

# Metabolic Syndrome is Related to Macronutrient Intake in a Medan Vegetarian Community in North Sumatera Indonesia

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Research Article

## Metabolic Syndrome is Related to Macronutrient Intake in a Medan Vegetarian Community in North Sumatera Indonesia

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Abstract

**Background and Objective:** A vegetarian (vegan, lacto, ovo and lacto ovo) diet characterized by low intake of simple carbohydrates, cholesterol and fat and high intake of fiber can reduce the prevalence of degenerative diseases, particularly those related to metabolic syndrome. Metabolic syndrome is defined as fasting glucose  $>110$  mg dL<sup>-1</sup>, triglyceride  $\geq 150$  mg dL<sup>-1</sup>, cholesterol  $\leq 200$  mg dL<sup>-1</sup>, BMI  $>25$  and waist  $>90$  cm for men and  $>80$  cm for women. This study aimed to determine if metabolic syndrome is related to macronutrient intake in a Medan vegetarian community using an observation method with a cross-sectional design. **Methodology:** The population studied included all members of the vegetarian Maha Vihara Maitreya Medan community whose ages ranged between 30 and 58 years. Data was analyzed using Pearson's correlation. **Results:** The result showed that macro nutrient intake can reduce the rate of metabolic syndrome ( $p < 0.05$ ). **Conclusion:** The vegetarian life style can be implemented to avoid the risk of disease related to diabetes mellitus, arteriosclerosis, coronary heart disease and hypertension.

**Key words:** Metabolic syndrome, macronutrients, vegetarian community, dietary habits, dietary fibers

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**Competing Interest:** The authors have declared that no competing interest exists.

**Data Availability:** All relevant data are within the paper and its supporting information files.

## 1 INTRODUCTION

Changes in acculturation resulting from modernization is exemplified by an increase in technological processes, which has increased the "sedentary" life style (lack of movement) and made food consumption unbalanced. These changes in food intake and activity levels greatly affect metabolism<sup>1</sup>, resulting in an increase in dislipidemia, hypertension, insulin resistance and obesity<sup>2</sup>. The prevalence of metabolic syndrome (Mets) has increased in both prosperous and developing countries. According to Nurjannah and Katrin<sup>3</sup>, metabolic syndrome is defined by fasting glucose levels  $>110 \text{ mg dL}^{-1}$ , waist circumference  $>90 \text{ cm}$  for men and more than  $80 \text{ cm}$  for women, triglyceride levels  $\geq 150 \text{ mg dL}^{-1}$  and cholesterol levels  $\geq 200 \text{ mg dL}^{-1}$ . Research from the United States has shown that the prevalence of metabolic syndrome in adults is approximately 21.8%. The prevalence of the disease increases with age, as the incidence is approximately 10% at twenty years of age and approximately 40% at sixty years of age<sup>4</sup>. Studies in Indonesia have shown that the incidence of metabolic syndrome was approximately 23.7% in Makassar (in 2004) and 28.4% in Jakarta (in 2008), however, in West Sumatra, the incidence was approximately 22.8%, where its prevalence increases with age<sup>5</sup>. Metabolic syndrome in Sumatera was associated with diabetes mellitus (DM) in approximately 1.8% of patients, as well as cardiovascular disease, including coroner heart disease (CHD), stroke, heart failure (in approximately 7.13% of patients), hypertension (in approximately 24.7% of patients) and central obesity (in approximately 30% of patients)<sup>6</sup>. Prevalence of metabolic syndrome will continue to increase and it will have a negative impact on quality of life<sup>7</sup>.

Many types of interventions can be implemented to reduce the risk of metabolic syndrome. For example, adopting a vegetarian life style can help prevent the disease, control body weight and make skins mouth, clean and shiny<sup>8</sup>. A survey conducted by the American Dietetic Association (AADA) in 2006 showed that approximately 4.9 million (2.3%) adults in the United States were vegetarian and approximately 1.4% were vegetarian or vegan, while in Canada, approximately 900 adults were vegetarian. A number of vegetarians have registered in the Indonesia Vegetarian Society (IVS) since it formed in 1998, including approximately 5000 people, in 2000, membership grew to 60,000 people and, in 2010, membership significantly increased to 500,000 people. In 2013, approximately 2000 people in Medan registered in IVS<sup>9</sup>.

