate	39	48.7	49	61.2	
High	27	33.8	11	13.8	
Vitamin C					0.195
Low	9	11.3	17	21.3	
Moderate	51	63.7	48	60.0	
High	20	25.0	15	18.7	
Vitamin D					0.227
Low	16	20.0	14	17.5	
Moderate	51	63.7	44	55.0	
High	13	16.3	22	27.5	
Vitamin B12					0.615
Low	16	20.0	12	15.0	
Moderate	46	57.5	46	57.5	
High	18	22.5	22	27.5	
Folic acid					0.846
Low	8	10.0	10	12.5	
Moderate	53	66.3	53	66.3	
High	19	23.7	17	21.2	
Magnesium (Mg)					0.908
Low	14	17.5	12	15.0	
Moderate	49	61.3	50	62.5	
High	17	21.2	18	22.5	

*$p<0.05$

This study found a significant difference in BMI between vegetarians and non-vegetarians. A study in school-aged children between 11 and 14 years showed that vegetarian children had an average 4 kg lower weight than those following an omnivorous diet (Schürmann, Kersting & Alexy, 2017). Vegetarian children were also leaner than omnivorous children, with more pronounced BMI differences during adolescence (Bettinelli *et al.,* 2019). Paslakis *et al.* (2020) claimed that vegetarians and vegans have a lower BMI than their omnivorous counterparts (Paslakis *et al.,* 2020). Other studies have also shown that vegans have a BMI five points lower than non-vegans, while lacto-ovo vegetarians who consume eggs have a BMI three points lower. The higher percentage of overweight non-vegans may be related to their consumption of fish or other animal products (Mariha & Wiarsih, 2019).

Macronutrient intakes

Carbohydrates, fats, and proteins found in different types of food can serve as valuable energy sources. The present investigation revealed a noteworthy disparity in energy consumption between the vegetarian and non-vegetarian cohorts. The results are attributed to disparities in food choices among the two groups. Vegetarians typically consume a greater amount of vegetables and plant-based foods that boast a higher fibre content and lower energy content. Foods made from animal products typically contain a greater amount of fat, which in turn leads to a higher energy content (Akther, 2016). The meal choices made by individuals play a significant role in the variation of total energy scores observed between vegetarians and non-vegetarians (Hargreaves *et al.,* 2020).

Carbohydrate intake in the vegetarian group was comparable to that of non-vegetarians in this study. This result arises from the need for more variation in the choice of carbohydrate-rich diets. The average daily carbohydrate intake did not significantly vary among the vegan, lacto-vegetarian, lacto-ovo vegetarian, and non-vegetarian groups. Rice was the primary source of carbohydrates for all participants. Furthermore, Balinese individuals frequently arrange various carbohydrates, such as maize, cassava, and tubers, to accompany rice. The absence of differences in carbohydrate intake can be attributed to the adolescent age since adolescents, particularly young women, tend to be mindful of their carbohydrate intake to manage their body weight (Azhar *et al.,* 2023).

Soybeans and their diverse preparations, including tofu, tempeh, beans, and mixed vegetables like cabbage and carrots, are exceptional protein sources for anyone following a vegetarian diet. The present investigation revealed a notable disparity in protein consumption between the vegetarian and non-vegetarian cohorts. The non-vegetarian group had the highest mean protein consumption, followed by the lacto-ovo vegetarian group and the lacto-vegetarian group; the lowest mean was observed in the vegan group. These observed outcomes can be attributed to the protein intakes of the lacto-ovo vegetarian and lacto-ovo vegetarian groups, which exhibited greater diversity by including eggs, milk, and processed items like cakes in contrast to the vegan group. For non-vegetarians, the primary source of protein is animal protein, such as meat and fish, which boasts a higher protein level than vegetable protein (Bakaloudi *et al.,* 2021; Hargreaves *et al.,* 2020; Segovia-Siapco *et al.,* 2019).

The variants in protein consumption between vegans and lacto-ovo vegetarians are still apparent. In the Adventist Health Study 2 (AHS-2), protein intake of lacto-ovo vegetarians and vegans

closely resembled that of fish eaters, semi-vegetarians, and non-vegetarians. The results can also be ascribed to the comparatively modest meat intake and predominant dependence on plant-based protein sources within the non-vegetarian Adventist population (Rizzo *et al.,* 2013). The EPIC-Oxford study conclusively found that the average protein intake for vegans and lacto-ovo vegetarians were 70 g and 64 g, respectively, with no notable disparities (Sobiecki *et al.,* 2016). The previous study revealed no discernible disparities in protein consumption between the lacto-ovo vegetarian and vegan groups (p>0.05) (Nebl *et al.*, 2019).

