

## Short Communication

# Body composition and nutrient intake of Buddhist vegetarians

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We described the body composition and nutrient intake of Buddhist vegetarians and compared the data with that of omnivores in South Korea. Vegetarian subjects were 54 Buddhist nuns, who adhered to a vegetarian diet in accordance with Buddhist teachings. We compared these findings with a group of 31 omnivore Catholic nuns who shared a similar lifestyle but different dietary pattern than those of the Buddhist nuns. All subjects completed the estimated three-day dietary record. Body composition was determined by a segmental multi-frequency-bioelectrical impedance analysis method. No height difference between the dietary groups existed but the vegetarians had a significantly higher body weight, fat free mass, body fat and body mass index (BMI, kg/m<sup>2</sup>) than the omnivores. The median BMI of both vegetarians and omnivores fell in the normal range (22.6 vs. 20.7 kg/m<sup>2</sup>). In vegetarians, body fat was inversely correlated with the duration of vegetarianism ( $p$  for trend = 0.043). The long duration group of the vegetarians had lower body fat than the short duration group (12.1 vs. 15.0 kg,  $p$  = 0.032). The status of the nutrient intake of Korean Buddhist vegetarians was comparable to that of omnivores, and the intake of some nutrients in vegetarians was more favorable than in the omnivores.

**Key Words:** vegetarian, duration of vegetarianism, body fat, BMI, nutrient intake

## INTRODUCTION

Western vegetarians have been widely studied.<sup>1,2</sup> Religious groups (e.g. Seventh Day Adventists) in US-studies<sup>3-5</sup> and nonreligious groups (e.g. health food shop users, members of vegetarian society) in Europe<sup>6-8</sup> have been predominantly investigated. In comparison, the nutritional status of vegetarians in East Asia has not been widely studied.

The Western vegetarian diet differs significantly from the typical Western diet which is characterized by a high intake of meat and total fat, especially saturated fatty acids or cholesterol, and a low intake of vegetables and fiber, vitamin C or folate. This dietary pattern is considered one of the most important dietary risk factors for obesity and other diseases. In contrast, the typical Asian diet is based mostly on grains and plant foods, and is similar to the Asian vegetarian diet. Therefore, the differences in dietary patterns between Asian vegetarians and omnivores are not as prominent as those found between individuals with the typical Western diets and Western vegetarians. In view of this fact, we predict that our study may reveal different results from Western vegetarian studies.

We described the body composition and nutrient intake of Buddhist vegetarians and compared these results with omnivores in South Korea.

The diet of Koreans is primarily based on food from plant origins. According to "The Korean National Health & Nutrition Examination Survey",<sup>9</sup> the average consumption of food from plant sources by Koreans amounts to 80 %. Current official statistics on Korean vegetarians are not available, but the Korean Vegetarian Union<sup>10</sup> has estimated that vegetarians account for less than 1% of the population, with increasing interest in vegetarianism.

Buddhist nuns and monks represent the oldest and the most traditional vegetarian group in Korea. Therefore, the increasing interest in the nutritional aspects of the vegetarian diet is specifically focused on the Buddhist vegetarian diet. They mainly eat "Temple food": originally cooked vegan and occasionally with the addition of dairy products. In general, the Korean Buddhist diet is characterized by avoidance of:<sup>11</sup> 1) food of animal origin, except milk products, 2) five pungent vegetables (O Shin Tschae): garlic (*allium sativum*), welsh onion (*allium fistulosum*), wild garlic (*allium monanthum*), garlic chives (*allium tuberosum*), and asant (*ferula asafoetida*), 3) alcohol and 4) high amounts of processed food.

## MATERIALS AND METHODS

A total of 178 subjects (97 vegetarians and 81 omnivores) voluntarily participated between October 2002 and March 2003. All subjects were women and residing in Daegu and Gyeongbuk Provinces of South Korea. Vegetarian subjects were Buddhist nuns who adhered to a vegetarian diet based on Buddhist teachings. The omnivore group consisted of 41 Catholic nuns and 40 college students and laboratory technicians. Of these subjects, only Catholic nuns were enrolled for this study because their lifestyle

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was similar and the dietary pattern different from that of the Buddhist nuns.

The inclusion criteria were: 1) apparently healthy, without physician-diagnosed diseases, and no medication intake, 2) no dietary supplement use (e.g. mineral and vitamin supplement or health functional foods) for the last six months 3) The subjects who completed three-day dietary record.

