Association between prudent diet, sweet food consumption, and the risk of stress, anxiety, and depression among Indonesian students

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Abstract. Mental health disorders are prevalent among students. A cross-sectional survey was conducted to investigate the relationship between prudent-diet and sweet food with the risk of stress, anxiety, and depression among Indonesian students. The study involved 190 Indonesian students, aged above 19 years, who completed online questionnaires, including DASS, HFIAS, and FFQ. Students were recruited through various social media platforms. Principal component analysis was used to determine prudent-diet and sweet food among the respondents. Logistic regression was used to predict the association between prudent diet and sweet food on stress, anxiety, and depression among students. Prudent-diet is identified by fruits and vegetables, animal/plant-based protein, whole grains, sweet food, and low consumption of processed meats/fish. Incorporating sweets into a prudent-diet was associated with 22% reduced stress and 8% reduced anxiety among Indonesian students.

1 Introduction

Mental health disorders are commonly experienced by university students. The prevalence of stress, anxiety, and depression among Indonesian students was 38.9%, 51.1%, and 25.0%, respectively [1]. Stress influences mood and behaviour, including elevated anxiety and/or depressed mood. Compared to depression, anxiety and stress symptoms are more frequent and vary from mild to extremely severe, indicating the urgent need for preventive actions and intervention to promote the students mental health [2].

Recent studies suggest that diet and metabolic status are important factors affecting the magnitude of physiological stress responses [3]. Nutrition plays a vital role in prevention and treating mental health disorders. Hence, nutrient deficiency has been linked to the underlying pathology of behavioural health disorders due to the critical function of nutrients in the neuroendocrine system. Pyridoxine, mecobalamin, folic acid, tryptophan, tyrosine, choline, histidine, phenylalanine, and glutamic acid were among the nutrients provided by a healthy diet. These nutrients are essential for the synthesis of neurotransmitters such as serotonin,

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dopamine, and norepinephrine which are involved in the regulation of mood, appetite, and cognitive function [4]. Dopaminergic and serotonergic neurotransmitters are regulated by omega-3 fatty acids which can improve both depression and anxiety [5, 6]. Several studies suggested that healthy dietary patterns such as prudent-diet, are associated with better mental health [7, 8]. Balanced dietary patterns such as fish, fruits, and fresh vegetables have been correlated with a reduced risk of depression or depressive symptoms [9, 10]. Otherwise, insufficient nutrient intake as a result of poor diet quality increases the risk of the development of behavioral health disorders.

Sugar has a varied effect on mental health. As the brain's exclusive energy source, it plays a crucial role in mental health and can enhance short-term memory [11, 12]. However, chronic sugar intake seems to have the opposite effect on cognition [13]. Previous studies suggested sugar supply quantity was positively associated with anxiety disorder [14]. Moreover, in depression and anxiety, there was a decreased intake of total calories and an increase in sugar consumption [15]. In contrast to healthy options, stress encourages the consumption of sweet and high-sugar foods [16]. However, sucrose intake for stress conditions resulted in elevated serotonin levels in the brain, ameliorated depression state, and relieve stress [14].

According to previous studies, diet plays an important role in mental health conditions, as well as sugar intake. Therefore, this research aims to investigate the relationship between a prudent-diet and the role of sweet food in the risk of stress, anxiety, and depression among Indonesian students.

2 Materials and methods

2.1 Study design

The study employs a cross-sectional study utilizing Internet-based questionnaire which was built in Google Sheets. Data were collected from 17th December 2023 to 12th January 2024. The study protocol was approved by the Ethics Committee of Universitas Airlangga Faculty of Dental Medicine Health Research number: 1262/HRECC.FODM/XI/2023. All participants provided written informed consent before participating in the study.

2.2 Participants

A total of 190 Indonesian students, aged above 19 years were recruited through various social media platforms (e.g., WhatsApp, Facebook, and Instagram) using snowball sampling. The inclusion criteria were living in study city for at least one month and being willing to complete the entire survey. There were no exclusion criteria applied. Sample analysis for principal component analysis (PCA) in practice had a subject to item ratio of less than 5:1. Total item we used in this study was 24 items, so the minimum subjects in the study was 120 samples [17].

2.3 Data collection measurements

A self-administered online questionnaire consisting of socio-demographics (such as sex, age, marital status); anthropometrics (weight and height); dietary pattern (using food frequency questionnaire); weekly activities (using IPAQ-SF); the depression, anxiety, and stress scales (DASS-42), and food insecurity (using HFIAS).

A food frequency questionnaire was used in this study, including 24 food groups: bread and pastry related products; noodles and related products; rice and related products; whole

grain; root Starch; orange, red purple, colour vegetables; sea vegetables; white/light green colour vegetables; dark green vegetables; peas/legume; fruits; desserts and sugary beverages; snacks; western dishes; fried desserts; organs and animal fats; processed meats/fish; dairy products; coffee (black coffee/latte); beef and lamb; chicken, duck, and goose; fish, crabs, squid, clams, fish and other seafood; soy products; and egg. The Cronbach's Alpha of 0.792 and interclass correlation coefficients (0.742-0.836) indicated good agreement between repeated FFQs. These results suggest that the FFQ is reliable among respondents.

