



The Correlation Between Micronutrient Intake and Nutritional Status with the Immune System During the COVID-19 Pandemic

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ABSTRACT

Micronutrient intake consists of vitamins and minerals, which are nutrients the body requires in adequate amounts. Nutrients are crucial for supporting the optimal functioning of the immune system. The immune system is the human body's natural defense against infection by viruses and bacteria. This study employed an observational analytic design with a cross-sectional approach. This study was conducted among 89 dentistry students from UMY, specifically the 2018 class. Nutritional status was assessed using BMI data, while micronutrient intake was evaluated using the 24-hour food recall form. The immune system was assessed using the Immune System Questionnaire (ISQ). The study's results revealed that the nutritional status of 65.17% of subjects fell within the normal nutritional category, 15.73% within the overnutrition category, and 19.10% within the undernutrition category. The adequacy of vitamins B1, B2, B6, and C indicated that most subjects fell into the low category (below the Nutritional Adequacy Intake). The description of the immune system revealed that 75.28% of subjects did not experience a decrease in their immune system. In comparison, the remaining 24.72% of subjects experienced a decrease in their immune system. In the results of statistical tests using the Spearman rank correlation for nutritional status and the immune system, a sig (2-tailed) value of <0.05 was obtained. Meanwhile, the results of statistical tests on the correlation between micronutrient intake (Vitamins A, B1, B2, B6, C, Calcium, and Zinc) and the immune system yielded a significant (2-tailed) p-value of >0.05. In conclusion, a significant relationship exists between nutritional status and the immune system; however, no significant relationship is found between micronutrient intake and the immune system

INTRODUCTION

The coronavirus (COVID-19) pandemic has become a major public health challenge worldwide. COVID-19 is an infectious disease caused by the coronavirus SARS-CoV-2. Roughly speaking, COVID-19 can be divided into two groups: asymptomatic or mild cases, which usually resolve on their own, and severe cases (around 15%), which progress to multi-organ failure, particularly respiratory failure, requiring hospitalization in an intensive care unit.

Several studies have demonstrated a significant correlation between disease severity and the release of proinflammatory cytokines and immune cells. In response to SARS-CoV-2, immune system dysregulation and high levels of proinflammatory cytokines may be the primary causes of tissue injury. The exact pathophysiological mechanisms of COVID-19 remain largely unknown; however, an efficient immune response to SARS-CoV-2 is considered fundamental to resolving COVID-19.

Several risk factors predispose a person to viral and bacterial infections, including inadequate nutrition and a weakened immune system. The human immune system has multiple layers of defense, ranging from the outermost layer (innate immunity), which functions to prevent microbes from entering and quickly eliminate those that successfully invade tissue, to adaptive immunity, which functions to eliminate microbes that successfully penetrate tissue.

The immune system is always active in monitoring threats to the body, but its activity increases when the body is infected. This increased activity also triggers an increase in metabolic rate. This energy is obtained from food. Hence, adequate nutritional intake is crucial to support the immune system's optimal function.

Diet can influence a person's nutrient intake. Nutrient intake is divided into macronutrients and micronutrients. The vitamins and minerals contained in micronutrients work together harmoniously to activate the body's natural immune system and strengthen its defenses, both in the bloodstream and within cells, thereby protecting the body from infection.

Micronutrients are essential components that support the function of macronutrients. Micronutrients are expressed in milligrams (mg) and are required in small amounts, yet they play very significant roles in the body. Micronutrient components are vitamins and minerals. Vitamins themselves are divided into fat-soluble vitamins and water-soluble vitamins. While fat-soluble vitamins consist of vitamins A, D, E, and K, water-soluble vitamins comprise vitamins B and C. Minerals are important substances, as all tissues and water in the human body contain minerals. Minerals are also crucial components of bones, teeth, muscles, tissues, blood, and nerves. Mineral elements are carbon (C), hydrogen (H), oxygen (O), and nitrogen (N). In addition, minerals also contain other chemical elements, such as calcium (Ca), chloride (CL), iron (Fe), magnesium (Mg), phosphorus (P), potassium (K), sodium (Na), sulfur (S), and zinc (Zn).