According to these criteria, 54 vegetarian Buddhist nuns aged 21-44 years and 31 omnivores Catholic nuns aged 22-41 years were included. They attended classes, in particular: a 4 year-college course for Buddhist nuns and a vocational training program for Catholic nuns. They belonged to a way of life with communal living in a temple or in a convent.

This study was approved by the Ethics Committee of Justus-Liebig University Giessen in Germany and all participants gave written and informed consent to participate.

#### **Anthropometric and body composition measurements using segmental multi-frequency-bioelectrical impedance analysis (SM-BIA)**

Height was measured to the nearest 0.1 cm and body weight to the nearest 0.1 kg using a digital scale integrated BIA. Body mass index (BMI) was calculated as body weight in kilogram divided by the square of height in meters ( $\text{kg}/\text{m}^2$ ).

Body composition was determined by a segmental multi-frequency-bioelectrical impedance analysis (SM-BIA) method (InBody 3.0, Biospace Co. Ltd, Korea). In contrast to single frequency, whole body measurement, which assumed the body as a single cylinder, SM-BIA assumes the body is five cylinders (arms, legs, and trunk) and measures with an 8-point tactile electrode at frequencies of 5, 25, 250, 500 kHz. Using the multi-frequency analysis, intracellular water and extracellular water currents are measured separately. The precision and accuracy of the device were validated by other studies.<sup>12-14</sup> After overnight fasting, the body compositions of the subjects were measured as the subject stood on the foot electrodes (left, right anterior and posterior) and grasping the hand electrodes (left, right thumb and palm). Height and age were entered in the BIA software, while body weight, body mass index (BMI,  $\text{kg}/\text{m}^2$ ), fat free mass and body fat were measured and calculated by the BIA software.

#### **Dietary Assessment**

The subjects were informed about portion sizes with food models and photographs of food<sup>15</sup> and were instructed to

complete the estimated dietary record using household measures. The estimated amount and the main ingredients of foods eaten were recorded by participants themselves for three consecutive days. In addition, the nuns in charge of cooking were asked to document the recipes of the vegetarian dishes. Based on this information (food records and recipes of the vegetarian meals), standardized recipes<sup>16</sup> were adapted and entered into the nutritional program. Can-Pro 2.0 (Computer Aided Nutritional Analysis Program version 2.0, The Korean Nutrition Society, 2002, Seoul) was used for analysis of dietary data.

#### **Statistical Analysis**

Statistical analysis was performed using SPSS for Windows (version 12.0.1). Initially after the normal distribution test (Kolmogorov-Smirnov test and Shapiro-Wilk test), normally distributed data were tested by Student's *t* test, whereas non-normally distributed data were analyzed by the Mann-Whitney U test and Spearman's rank-order correlation coefficient. The Jonckheere-Terpstra test assessed trend analysis for duration of vegetarianism and body fat. A *p* value of < 0.05 was considered statistically significant.

#### **RESULTS**

The characteristic of the study population is presented in Table 1. The mean age of the vegetarian and omnivore groups was 30.4 and 31.4 years, respectively. The duration of vegetarianism ranged from 3 to 34 years (median [interquartile range], 6.5 [4-13]). There was no difference in terms of height between the dietary groups, but the vegetarians had a significantly higher body weight, fat free mass, body fat and BMI compared with the omnivores. The median BMI of both vegetarians and omnivores fell in the normal range<sup>17</sup> (22.6 vs. 20.7  $\text{kg}/\text{m}^2$ ).

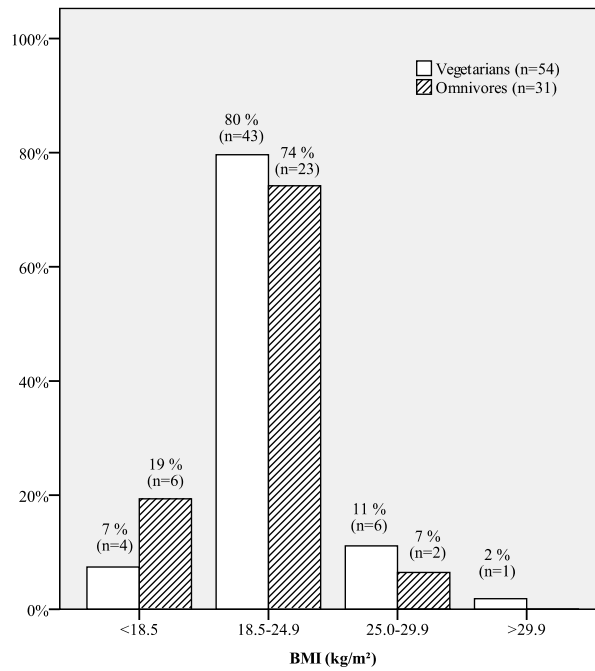
BMI was classified in accordance with the WHO-Criteria.<sup>17</sup> As shown in Figure 1, 80% of vegetarians and 74% of omnivores were in the normal range (18.5-24.9  $\text{kg}/\text{m}^2$ ). The prevalence of underweight (BMI < 18.5  $\text{kg}/\text{m}^2$ ) cases in the omnivore group was higher than in the vegetarian group, while the vegetarians showed tendencies of pre-obesity (25.0-29.9  $\text{kg}/\text{m}^2$ ). None of the omnivores and one vegetarian fell into the classification of grade I obesity (30.0-34.9  $\text{kg}/\text{m}^2$ ).