Vegetarians typically consume a large amount of cereals, nuts, vegetables, fruits and protein, which is made from gluten to taste more like fish and meat. Food consumed by the

vegetarian community contains high fiber (water soluble and non water soluble), a low index of glycemic, polyunsaturated fatty acids (PUFAs) and bioactives (isoflavone, genistein and quecetin). These substances reduce the risk of developing metabolic syndrome<sup>10</sup>. Studies by Setiyani and Yekti<sup>11</sup> in Surabaya, Semarang and Yogyakarta found that the vegetarian community has lower Levels of cholesterol, glucose, triglycerides and obesity compared to non-vegetarians, however, studies in Bali in Siahaan on Hindu vegetarians found different results<sup>12</sup>.

This study aimed to determine the relationship between macronutrient intake and metabolic syndrome in a vegetarian community in Medan North Sumatera.

## MATERIALS AND METHODS

This study was observational and used a cross-sectional design. Data was collected in the Maha Vihara Complex Residence Cemara Asri Medan for two months (from the beginning of May, 2014 to June, 2014).

**Population, sample and participants:** The population of this study included all 221 vegetarians in the Maha Vihara Complex Perumahan Cemara Asri Medan community. Participants were members of IVS in North Sumatera, were vegetarian for 30-58 years and did not suffer from any painful condition.

**Instrument development and data collection:** Data was collected by 12 enumerators and informed consent was given. Nutrient absorption (energy, carbohydrate, protein, fat and fiber) data were collected. Face-to-face interviews were conducted using an interview method called Food Recall 24 h for 3 days (but not at a stretch). Blood glucose was measured using the GOD-PAP method with the LOT D393 instrument from Biocon Germany. Blood absorption was measured by a health analyst. Blood sample (2cc) was collected and mixed with anticoagulant. Body weight was measured by using the digital scale Camry with an accuracy of 0.01 kg. Height was taken with a microtoice at 0.1 cm. A tape measure was used to measure waist circumference. This study was approved by the research ethics commission in the field of health of faculty of Medical, North Sumatera University registered number: 484/KOMET/FKUSU/2014.

## RESULTS AND DISCUSSION

**Characteristics of the vegetarian community:** Most participants were female (63.70%) between 30 and 39 years of

age (37.2%). Most participants were also vegan (58.8%) and most had been vegetarian for over 6 years. The characteristics of the vegetarian community are shown in Table 1.

**Macronutrient intake (energy, carbohydrate, protein, fat and fiber):** Based on the results of the food recall survey for 24 h and 3 days (not successively), the average intake of macro nutrients are shown in Table 2.

Table 2 shows that the average intake of energy sample was 2111.5 Kcal with the highest intake at 2133.0 Kcal (70.58% as intake). The average absorption of carbohydrates was 334.0 g (59.01% in the good category). The average intake of protein was 66.36 g with the highest intake at 105 g (52.3 g in the good category). The average intake of fat was 68.20 g with the highest intake at 103.2 g (51.15% in the good category). The average intake of fiber was 30.82 g with the highest intake at 32.47 g (79.42% as higher intake). Most of the nutrients consumed in the vegetarian community belonged in the good category (<80-100% from AKG Indonesia, 2013).

**Components of metabolic syndrome (blood glucose, triglycerides, cholesterol, BMI and waist circumference):** Metabolic syndrome is comprised of diseases like diabetes mellitus (DM), Coronary heart disease and hypertension<sup>13</sup>. The average score of metabolic syndrome in the vegetarian community is shown in Table 3.

The average blood glucose was 102.25 mg dL<sup>-1</sup> with the highest at 251 mg dL<sup>-1</sup> (81.37% in the normal category). Triglycerides were 130.31 mg dL<sup>-1</sup> with the highest at 136 mg dL<sup>-1</sup> (58.82% in the normal category). The average cholesterol was 192.15 mg dL<sup>-1</sup> with the highest at 251 mg dL<sup>-1</sup> (63.72% in the normal category). The BMI was 23.99 mg dL<sup>-1</sup> with the highest at 37 mg dL<sup>-1</sup> (58.82% in the normal category) and the average waist circumference was 79.37 mg dL<sup>-1</sup> with the highest at 97 mg dL<sup>-1</sup> (62.74% in the normal category).

