Relationships of Chronotype and Daily Intake of Magnesium, Sodium and Potassium with Nutritional Status among Adolescents in Kerinci Regency

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Abstract: Circadian rhythm and daily intake of micronutrients have different correlations with nutritional status. This study investigated the relationships of chronotype and daily intake of magnesium, sodium and potassium with nutritional status among adolescents. One hundred and forty-three students at several senior high schools in Kerinci Regency, Jambi Province were participated in this cross-sectional study. Data of chronotype and micronutrient intake were collected using questionnaires and analyzed using the multiple logistic regression test. More than half of adolescents have morning chronotype and 85.3% of adolescents have low potassium intake. However, malnutrition (underweight and overweight) was found in 42.7% of adolescents. Chronotype and Mg intake were significantly related to nutritional status (OR= 2.4 p= 0.019 and OR= 2.5 p= 0.018) but sodium and potassium intake were not related to nutritional status. Night chronotype significantly increased 2.4 times risk of poor nutritional status (p= 0.019) but inadequate magnesium intake increased 2.5 times risk of poor nutritional status (p= 0.018). In conclusion, chronotype and magnesium intake have relationships but no relationship with nutritional status for sodium and potassium intake among adolescents in Kerinci regency, Jambi province.

1 INTRODUCTION

The nutritional status problem in Indonesia is a double burden of malnutrition. A double burden of malnutrition means overweight and underweight happen altogether within the country area. It does not just happen in developed countries but also in developing countries such as Indonesia (Lembong *et al.,* 2018; Kumala and Bardosono, 2014). Nutritional status can be affected by interaction between nutrition intake, daily body needs, and environment. Indonesia's adolescent malnutrition prevalence in 2018 for 16-18 years old is 13.5% for overweight and 8.1% for underweight (Harjatmo *et al.,* 2017; Kementerian Kesehatan Republik Indonesia, 2018a). In Kerinci Regency, the prevalence of overweight in 2018 for 13-15 years old adolescent is 15.3% and underweight is 5.5% (Kementerian Kesehatan Republik Indonesia, 2018b).

Chronotype is a manifestation of the circadian rhythm. In adolescents, there is a biological mechanism that affects the circadian rhythm. When they hit puberty, there exists a shift toward eveningness and back to morningness at the end of the adolescent period (Diaz-Morales & Escribano, 2014).

Evening chronotype can affect bad intake habits. According to a study by Toktas *et al.*, 2018, the individual intake of food of an evening chronotype person is higher in calories, fat, and carbohydrate than a morning chronotype. The evening chronotype prefers fast food (mean calory 727 kcal, fat 29.63 g, and carbohydrate 103.58 g) to the morning chronotype. This kind of intake habit can affect body weight.

Nutritional status is usually connected with macronutrients such as calories, fat, protein, or carbohydrate. However, less consider the effect of micronutrients on nutritional status. Micronutrient is defined as minerals and or vitamins, which are needed only small amount (< 100 mg/day). Micronutrient such as magnesium, sodium, and potassium also have a relation to body weight (Tal *et al.,* 2019; Thaha,

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2010). Inside mitochondria, magnesium and *adenosine triphosphate* (ATP) make the Mg-ATP complex that produces energy for the metabolic system. Therefore, low magnesium intake can also cause bodyweight increase (Grimes *et al.,* 2016).

A high sodium plasma concentration forces the body to defend homeostasis by stimulating the hypothalamus. This stimulation, therefore, might cause thirst where the body will gain extracellular water volume from drinking water, leading to a bodyweight increase. Besides that, sodium can increase lipogenic enzymatic activity and the capacity to incorporate glucose into lipids, increasing fat mass and adipose size (Elfassy *et al*., 2018; Larsen *et al.*, 2013; Song *et al.,* 2013).

According to Tal *et al.,* 2019, potassium has a relation to decreasing BMI. However, the real mechanism is still unknown. He estimates potassium plays a role in producing energy by increasing Mg, Iron, and calcium metabolism.

2 MATERIALS AND METHOD

This research was an analytical observational study with a *cross-sectional* design and was conducted from November to December 2021. The population of this study was adolescents, who studied in the senior high schools in Kerinci Regency, Jambi Province (5039 adolescents). the sample size was calculated using the estimated proportion formula and got a minimum of 105 subjects (Masturoh & Anggita, 2018), subjects were determined using *cluster random sampling* from senior high school and got 7 schools out of 14 schools in Kerinci. The selection of the research subjects used inclusion criteria: aged ≤18 years old and studied in X-XII grades while the exclusion criteria were smoking, drinking alcohol, drinking coffee more than 1 glass/day, and having a stress score (≥20). The author got 143 research subjects after inclusion and exclusion criteria selection. The protocol of this study has been approved by the Research Ethics Committee, Faculty of Medicine of Universitas Sebelas Maret Surakarta with protocol ID 01/02/10/108.