In vegetarians, body fat was correlated not with age (*p* = 0.854), but with duration of vegetarianism, although duration of vegetarianism had a positive correlation with age (spearman's coefficient  $\rho$  = 0.326, *p* = 0.016).

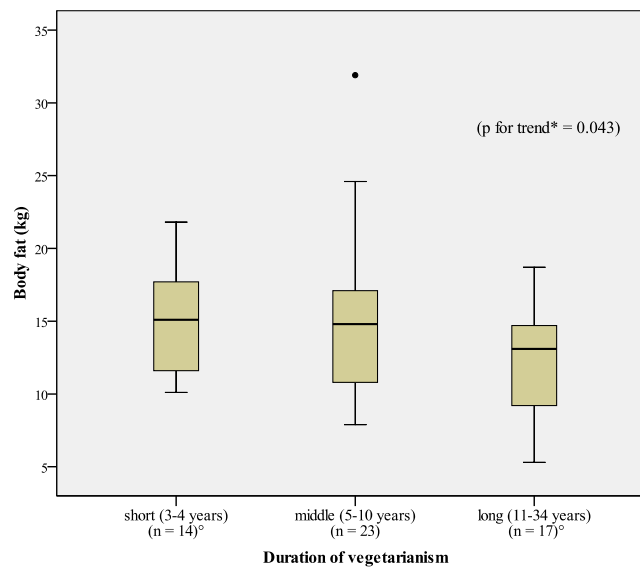
**Table 1.** Characteristic of the study population

	Vegetarians (n = 54)	Omnivores (n = 31)	<i>p</i> value
Age (y)	30.4 (5.98)	31.4 (4.08)	0.383 <sup>†</sup>
Duration of vegetarianism (y)	6.5 [4.0-13.0]	-	
Height (cm)	160.0 [158.8-164.0]	160.0 [156.0-162.0]	0.170
Weight (kg)	57.6 [54.5-61.9]	53.5 [48.5-60.8]	0.016
Fat free mass (kg)	44.5 (3.75)	41.8 (5.10)	0.013 <sup>†</sup>
Body fat (kg)	13.8 [10.8-16.4]	11.7 [8.5-15.3]	0.037
BMI ( $\text{kg}/\text{m}^2$ )	22.6 [20.5-24.1]	20.7 [18.9-22.2]	0.010

Normally and non-normally distributed data are presented as mean (SD) and median [1. - 3. inter-quartile], respectively. <sup>†</sup> *t* test, No super-script Mann-Whitney U test.



**Figure 1.** BMI-Classification according to WHO-Criteria (BMI in kg/m<sup>2</sup>)



**Figure 2.** Body fat (kg) of vegetarians by the duration of vegetarianism. \*Jonckheere-Terpstra test, °t test ( $p = 0.032$ )

According to the length of adherence to the vegetarian diet, the vegetarians were divided into three subgroups: 3-4 years as short ( $n = 14$ ), 5-10 years as middle ( $n = 23$ ), and 11-34 years as long ( $n = 17$ ). The body fat of these groups is depicted in Figure 2. The Jonckheere-Terpstra test showed that the body fat of vegetarians tended to decrease with the duration of vegetarianism ( $p = 0.043$ ). In addition, the long-term vegetarian group had a lower body fat than the short-term group (12.1 vs. 15.0 kg,  $t$  test,  $p = 0.032$ ). But there was no significant difference in BMI, body weight, and fat free mass between the short- and long-term groups.