About 28.4% of the vegetarian community has metabolic syndrome, 11.7% are vegan and 16.7% are non-vegan (Table 4). Metabolic syndrome is determined if at least 3 criteria are met, including waist circumference (more than 90 cm for men and more than 80 cm for women), fasting glucose levels more than 110 mg dL<sup>-1</sup>, BMI more than 25, cholesterol levels more than 200 mg dL<sup>-1</sup> and triglyceride levels more than 150 mg dL<sup>-1</sup><sup>14</sup>.

**Correlation between macronutrient intake and components of metabolic syndrome in the vegetarian community:**

Macronutrients are nutrients required in large amounts. An imbalance of carbohydrates, protein and fat, as well as a lack of fiber, can result in metabolic syndrome<sup>15</sup>. The correlation between macronutrients and metabolic syndrome is shown in Table 5.

Table 1: Characteristics of vegetarian sample based on gender, age, type of vegetarian lifestyle and duration of vegetarian lifestyle

| Frequency                                      | No. | %     |
|--|-----|-------|
| <b>Gender</b>                                  |     |       |
| Male   | 37  | 36.3  |
| Female   | 65  | 63.7  |
| Total  | 102 | 100.0 |
| <b>Age (year)</b>                              |     |       |
| 30-39  | 38  | 37.2  |
| 40-49  | 30  | 29.4  |
| 50-59  | 34  | 33.4  |
| Total  | 102 | 100.0 |
| <b>Vegetarian classification</b>               |     |       |
| Vegan  | 60  | 58.8  |
| Lacto vegetarian                               | 6   | 5.8   |
| Ovo vegetarian                                 | 4   | 3.9   |
| Lacto ovo vegetarian                           | 32  | 31.5  |
| Total  | 102 | 100.0 |
| <b>Duration of vegetarian lifestyle (year)</b> |     |       |
| <3   | 12  | 11.8  |
| 3-6  | 10  | 9.8   |
| >6   | 80  | 78.4  |
| Total  | 102 | 100.0 |

Table 2: Average Intake of macronutrients (energy, carbohydrate, protein, fat and fiber) in the vegetarian community

| Macronutrient    | Minimum | Maximum | Mean    | n   | Standard deviation |
|------------------|---------|---------|---------|-----|--------------------|
| Energy (Kcal)    | 2090.00 | 2133.00 | 2111.50 | 102 | 109.14             |
| Carbohydrate (g) | 29.17   | 334.00  | 320.40  | 102 | 68.45              |
| Protein (g)      | 32.23   | 105.00  | 66.36   | 102 | 20.70              |
| Fat (g)          | 40.60   | 103.20  | 68.20   | 102 | 16.68              |
| Fiber (g)        | 29.17   | 32.47   | 30.82   | 102 | 8.39               |

Table 3: Average components of metabolic syndrome in vegetarians

| Components of metabolic syndrome           | Minimum | Maximum | Mean   | n   | Standard deviation |
|--|---------|---------|--------|-----|--------------------|
| Blood glucose (mg dL <sup>-1</sup> )       | 62      | 251     | 102.25 | 102 | 37.570             |
| Triglyceride (mg dL <sup>-1</sup> )        | 119     | 136     | 130.31 | 102 | 44.060             |
| Cholesterol (mg dL <sup>-1</sup> )         | 152     | 251     | 192.15 | 102 | 24.584             |
| BMI (mg dL <sup>-1</sup> )                 | 17      | 37      | 23.99  | 102 | 4.398              |
| Waist circumference (mg dL <sup>-1</sup> ) | 60      | 97      | 79.37  | 102 | 7.746              |

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Table 4: Distribution of metabolic syndrome activity based on vegetarian type

| Metabolic syndrome | Jenis vegetarian |      |           |      |
|--------------------|------------------|------|-----------|------|
|                    | Vegan            |      | Non vegan |      |
|                    | No.              | %    | No.       | %    |
| <3                 | 25               | 24.5 | 48        | 47.1 |
| ≥3                 | 17               | 16.7 | 12        | 11.7 |