LITERATURE REVIEW

Many studies have been conducted on nutritional intake, nutritional status, and immune status, such as those by ILM Thaha (2010) on the role of micronutrients in improving the immune system of multidrug-resistant tuberculosis (MDR-TB) patients⁷ and Angraini et al. (2014) on the relationship between nutritional status, immunonutrition, and immune status,⁸ but few studies specifically discuss micronutrients, especially during the global COVID-19 pandemic. This motivated researchers to investigate the relationship between micronutrient intake, nutritional status, and the immune system during the COVID-19 pandemic.

This study examined dentistry students from Universitas Muhammadiyah Yogyakarta, class of 2018, who were final-year students, working on their final assignments/scientific papers, and taking online courses during the study period. These factors are considered to influence nutritional intake through changes in eating patterns and the stability of the individual's immune system.

METHODS

This study used an analytical observational study with a cross-sectional approach. This study has been approved by the Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, with the number: No 203/EC-KEPK FKIK UMY/VII/2021. In this study, a total sampling technique was employed, resulting in a sample of all dentistry students from Universitas Muhammadiyah Yogyakarta, class of 2018, who met the following inclusion and exclusion criteria. The inclusion criteria included: 1) Research subjects were students who were actively participating in learning in semesters 3 and 5; 2) Research subjects were willing to follow the course of the study until completion. In contrast, the exclusion criteria were: 1) Subjects refused to fill in the necessary data related to the study; 2) Subjects took leave from the study in the current semester, namely semesters 3 and 5. This study was conducted from August 2021 to November 2021. The influencing variables in this study included micronutrient intake and nutritional status, while the affected variable was the immune status of the 2018 dentistry students.

The micronutrient intake studied included vitamin A, B complex (B1, B2, B6), and C, as well as calcium and zinc, as percentages interpreted as insufficient (<80%), sufficient (80-110%), and excess (>110%) according to the RDA. Data collection was conducted using the 24-Hour Food Recall Form, and assessment was performed utilizing Nutrisurvey software. Nutritional status is assessed by examining a person's nutritional status in the form of numerical variables, interpreted using specific criteria to determine whether it is overnutrition (body mass index >25 kg/m²), normal (body mass index 18.5-25 kg/m²), or undernutrition (body mass index <18.5 kg/m²). Assessment using Body Mass Index (BMI) measurements included height (in cm) and weight (in kg). In addition, the immune system in this study was used to see the individual's body's resistance to disease, which was assessed using the Immune Status Questionnaire (ISQ) and grouped into two categories based on the final value: a decrease in the immune system (<6) and no decrease in the immune system (= or >6).

These instruments were then distributed to research subjects using Google Forms via the WhatsApp application.

From the data obtained through the 24-Hour Food Recall Form and ISQ questionnaires, which had been checked for completeness, bivariate analysis was performed to determine the relationship between the influencing variables and the affected variables. The data were tested for normality utilizing SPSS software with the Kolmogorov-Smirnov test, and it was found that the data were not normally distributed. The Spearman Rank correlation test was then used to determine the relationship between the influencing variables and the affected variables.

RESULTS

The subjects participating in this study were all 89 active students in the 2018 class of the dentistry study program at UMY, who met the inclusion criteria. Respondents who did not meet the criteria were excluded from the analysis. The following table presents the distribution of subject characteristics according to micronutrient intake, nutritional status, and immune system variables.

Table 1. Distribution of Subjects Based on Micronutrient Intake

Category	n (%)						
	Vit. A	Vit. B1	Vit. B2	Vit. B6	Vit. C	Ca	Zn
Insufficient	41 (46.07)	88 (98.88)	66 (74.16)	72 (80.90)	84 (94.38)	84 (94.38)	66 (74.16)
Sufficient	12 (13.48)	0 (0)	14 (15.73)	10 (11.24)	1 (1.12)	4 (4.49)	18 (20.22)
Excess	36 (40.45)	1 (1.12)	9 (10.11)	7 (7.87)	4 (4.49)	1 (1.12)	5 (5.62)
Total	89 (100)	89 (100)	89 (100)	89 (100)	89 (100)	89 (100)	89 (100)

Table 1 shows that in this study, the most consumed vitamin in the excess category was vitamin A, at 40.45%, and the most consumed mineral in the excess category was zinc (Zn), at 5.62%. The most consumed vitamin in the sufficient category was vitamin B2, at 15.73%, and the most consumed mineral in the same category was zinc (Zn), at 20.22%. The most consumed vitamin in the insufficient category was vitamin B1, at 98.88%, while the most consumed mineral in the insufficient category was calcium (Ca), at 94.38%.