Nutrient intake from the three-day dietary records is presented in Table 2. Intake of total energy, energy from

protein, total protein and total fat did not differ between the dietary groups. The vegetarians consumed more energy from fat. On the other hand, the omnivore group had higher intake of both carbohydrates and energy from carbohydrates. Nevertheless, the vegetarians ingested more crude fiber. As expected, the omnivores had significant higher intakes of all nutrients from animal origin (e.g. animal protein, animal fat, cholesterol, animal calcium, animal iron) than the vegetarians. But the intake of some nutrients from plant origin, such as plant fat, vitamin E and plant iron did not differ between the dietary groups. In addition, there were no differences in terms of intake of: vitamin B<sub>1</sub>, vitamin B<sub>2</sub>, total calcium and total iron. The vegetarians had a significantly higher intake of vita-

**Table 2.** Nutrient intake from three-day dietary records

	Vegetarians (n = 54)		Omnivores (n = 31)		<i>p</i> value
Energy (kcal)	1756.2	[1371.2-2020.7]	1866.7	[1627.7-2103.0]	0.075
Protein, in % kcal	11.7	[11.1-12.8]	11.5	[10.7-15.7]	0.371
Carbohydrates, in % kcal	72.8	[67.5-75.8]	75.3	[72.5-77.4]	0.047
Fat, in % kcal	15.6	[12.3-19.8]	13.0	[12.0-15.2]	0.049
Total protein (g)	51.3	[39.6-64.0]	56.4	[46.3-61.7]	0.165
plant protein (g)	48.1	(12.47)	42.6	(7.88)	0.015 <sup>t</sup>
animal protein (g)	2.5	[0.3-5.2]	11.3	[9.9-14.6]	0.000
Carbohydrates (g)	312.9	[252.6-371.9]	355.5	[306.4-383.7]	0.014
Crude fiber (g)	9.3	[7.1-11.4]	7.6	[6.6-8.9]	0.011
Total fat (g)	30.2	[21.9-40.3]	28.7	[24.2-36.5]	0.906
plant fat (g)	27.0	[19.7-36.1]	23.4	[18.4-27.5]	0.089
animal fat (g)	2.3	[0.1-6.8]	5.2	[3.4-8.8]	0.004
Cholesterol (mg)	10.8	[3.4-29.8]	70.0	[56.7-117.4]	0.000
Vitamin A (mg RE <sup>*</sup> )	0.63	[0.48-0.84]	0.55	[0.46-0.64]	0.018
β-carotene (mg)	3.61	[2.83-4.76]	3.02	[2.67-3.65]	0.030
Vitamin E (α-TE <sup>§</sup> )	12.4	(4.61)	11.1	(2.92)	0.094 <sup>t</sup>
Niacin (mg)	13.9	(3.84)	11.8	(2.01)	0.001 <sup>t</sup>
Vitamin B <sub>1</sub> (mg)	1.1	(0.34)	1.2	(0.25)	0.138 <sup>t</sup>
Vitamin B <sub>2</sub> (mg)	0.9	(0.27)	0.8	(0.15)	0.099 <sup>t</sup>
Vitamin B <sub>6</sub> (mg)	2.1	(0.53)	1.9	(0.33)	0.005 <sup>t</sup>
Total calcium (mg)	524.1	[426.6-695.0]	519.0	[457.2-595.1]	0.956
plant calcium (mg)	449.8	(130.62)	361.2	(70.44)	0.000 <sup>t</sup>
animal calcium (mg)	69.8	[8.3-149.9]	153.6	[140.9-205.9]	0.000
Total iron (mg)	14.1	[10.9-17.3]	15.2	[12.4-21.6]	0.059
plant iron (mg)	13.9	[10.7-17.1]	14.0	[10.7-20.3]	0.338
animal iron (mg)	0.1	[0.0-0.3]	2.0	[0.8-1.3]	0.000

Normally and non-normally distributed data are presented as mean (SD) and median [1. - 3. inter-quartile], respectively. <sup>t</sup> *t* test, No super-script Mann-Whitney U test, <sup>\*</sup>RE Retinol Equivalent, <sup>§</sup>α-TE α-Tocopherol Equivalent.

min A, β-carotene, niacin, vitamin B<sub>6</sub> and plant calcium than the omnivores.

The median percentage of animal protein intake from total protein was 21.6 % in omnivores and 3.9 % in vegetarians. The median percent of energy intake from food of animal origin was 2.1 % in vegetarians and 5.0 % in omnivores.