Data on basic characteristics among selected adolescents were collected using an open questionary and Morningness Eveningness Questionnaire Self-Assessment (MEQ-SA) (Yula, 2021) was used to collect the chronotype data. The chronotype data were classified as morning and evening chronotypes. Daily intake of magnesium, sodium, and potassium was taken using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) (the standard form of SQ-FFQ), which was then classified as inadequate (magnesium: male <250 mg/ female <220 mg and potassium: <4700 mg) and adequate (magnesium: male ≥250 mg/ female ≥ 220 mg and potassium: ≥4700 mg) while sodium intake was adequate (≤1500 mg) and excessive (>1500 mg). The Perceived Stress Scale (PSS-10) (Indira, 2016) was used to determine stress scores among selected adolescents with a score above 19 excluded from this study.

Anthropometry data, such as height and body weight, were measured using a microtoice and a body weight scale respectively. The age was measured using an open questionnaire. Body mass index (BMI) for age is classified as severely thinnes (<-3SD), thinnes (-3SD till <-2SD), normal (-2SD till +1SD), overweight (+1SD till +2SD) and obese (>+2SD) (Kementerian Kesehatan Republik Indonesia, 2020), but the result in this research classified as malnutrition (underweight and obese) and normal nutrition status for statistic need. Before the research begins, the subject will be asked to fill out informed consent as approval to be included in the research.

All collected data with 143 research subjects were analyzed using the IBM Statistic 24. Categorical and numerical data were presented as frequency, percentage, mean and ± standard deviation respectively. The chi square test was used to figure out the relationship between independent and dependent variables. The significant relationships of individual variables were then further analyzed using the Multiple Logistic Regression test whether or not all variable influenced nutritional status. Data of all statistic test were considered a significant value with p-value <0.05.

3 RESULTS AND DISCUSSION

3.1 Results

3.1.1 Characteristics of Subject

Table 1 shows the characteristic of the subjects. The result showed that the majority of the subject is female with 83 subjects (58%), the majority of students are in age 16 with 72 subjects (50,3%), the majority of the subject are morning type (90 subjects/62,9%), the majority of the subjects are adequate magnesium (91 subjects/63,6%), the majority of the subjects are also adequate sodium (105 subjects/73,4%), the majority of the subjects are inadequate potassium (122 subjects/85,3%), and more than half of them are normal in nutritional status (82 subjects/57,3%).

Table 1: Characteristics of Subject.

Variable	N	%	$\bar{X}$	SD
Gender				
Male	60	42.0	-	-
Female	83	58.0		
Age (years old)				
14	5	3.5		
15	27	18.9		
16	72	50.3	16.06	0.882
17	31	21.7		
18	8	5.6		
Dichotomy Chronotype				
Morning (score >50)	90	62.9	-	-
Evening (score ≤50)	53	37.1		
Magnesium intake habit				
Inadequate (M <250 mg/ FM <220 mg)	52	36.4	-	-
Adequate (M ≥250 mg/ FM ≥ 220 mg)	91	63.6		
Sodium intake habit				
Adequate (≤1500 mg)	105	73.4	-	-
excessive (>1500 mg)	38	26.6		
Potassium intake habit				
Inadequate (<4700 mg)	122	85.3	-	-
Adequate (≥4700 mg)	21	14.7		
Dichotomy nutritional status				
Normal	82	57.3	-	-
Malnutrition (under and overweight)	61	42.7		

Table 2: Bivariate; Relationships of Chronotype and Daily Intake of Magnesium, Sodium and Potassium with Nutritional Status.

Independent Variable	Nutritional Status		OR	CI 95%		P value
	Normal	Malnutrition (Over/Under Weight)		Lower	Upper	
Dichotomy Chronotype						
Morning (score >50)	59	31	2.4	1.238	4.978	0.016
Evening (score ≤50)	23	30				
Magnesium intake habit						
Adequate (M <250 mg/ FM < 220 mg)	60	31	2.6	1.310	5.317	0.01
Inadequate (M ≥250mg/ FM ≥ 220 mg)	22	30				
Sodium intake habit						
Adequate (≤1500 mg)	60	45	0.97	0.458	2.055	1
excessive (>1500 mg)	22	16				
Potassium intake habit						
Adequate (≥4700 mg)	16	5	2.7	0.936	7.880	0.09
Inadequate (<4700 mg)	66	56				

Table 3: Multivariate; Relationships of Chronotype and Daily Intake of Magnesium, Sodium and Potassium with Nutritional Status.