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Table 5: Correlation between macronutrient intake and metabolic syndrome in the vegetarian community across different measures

| Variable     | Blood glucose       | Triglycerides   | Cholesterol     | BMI            | Waist circumference |
|--------------|---------------------|-----------------|-----------------|----------------|---------------------|
| Energy       | r 0.499<br>p 0.001* | 0.493<br>0.001* | 0.510<br>0.194  | 0.354<br>0.012 | 0.289<br>0.037*     |
| Carbohydrate | r 0.519<br>p 0.001* | 0.570<br>0.003  | 0.115<br>0.249  | 0.183<br>0.066 | 0.123<br>0.220      |
| Protein      | r 0.093<br>p 0.354  | 0.034<br>0.737  | 0.007<br>0.947  | 0.275<br>0.045 | 0.095<br>0.343      |
| Fat          | r 0.043<br>p 0.668  | 0.358<br>0.015* | 0.324<br>0.001* | 0.563<br>0.002 | 0.558<br>0.002*     |
| Fiber        | r 0.510<br>p 0.001* | 0.511<br>0.001* | 0.298<br>0.002* | 0.035<br>0.728 | 0.375<br>0.027*     |

\*Significant, r: Pearson correlation, p: Level of significance 0.05

Table 6: Correlation between macro nutrient intake and metabolic syndrome in the Vegetarian community across different nutrients

| Variable     | Score p | Score r |
|--------------|---------|---------|
| Energy       | 0.001   | 0.485   |
| Carbohydrate | 0.001   | 0.535*  |
| Protein      | 0.021   | 0.327   |
| Fat          | 0.004   | 0.579*  |
| Fiber        | 0.335   | 0.274   |

\*Significant, r: Person correlation, p: Level of significance 0.05

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Table 5 shows that there is a significant correlation between energy intake and blood glucose, triglycerides, BMI and waist circumference (p<0.05). Based on carbohydrate intake, only blood glucose and triglyceride have a strong correlation (p<0.05). Based on protein intake, only BMI that have a medium correlation (p<0.05). Based on fat intake, only triglyceride, cholesterol, BMI and waist circumference have medium and high correlations (p<0.05). Based on fiber intake, only blood glucose, triglyceride, cholesterol and waist circumference have significant high and medium correlations.

Table 6 shows a correlation between macronutrient absorption and metabolic syndrome, as well as a medium correlation between energy and fiber and a high correlation between carbohydrate, fat and protein intake.

In this study, 90% of the population belonged to Buddha Maitraya, whose members are vegetarian (vegan) or vegetarian lacto, ovo and lacto ovo. Some members of the community were afraid of the risk of anemia from not consuming animal products, which was the main reason for not adopting a vegetarian or vegan lifestyle. Most of the participants had been vegetarian for at least 6 years.

**Relationship between macronutrient intake and metabolic syndrome:** Macronutrients are nutrients that humans need in

large quantities and consist of carbohydrates, fat, protein and fiber. These nutrients are metabolized and converted into energy. The vegetarian community in Medan consumes energy, carbohydrates, fats and proteins in a balanced manner but sometimes lacks of essential nutrients<sup>16</sup>.

This study demonstrated that the vegetarian community consumes energy compared with AKG 2013, including the normal category at 70.58% with 65.80% contributed by the vegetarian and vegan population. These results are similar to studies by Sugianti *et al.*<sup>17</sup> and Wiardani and Kusumayanti<sup>2</sup>, who showed that consumption of fruits and vegetables in large numbers usually result in a lower intake of energy compared with consumption of all kinds of food (as in omnivores). Carbohydrate intake at normal levels was 49.01%, with only 5.37% of those who consume more than this level, all of them belong to the vegetarian and vegan community.

Fraser<sup>8</sup> and Setiyani and Yekti<sup>11</sup> reported that the vegetarian community tends to consume simple or complex sources of main energy. The amount of protein consumed is approximately 27.35%. This result is supported by Hassan *et al.*<sup>18</sup>, who found that protein sources for vegetarians, vegans and non-vegans, are usually derived from protein vegetable oils including nuts and cereals. The consumption of the source of fat is approximately 52.15% in the vegan community and approximately 12.28% in the non-vegan community. These results are supported by Jalal *et al.*<sup>5</sup>, who found that fiber intake is only 20.58% in those who consume fat. Rizzo *et al.*<sup>19</sup> and Siahaan *et al.*<sup>9</sup> reported that the vegetarian community tends to consume fiber from nuts, cereals, fruits and vegetables in large portions. Sugianti *et al.*<sup>17</sup>

suggested that a high intake of complex carbohydrates (polysaccharides) found in nuts, fruits and vegetables can prevent metabolic syndrome.