Table 2. Distribution of Subjects Based on Nutritional Status

Category	n	%
Overnutrition	58	65.17
Normal	14	15.73
Undernutrition	17	19.10
Total	89	100

Table 2 reveals that the majority of respondents were categorized as having normal nutrition (65.17%), while 15.73% were in the overnutrition category and 19.10% were in the undernutrition category.

Table 1. Distribution of Subjects Based on the Immune System

Category	n	%
There was no decrease.	67	75.28
There was a decrease.	22	24.72
Total	89	100

Table 3 shows that the immune system remains intact in the majority of subjects (75.28%), while a decrease in immune system function is observed in 24.72% of subjects.

Table 4. Results of Bivariate Analysis with Spearman's Rank

Spearman's rho	Immune System	
Vitamin A	Correlation Coefficient	-0.033
	Sig. (2-tailed)	0.757
	N	89
Vitamin B1	Correlation Coefficient	0.061
	Sig. (2-tailed)	0.570
	N	89
Vitamin B2	Correlation Coefficient	0.095
	Sig. (2-tailed)	0.374
	N	89
Vitamin B6	Correlation Coefficient	0.143
	Sig. (2-tailed)	0.182
	N	89
Vitamin C	Correlation Coefficient	0.032
	Sig. (2-tailed)	0.768
	N	89
Calcium	Correlation Coefficient	0.028
	Sig. (2-tailed)	0.795
	N	89
Zink	Correlation Coefficient	0.057
	Sig. (2-tailed)	0.595
	N	89
Nutritional status	Correlation Coefficient	0.369**
	Sig. (2-tailed)	0.000
	N	89

** . Correlation is significant at the 0.01 level (2-tailed).

Table 4 presents the results of statistical tests using Spearman's Rank, which yielded a sig (2-tailed) value > 0.05, indicating no significant relationship between micronutrient intake, comprising vitamins A, B1, B2, B6, C, calcium, and zinc, and the immune system. In comparison, the results of statistical tests correlating nutritional status and the immune system yielded a sig. (2-tailed) value < 0.05, suggesting a significant relationship between nutritional status and the immune system.

DISCUSSION

The immune system profile showed no immune system decline in the majority of subjects (75.28%), while 24.72% of subjects experienced immune system decline. These results align with previous research by Wanty et al. (2017), which found that the immune system in the normal category was more pronounced than in the other categories

Research indicates that various factors impact an individual's immune status. These include physiological factors, such as aging, diet, and nutrition; psychological factors; environmental factors; and physical activity and exercise. The lack of immune system decline in this study might be due to the respondents' average age of 20, whose immune systems tend to function better than those of older adults.

Based on Table 4, micronutrient intake, including fat-soluble vitamins, particularly vitamin A, was found to be predominantly deficient (46.07%). These results corroborate with research conducted by Nasaru et al. (2021), which uncovered that 87.5% of respondents' vitamin A intake was still deficient.

Vitamin A deficiency occurs due to insufficient vitamin A intake, which is common in developing countries, including Indonesia. This is because the primary source of vitamin A, animal foods, is relatively expensive. Vitamin A deficiency can also be caused by impaired absorption of this vitamin. Patients with protein-energy malnutrition can also experience vitamin A deficiency. Vitamin A deficiency causes night blindness, eye changes, skin changes, growth disorders, and other conditions.

Water-soluble vitamins, such as vitamins B1, B2, B6, and C, were found to be mostly deficient according to the RDA. This study reported that 98.88% of respondents consumed insufficient amounts of vitamin B1, indicating that almost all respondents consumed insufficient amounts. This finding is consistent with research by Polak et al. (2021), which reported that 86.7% of respondents were deficient in vitamin B1. Vitamin B1 helps maintain blood vessel permeability and wall permeability. It prevents fluid buildup in body tissues, which, for example, can help prevent beriberi. Vitamin B1 can also help restore gastric contractions, promoting the secretion of digestive juices and improving appetite.