Carbohydrates and protein have significantly lower energy density than fat, with fat containing around 2.25 times more energy per unit of weight. Non-vegetarians were found to have a greater mean fat intake compared to vegetarians. These findings pertain to non-vegetarians choosing animal-based diets with greater fat content than plant-based fat sources. The choice of food sources containing high fat was relatively low in the vegetarian group. However, lacto-vegetarians and lacto-ovo vegetarians can still fulfil their fat requirements by consuming eggs, dairy products, and processed foods like cakes and ice cream. Vegans may potentially have omega-3 fatty acid eicosapentaenoic acid (EPA) inadequacy. However, lacto-ovo and lacto-vegetarians typically ingest an adequate amount of essential fatty acids (Vitale & Hueglin, 2021). Thus, a well-planned vegetarian diet should be followed to fulfil appropriate macronutrient requirements.

This study found that some respondents in the vegetarian group had low macronutrient intakes. This condition may be related to them limiting their food intake through a vegetarian diet to lose weight, which was found in 20.0% of vegetarian respondents. Low nutritional intake may be related to the age of the respondents who belonged to the late adolescent group, where at this age, they tend to be very concerned about their appearance, including weight. The results of this study also showed that some respondents in the vegetarian and non-vegetarian groups had high macronutrient intakes. When viewed from the menu selection in the vegetarian group, it was found that there was a gluten-based food menu, where gluten has high calories. Similarly, the high selection of carbohydrates contributed to the high calorie intake in the non-vegetarian group. Thus, the selection of food ingredients tailored to each individual's needs is needed.

Micronutrient intakes

Calcium intake of vegetarians and non-vegetarians in this study showed no significant difference. This outcome could be attributed to the fact that most of the vegetarian participants in this study followed lacto-vegetarian and lacto-ovo vegetarian diets. Vegetarians who abstain from consuming animal meat but still use dairy, eggs, and other animal products in their diet are referred to as lacto-ovo vegetarians. Lacto-vegetarians eliminate eggs from their diet but consume dairy products, while ovo-vegetarians avoid dairy but consume eggs. A vegan diet strictly eliminates any foods originating from animals. Lacto-vegetarians and lacto-ovo vegetarians still consume milk, but only if it is obtained without causing harm to animals and if the milking process is done manually, without using machines. Cow's milk is a proven source of calcium and phosphorus. It also contains lactose and casein phosphopeptide components, which have been shown to enhance calcium absorption and mineral retention (Schürmann *et al.,* 2017). Certain varieties of tofu possess calcium levels comparable to milk (Bakaloudi *et*

al., 2021). Nevertheless, it is important to acknowledge that oxalates and phytates can greatly diminish calcium absorption in some foods.

The study demonstrated a notable disparity in iron consumption between the vegetarian and non-vegetarian cohorts. This outcome occurred because the vegetarian and non-vegetarian groups had distinct sources of iron-rich diets. Meat, dairy products, cereals, and spices contain substantial iron (Prentice *et al.,* 2017). Nebl *et al.* (2019) found that vegetarian diets typically have higher iron content compared to other diets, based on their research. Vegetarians acquire iron via plant-derived sources, such as spinach, legumes, and grains. Plant-based foods are rich in iron, although it should be noted that the iron in these foods is non-heme iron, which is comparatively less easily absorbed by the digestive system. Moreover, several plant-based diets contain phytates, polyphenols, and fibre that can impede iron absorption.

Food contains two distinct forms of iron: haem iron and non-haem iron. Within animal-derived goods, 40% of the overall iron content is haem iron, whereas the remaining 60% comprises non-haem iron. Plant-based products exclusively include non-haem iron. Vegetarians will adjust to decreased iron intake by reducing the faecal ferritin they excrete. Both haem iron and non-haem iron are absorbed in the small intestine. However, they utilise distinct processes for absorption. Haem iron is absorbed through the intestinal wall, irrespective of the required amount. In contrast, non-haem iron absorption is more tightly regulated, as it is readily absorbed when the body requires iron. This serves as a protective mechanism against iron excess (Saunders *et al.,* 2012).

Vegetarian and vegan diets provided equal or higher amounts of iron than non-vegetarian diets in this study. Vegetarians typically consume more significant amounts of iron because most foods they eat are rich in iron. Nevertheless, vegetarians may exhibit lower serum ferritin levels while consuming adequate amounts of iron due to variations in absorption capacity between haem and non-haem irons. It is important to note that these lower levels still fall within the normal range. Vegetarians can mitigate the risk of low iron levels by incorporating foods abundant in enhancers, such as vitamin C and organic acids (including citric, malic, and lactic acids), into their diet (Saunders *et al.,* 2012).