Hassan *et al.*<sup>18</sup> found that vegetable oil, which is used as a main source of protein for vegetarians and vegans, as well as soy protein which is contained in soy bean milk, can reduce insulin and cholesterol levels in the blood which can prevent FASN activity and metabolic syndrome. Handayani *et al.*<sup>20</sup> and Jian *et al.*<sup>21</sup> reported that PUFA intake by the vegetarian community, particularly linolenic acid, can reduce insulin resistance by changing the fluidities of membrane and function of the receptor, resulting in a correlation between the insulin receptor and insulin uptake of glucose. De Biase *et al.*<sup>22</sup> and Sugianti *et al.*<sup>17</sup> also stated that intake of fiber-late water and non-late water helps to stop the accumulation of glucose and fat, thereby preventing fat accumulation in nets of adipose and in abdominal holes, serving to normalize BMI and circumference.

Well-planned consumption of macronutrients can reduce the prevalence of degenerative disease (DM, coronary heart disease, atherosclerosis and hypertension) and obesity (total obesity and visceral obesity). This study showed that consuming macronutrients can prevent the development of metabolic syndrome. Overall, 28.4% of the population had metabolic syndrome but in vegetarian vegans, 11.7% had metabolic syndrome and in vegetarian non-vegans (lacto, ovo and lacto ovo), 16.7% had metabolic syndrome. There was a significant correlation between macronutrient intake and metabolic syndrome. These results indicate that consumption of high fiber and some bioactive substances can minimize the risk of developing metabolic syndrome, however, 28.4% of the community had an indication of metabolic syndrome. Limitations of this study and possible confounding variables include that the vegetarian lifestyle was required for less than 6 months and many participants were over 50 years old and had a low activity lifestyle. These results are similar to the research done by Sargowo<sup>7</sup> and Setiyani and Yekti<sup>11</sup>.

A vegetarian lifestyle can be used as an alternative to reduce risk of degenerative disease as a result of metabolic syndrome through the obstruction of reactive oxygen species (ROS). If this free radical is high, it will affect the work of insulinine liminating glucose hepatitis and will reduce glucose intake in skeleton muscle, glicolisis, synthesis glycogen and insulin secrecy from b cells in the pancreas. Bioactive substances (flavonoid, quecetin and isoflavone) are contained in high amounts in vegetarian food. Handayani *et al.*<sup>20</sup> reported that bioactive substances can also improve insulin resistance through PPAR by reducing fat intake and increasing fat oxides to prevent hyperglycemia and lipogenesis (triglycerides and

cholesterol). Weaver<sup>23</sup> also reported that that there was no increase in fat in the whole body (obesity) or in the abdominal holes. This result is similar to the research conducted by Craig and Mangels<sup>24</sup> and Sutadarma *et al.*<sup>25</sup>, who found a correlation between high energy food density and increases in BMI, waist circumference and metabolic syndrome in Americans older than twenty years, in addition, low energy food density was not related to metabolic syndrome.

**Application:** The vegetarian lifestyle can prevent diseases related to metabolism and cardiovascular conditions, including DCM, atherosclerosis, CDH and hypertension.

## CONCLUSION

If macronutrient intake is well-regulated, the risk of generative disease, coronal atherosclerosis, hypertension and obesity (total obesity and visceral obesity) is reduced. Based on this study, macronutrient intake can prevent metabolic syndrome in the vegetarian and vegan community. There is a significant correlation between the absorption of macronutrients (energy, carbohydrate, protein, fat and fiber) and metabolic syndrome.

The vegetarian diet includes bioactive substances that can improve insulin resistance through PPAR by reducing fat intake and increasing fat oxides in order to prevent hyperglycemia and lipogenesis (triglycerides and cholesterol), as well as prevent fat increase in the whole body (obesity) and in the abdominal holes (visceral obesity).

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