## DISCUSSION

Unlike many of the other Western vegetarian studies, the Buddhist vegetarians in this study had higher body fat and BMI, as well as higher fat free mass than the omnivore group. But this was consistent with other Korean Buddhist vegetarian studies.<sup>18,19</sup> Korean Seventh Day Adventist and Chinese vegetarian studies often showed no difference in BMI between vegetarians and omnivores, especially in age matched female groups.<sup>20-28</sup> On the other hand, the vegetarians, especially the vegans in the Western studies have significantly lower BMI than the omnivores.<sup>29,30</sup> This difference is obvious, when the omnivore group is obese. Moreover, Korean omnivores were found with a much lower BMI than Western omnivores. In spite of a tendency for overweight in Buddhist vegetarians, the median BMI of the vegetarians (22.6 kg/m<sup>2</sup>) was still within the normal range and comparable with that of European vegetarians of the similar age, and even lower than that of US vegetarians.<sup>29,31,32</sup>

Interestingly, in Buddhist vegetarians body fat tended to decrease with the duration of vegetarianism. The long-term vegetarian group had lower body fat than the short-term group. But fat free mass and BMI was not correlated with length of adherence to the vegetarian diet. Similarly,

the German Vegan Study<sup>33</sup> showed that there was no significant difference in the BMI between strict and moderate vegans, however, the strict vegans had a significant lower body fat mass than the moderate vegans.

Dietary patterns of vegetarians are so diverse that it is not easy to categorize the type of vegetarians according to this term alone.<sup>1,34,35</sup> More than twenty years ago, Korean Buddhist nuns and monks were vegans.<sup>36,37</sup> The modern Korean Buddhist nuns and monks still follow a vegan diet, however, occasionally they consume milk, yoghurt, cheese or breads, cookies and cakes which often contain eggs or butter.<sup>38-41</sup> These Western snacks are the main source of cholesterol and animal fat in the Buddhist vegetarian diet. The type of snacks and the frequency of their consumption varied, because most of them were irregularly donated by Buddhist followers. Therefore, in our study, it was difficult to estimate their usual intake of cholesterol or animal fat. Total energy intake was also strongly influenced by the consumption of these snacks, containing relatively high amounts of fat and sugar, because "Temple Food", according to the Korean traditional cooking, consists mainly of a low fat and low sugar diet.<sup>38,41</sup> Korea belongs to the group of countries with low milk consumption.<sup>42</sup> The Buddhist nuns can be defined as lacto-vegetarians, however the amount of foods from animal sources they consume is comparable with that of Western "moderate vegans".<sup>33</sup>

The intake of carbohydrates and fat makes the difference in the nutrient intake between the Western and the Korean diet; Korean vegetarians, as well as omnivores, also have a higher carbohydrate intake and a lower fat intake compared with other Asian vegetarians.<sup>18,25,28,43,44</sup>

Rice and other grains are the basis of the high carbohydrate diet in Korea. Although the consumption of grain products has been declining continuously, the daily average intake of grain products was 306 g and it accounted for 58 % of the total energy intake.<sup>9</sup> Therefore, it is not rare in Korea to find no difference in total carbohydrates intake between vegetarians and omnivores.<sup>21,22,45</sup> In our study, omnivores consumed even more carbohydrates than vegetarians. This was due to high consumption of fruits in the study period. But there were no differences in terms of intake of grain products and sugar products between the dietary groups. Nevertheless, vegetarians consume more crude fiber than omnivores because of their higher consumption of vegetables with low energy density. Both the vegetarian diet and the traditional Asian diet primarily consist of vegetables and grains. Therefore, there are no significant differences in the intake of foods of plant origin such as carbohydrates, vitamin C, vitamin E and PUFA between the vegetarians and the omnivores in this study, as well as in other Asian vegetarian studies.<sup>21,22,26,46</sup>

During the rapid economic development in low-income countries, a dramatic transition and adaptation to the Western dietary habits ("westernization") occurred. Like in other Asian countries, the dietary practices in Korea have rapidly changed; the consumption of animal source food has been increasing. At the same time, efforts at the regional and governmental level not only to keep but also to develop a traditional Korean diet have been established. Therefore, the dietary shift to "westernization" with high fat intake has not changed the Korean diet as drastically as in other Asian countries.<sup>47</sup> The low fat content of Buddhist diets is integral to their cooking method based on the typical Korean cooking style.<sup>38</sup> In a previous study on the Buddhist nuns in the same Buddhist temple in 1981<sup>19</sup> and in 1997,<sup>18</sup> the percentage of energy intake from fat was only 4.9 % and 11.6 %, respectively. As they rarely eat-out or consume processed food, the Buddhist vegetarians maintained a relatively low energy intake from fat. A Korean Seventh Day Adventist (SDA) study showed the nutrient intake of SDA-college students who ate accordingly to a well-planned lacto-ovo-vegetarian diet based on the traditional cooking method. The distribution of energy intake from macronutrients was described as 70% carbohydrates, 16 % protein and 14 % fat.<sup>48</sup> These results are similar to that of the vegetarians and omnivores in our study.