The vitamin B2 intake of 74.16%, classified as insufficient, aligns with research conducted in Semarang Regency by Maadi et al. (2019), which found that the number of respondents with insufficient vitamin B2 intake was higher than in the other categories. Vitamin B2 plays a vital role in human metabolism and the formation of steroid molecules, glycogen, and red blood cells. Vitamin B2 also supports the growth of other organs, such as the skin, which plays a vital role in the body's external defense system.

In this study, 80.90% of respondents were found to be deficient in vitamin B6 intake. This supports previous research by Pratiwi (2018), which found that respondents with deficient vitamin B6 intake were more numerous than those in other categories. Low plasma vitamin B6 deficiency has been observed in patients with chronic alcohol dependence, obesity, protein-energy malnutrition, pregnancy, preeclampsia and eclampsia, and malabsorption conditions such as celiac disease, inflammatory bowel disease, and bariatric surgery. Furthermore,

vitamin B6 deficiency is often associated with deficiencies of other B vitamins, such as folic acid and B12.

Vitamin C intake was found to be insufficient in 94.38% of the study participants. Previous research by Rawung et al. (2021)¹⁹ also found that 83.1% of respondents reported an insufficient intake of vitamin C. Adequate vitamin intake is essential for strengthening the immune system during the current pandemic. Vegetables and fruit are excellent sources of various vitamins that act as antioxidants. Vitamin C can provide protection against coronavirus infection by stimulating the production of antibodies and enhancing the immune system.

Furthermore, 94.38% of the respondents' calcium (Ca) intake was found to be insufficient. This finding aligns with previous research, which revealed that 85.6% of respondents had an insufficient calcium intake (Mantur, 2021). Several risk factors that can lead to calcium deficiency include consumption of carbonated soft drinks, lack of active vitamin D, menstruation, lack of physical activity, and emotional instability, such as stress, pressure, and anxiety. Adequate calcium intake is crucial for the development and maintenance of peak bone mass.

Zinc (Zn) intake was also discovered in 66 individuals, with 74.16% categorized as insufficient. This finding aligns with previous research, which shows that 59.8% of respondents had an insufficient zinc intake (Ernawaty, 2020).²³ The main causes of zinc deficiency include insufficient intake, increased zinc requirements, malabsorption, and disease states that require increased zinc requirements. This is often exacerbated by physiological conditions, such as pregnancy and periods of rapid growth and development. Zinc deficiency increases susceptibility to childhood diarrhea and can further impair zinc absorption, leading to prolonged zinc malnutrition.

Based on nutritional status, 61.80% of respondents were categorized as having a normal nutritional status, while 17.98% were categorized as having overnutrition, and 20.22% were categorized as having undernutrition. This finding is consistent with previous research on adults aged 20 to 60 years, which reported a higher frequency of normal nutrition compared to individuals who are underweight. In this study, no significant relationship was revealed between micronutrient intake (Vitamin A, Vitamin B1, Vitamin B2, Vitamin B6, Vitamin C, Calcium, and Zinc) and the immune system. This contrasts with previous research, which stated that micronutrient intake can boost immunity through several mechanisms and that micronutrient deficiencies can increase the risk of infection. In addition, there was a significant relationship between nutritional status based on BMI and the immune system. This contradicts previous research, which has unearthed no significant relationship between nutritional status and the cellular immune system.

Other studies have shown no relationship between macronutrient intake and the immune system of college students during the COVID-19 pandemic; however, a relationship has been found between nutritional status and the immune system of college students during the same period.²⁷ Additionally, college students were in the insufficient vitamin D intake category, as many as 98.8%, and only 1.2% were in the sufficient category. Sun exposure among college

students was categorized as follows: high (39.3%), moderate (40.4%), and low (20.2%). Additionally, college students with a normal immune system comprised 24.7% of the population, compared to those with a decreased immune system, which accounted for as much as 75.3%.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of data analysis and discussion of research on the relationship between nutritional status and micronutrient intake with the immune system during the COVID-19 pandemic among dentistry students, Universitas Muhammadiyah Yogyakarta, class of 2018, it can be concluded that there is a significant relationship between nutritional status and the immune system during the COVID-19 pandemic. However, no significant correlation exists between micronutrient intake and the immune system during this period.

Students are advised to increase their intake of micronutrients to prevent malnutrition and maintain a normal nutritional status. Institutions are advised to conduct outreach programs to increase student knowledge about the importance of adequate micronutrient intake. Future research is expected to be conducted on a broader population using more varied data collection methods.

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