The European Prospective Investigation into Cancer and Nutrition (EPIC)-Oxford research, which included 43,000 women, found that vegetarians and non-vegetarians had comparable iron intakes and haemoglobin concentrations (Davey *et al.,* 2003). Multiple studies conducted in Western societies indicated minimal or no disparity in iron levels (measured by haemoglobin levels, haematocrit, total iron binding capacity, transferrin saturation, and serum iron levels) between vegetarians and non-vegetarians. However, several studies suggested that vegetarians may be more susceptible to insufficient iron stores (Saunders *et al.,* 2012).

The study revealed no disparity in vitamin C consumption between vegetarian and non-vegetarian participants. The non-vegetarian participants in this study ingested enough quantities of vegetables and fruits, resulting in no disparity for vitamin C intake. A balanced diet is an effective method for vegetarians and non-vegetarians to ensure enough micronutrient consumption per the body's requirements. Vitamin C concentration of food is additionally affected by storage and processing techniques (Schüpbach *et al.,* 2017).

Thus, one must consider the choice of food ingredients, as well as the storage and processing procedures.

Our research revealed no disparity in zinc consumption between the vegetarian and non-vegetarian cohorts, despite several prior studies suggesting a potential risk of zinc insufficiency among vegans. Meat, dairy products, eggs, and plant foods like nuts and seeds are rich in zinc. Nonetheless, plant-based meals rich in zinc also possess phytates, which can impede zinc absorption in the gastrointestinal tract. The content of phytate can be decreased through many approaches applied to grains, including soaking, germination, fermentation, enzymatic intervention, or genetic alteration. Zinc has a crucial role in regulating the immune system and facilitating the function of several enzymes. Insufficient zinc intake may be linked to dermatitis, diarrhoea, and baldness (Bakaloudi *et al.,* 2021).

Vegetarians who abstain from animal protein may face the risk of insufficient consumption of vitamins D and B12. Notable food sources abundant in vitamin B12 comprise beef, dairy, eggs, fish, and shellfish. Vitamin B12 in vegetarians, particularly vegans, is solely derived from plant-based proteins such as fortified tofu and tempeh. Nonetheless, lacto-vegetarians and lacto-ovo vegetarians can acquire it through animal-derived foods such as dairy products and eggs. It is a well-established fact that animal meals contain higher levels of vitamin D compared to plant foods, as supported by multiple studies (Watanabe, 2007; Watson, Lee & Garcia-Casal, 2018; Zeuschner *et al.,* 2013). This study revealed no notable disparity in vitamin D intake between the vegetarian and non-vegetarian cohorts.

Plant-based diets and raw grains contain more magnesium than omnivorous diets, which contain meat and dairy items (Blaurock *et al.,* 2021). Nevertheless, the absorption of magnesium may be influenced by oxalates and phytates, leading to a decrease in magnesium absorption (Schüpbach *et al.,* 2017). Oxalates are commonly found in fruits and vegetables like spinach, sweet potatoes, peanuts, avocados, and oranges. However, phytates can be found in grains, vegetables, and egg yolks. There was no notable disparity in folic acid consumption between vegetarians and non-vegetarians. These findings demonstrated the significance of maintaining a balanced diet by selecting appropriate foods and ensuring sufficient intake of macronutrients and micronutrients, irrespective of whether an individual adheres to a vegetarian or non-vegetarian dietary pattern.

CONCLUSION

In conclusion, our study demonstrated no differences in carbohydrate intake between vegetarian and non-vegetarian groups. Due to the vegetarian group's abstinence from animal-based meals, which are unquestionably higher in calories, protein, and fat, disparities were observed in their consumption of fat and protein. Micronutrients like calcium, zinc, vitamin C, vitamin D, vitamin B12, and magnesium were not found to differ; only iron intake showed a significant difference. Therefore, nutritional deficits can be prevented by carefully managing vegetarian diets. The present study has yet to investigate the implementation of vegan and vegetarian diets specifically designed to accommodate nutritional requirements. Accordingly, this area of research holds promise as a potentially valuable avenue for future exploration, particularly in addressing obesity in patients.

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Authors' contributions

Sumadewi KT, conceived and designed the project, and drafted the manuscript; Witari NPD and Astini DAAA, recruited respondents and collected data; Evayanti LG and Dewi AAAAP, conducted data analysis; Kerans FFA, revised the draft manuscript. The authors agreed with the manuscript and declare that the content has not been published elsewhere.

Conflict of interest

The authors declare that they have no competing interests in the research, writing, or publication of this paper.

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