The dietary cholesterol intake of Buddhist vegetarians came mainly from different types of breads, custard cream puffs, castella (sponge cake), muffins, doughnuts, cheese and milk. The mean cholesterol intake was lower than that of Western female vegans.<sup>49-51</sup>

Compared with carbohydrate and fat intake, the difference in protein intake between the Asian and Western population is not large; the protein intake of Buddhist vegetarians was comparable with other Asian vegetarians<sup>18,21,27,28</sup> and Western vegans.<sup>49-51</sup>

Dairy products are a rich source of calcium and are readily available. Achieving adequate calcium intake without supplements depends on the consumption of dairy products. The German Nutrition Survey<sup>52</sup> showed that dairy products accounted for about 50 % of the cal-

cium intake, and bottled water ranked second with 15 %. In the US, dairy products provided about 73 % of the dietary calcium, whereas calcium from vegetables accounted for only 7 %.<sup>53</sup> In contrast, according to the report on the National Health and Nutrition Survey<sup>9</sup> in Korea, foods from animal sources contributed to 41.8% of total calcium intake (dairy products 18.2 %, fish group 20.2 %). Plant foods provided the remaining 58.2 %. Vegetables were the leading source of calcium (27.4 %). In our study the omnivore group had consumed 67.3 % of total calcium and 93.5 % of total iron from plant sources. While plant were the source for 90.4 % of total calcium and 98.9% of total iron for vegetarians. Calcium and iron have showed the highest deficiencies in the Korean diet. Many studies showed that vegetarians have a relatively higher intake of calcium and iron, but this may not indicate optimal nutritional status. Bioavailability of calcium and iron of plant origin are more sensitive to inhibitory and enhanced effects by other components (e.g. vitamin C, phytate, caffeine, protein etc). Therefore, vegetarians should be more concerned about meal composition and bioavailability of such nutrients.

## CONCLUSION

Diets in Asian countries are currently undergoing nutrition transition. Vegetarianism protects the body from the adverse effects of the 'westernization' of diets. Unlike most Western vegetarians documented, Buddhist vegetarians in this study had higher fat free mass, body fat and BMI than omnivores. Body fat was inversely correlated with duration of vegetarianism for the vegetarians. The nutrition status of Korean Buddhist vegetarians was comparable to that of omnivores, and the intake of some nutrients in vegetarians was even more favorable than that of omnivores.

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## AUTHOR DISCLOSURES

The Authors declare that they have no conflict of interest.

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## Short Communication

# Body composition and nutrient intake of Buddhist vegetarians

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## 信奉佛教的素食者之體組成及營養素攝取

我們說明南韓信奉佛教的素食者之體組成及營養素攝取，並與雜食者的數據作比較。有 54 名佛教尼姑的素食者為研究對象，她們依佛教的教條而吃素。另外一組 31 名雜食的天主教修女做比較對象，她們與佛教尼姑有相似的生活型態，卻有不同的飲食模式。所有的受試者完成 3 天的飲食紀錄。以部份多頻率生物電阻法評估體組成。兩組間沒有身高的差異，但是素食者比起雜食者，有顯著較高的體重、非脂肪重、體脂肪及身體質量指數(BMI,  $\text{kg}/\text{m}^2$ )。素食者及雜食者的 BMI 中位數均屬正常範圍 (22.6 及 20.7  $\text{kg}/\text{m}^2$ )。在素食者，體脂肪與吃素的持續時間為負相關( $p$  for trend = 0.043)。長期的吃素者比起吃素時間短的受試者有較低的體脂肪(12.1 vs. 15.0 kg,  $p=0.032$ )。韓國佛教徒的吃素者之營養素攝取狀況與雜食者是可比較的，且某些營養素的攝取比起雜食者更佳。

**關鍵字：**素食者、吃素持續時間、體脂肪、身體質量指數、營養素攝取