Parameter	p-value	OR	CI 95%		Nagelkerke R Square
			Lower	Upper	
Chronotype	0.019	2.404	1.154	5.009	0.134
Magnesium intake habit	0.018	2.506	1.170	5.367	
Sodium intake habit	0.757	1.141	0.494	2.634	
Potassium intake habit	0.418	1.615	0.501	5.269	

3.1.2 The Analysis of Chronotype, Daily Intake of Magnesium, Sodium and Potassium with Nutritional Status

Based on table 2 chronotype, magnesium intake habit and potassium have a relation to nutritional status (p<0,05), but sodium has no relation to nutritional status. Evening chronotype significantly increased 2.4 times the risk of malnutrition, inadequate magnesium significantly increased 2.6 times the risk of malnutrition and inadequate potassium increased 2.7 times the risk of malnutrition while excessive sodium has no risk of malnutrition (OR 0.97).

Based on table 3, only chronotype and magnesium intake habits have a relation to nutritional status (p<0,05), but sodium and potassium intake have no relation to nutritional status. Evening chronotype significantly increased 2.4 times the risk of malnutrition and inadequate magnesium significantly increased 2.6 times the risk of malnutrition while excessive sodium (OR 1,14) and inadequate potassium (OR 1,61) have no risk of malnutrition. These independent variables together have 13,4% in total effect on nutritional status. another 86,6% come from outside of these independent variables.

3.2 Discussion

Chronotype has relation with nutritional status with p value 0.019 (p<0.05), Evening chronotype significantly increased 2.4 times the risk of malnutrition. This research is linear with the research conducted by Rafkhani *et al*., (2021) stated that there is an indirect relation chronotype to nutritional status with a p-value of 0.037 with mediator dietary habit. Evening chronotype has unhealthy intake behavior compared to morning chronotype, their eating time and lifestyle change, they prefer to eat high macronutrient like energy after eight pm (Toktas *et al*, 2018). According to research from Agagunduz *et al* (2020), Resting Energy Expenditure (REE) in adolescents with obesity changed based on gender and chronotype. Night chronotype change REE that caused the risk of obesity in adolescents. This may happen based on the changing circulation level of some nutrition such as glucose, fatty acid, and triglyceride, alongside some hormones such as insulin, glucocorticoid, and adipokines.

Magnesium has relation with nutritional status with p value 0,018 (p<0,05), Inadequate magnesium increased 2,5 times risk of malnutrition. This research is in line with the research conducted by Patimah *et al.,* (2021), which stated that magnesium intake in female students has a relation to nutritional status with a p-value of 0,001. Magnesium plays a role in insulin and epinephrine secretion. Insulin can transport glucose into cells. Inside mitochondria, magnesium, and *adenosine triphosphate* (ATP) make the Mg-ATP complex that produces energy for the metabolic system. Therefore, low magnesium intake can also cause body weight increase (Shamnani *et al.*, 2018; Grimes *et al.,* 2016).

Sodium has no relation to nutritional status with a p-value of 0.757 (p>0.05). This research is in line with the research conducted by Sari *et al.,* (2017), which stated that there is no relation between sodium with nutritional status with a p-value of 0.678. Although, theoretically, excessive sodium makes a high concentration of plasma sodium leads to body homeostasis unstable. The human body needs to maintain its homeostasis, which might lead to thirst stimulation. Therefore, sodium increases extracellular water volume, leading to body weight gain (Lee *et al*., 2018; Elfassy *et al*., 2018).

Potassium has no relation with nutritional status with a p-value of 0,418 (p>0,05). This research is in line with the research conducted by Maigoda *et al.,* (2020), which stated that there is no relation to potassium intake with SGA (*Subjective Global Assessment*), SGA is used to estimate malnutrition in hemodialysis patients. Theoretically, high potassium can decrease BMI levels. Although it is still unclear how potassium has a relation to nutritional status, it is estimated this relation is how potassium can reduce inflammation and increase insulin sensitivity. Potassium can also modulate energy balance through the deposition/ mobilization of fat or energy balance (Tal *et al.,* 2019).

4 CONCLUSION

Chronotype and magnesium intake have relationships with nutritional status but sodium and potassium have no relationship with nutritional status among adolescents in Kerinci regency, Jambi province.

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