The depression, anxiety, and stress scales (DASS-42) were used to measure levels of stress, anxiety, and depression. This scale comprises 42 items evaluating the psychological state of an individual, with each item rated on a four-point measurement method based on the Likert Scale (0: never – 3 very often). Scores were then calculated for each category of stress, anxiety, and depression. A normal stress score is considered to be between 0-14 while a score of 15 or above indicates moderate to severe levels of stress. Similarly, a normal anxiety score is between 0-7, while a score of 8 or above indicates moderate-severe levels of anxiety. A normal depression score is between 0-9, while a score of 10 or above indicates moderate to severe levels of depression [18]. The Household Food Insecurity Access Scale (HFIAS) was used to measure food insecurity during the previous four weeks [19]. The short-form International Physical Activity Questionnaire (IPAQ-SF) was used to measure physical activity [20].

2.4 Statistical analysis

Categorical data were presented as counts (percentage), while continuous data were presented as means (standard deviation).The *p*-value was calculated using χ-square for categorical variables and Mann-Whitney u-test for continuous variables. PCA analysis was used to confirm the variability of dietary patterns among respondents. Dietary pattern was constructed based on linear combination of the groups, reflecting combinations of food consumed together. The eigenvalue >1.0 criterion was used to determine the number of principal components (PCs) retained. The first two PCs with the highest explained variance were selected. Logistic regression was performed to estimate Odds Ratio (OR) of stress, anxiety, and depression by using dietary patterns as associate factors. SPSS version 21 (IBM Corp., Armonk, USA) was used to perform all statistical analysis.

3 Results

3.1 Characteristics of students stratified by stress level

A total sample of 190 participants completed the questionnaire with 168 (88.4%) indicated normal status levels and 22 (11.6%) indicated stress levels. Table 1 shows the baseline characteristics of students involved in this study. Compared to respondents with normal status, respondents with stress were younger, had a higher prevalence of no children (95.5% vs 72.7%), and to a lesser extent, showed a higher prevalence of food insecurity. Our study found that among students, stress was associated with anxiety and depression ($p<0.01$) (Table 1).

Table 1. Student characteristics based on stress level (n=190)

	Stress		
	Normal (n=168)	**Stress (n=22)**	***p*-value[a]**
Subject characteristics			
Age(years)	26.46 (6.92)	22.73 (3.09)	0.014
Height(m)	158.85 (7.78)	160.73 (6.80)	0.282
Weight(kg)	59.27 (16.39)	62.14 (21.20)	0.457
Body Mass Index(kg/m^2)	23.43 (6.19)	24.30 (9.50)	0.565
Sex			0.520
Male	42 (25.1)	5 (22.7)	
Female	125 (74.9)	17 (77.3)	
Education			0.090
Undergraduate	47 (28.0)	11 (50.0)	
Master degree	87 (51.8)	9 (40.9)	
Doctoral degree	34 (20.2)	2 (9.1)	
Food insecurity			0.075
Food secure	128 (76.2)	13 (59.1)	
Food insecure	40 (23.8)	9 (40.9)	
Number of kids			
No kids	133 (72.7)	21 (95.5)	0.018
>=1 kids	50 (27.3)	1 (4.5)	
Anxiety			<0.001
Normal	99 (58.9)	0 (0.0)	
Anxiety	69 (41.1)	22 (100.0)	
Depression			0.001
Normal	84 (50.0)	3 (13.6)	
Depression	84 (50.0)	19 (86.4)	

[a]*p*-value was performed by χ-square for categorical variables and Mann-Whitney u-test for continuous variables. Continuous data are presented as the mean ± standard deviation, while categorical data are presented as counts (percentage of the same group).

Table 2. Principal component analysis-PC Loadings for food groups > |0.2| with varimax rotation

	Western-Indonesian diet	**Prudent diet and sweets**
Eigenvalue	6.31	3.47
Variance explained stress	26.27%	14.46%
Bread & pastry related products	0.291	
Noodles & related products	0.623	
Rice & related products		
Whole grain	0.456	0.394
Root starch	0.918	
Orange, red purple, colour vegetables		0.595
Sea vegetables	0.733	0.291
White/light green colour vegetables		0.817
Dark green vegetables		0.786
Peas/legume	0.245	0.755
Fruits		0.433
Desserts and sugary beverages		0.207
Snacks		
Western dishes	0.866	
Fried desserts	0.468	

	Western-Indonesian diet	Prudent diet and sweets
Organs and snimal fats		
Processed meats/fish	0.459	-0.359
Dairy products		
Coffee, black coffee, latte	0.626	
Beef and lamb	0.512	
Chicken, duck and goose	0.348	
Fish, crabs, squid, clams, fish and other seafood		0.395
Soy products		0.597
Egg		

3.2 Principal component analysis

FFQ data were used to derive dietary pattern-related stress using PCA, by choosing varimax rotation. PCA analysis identified seven different PCs, but we selected the two first PCs with highest explained variance, which accounted for 40.73% of the variance. PCs1 explained 26.27% of variance and described a western-Indonesian diet pattern, while PCs2 explained 14.64% of variance and corresponded to a PD pattern (Table 2). Western-Indonesian diet was identified by high intake of bread and pastry related products; noodle and related products; whole grains; root starch; sea vegetables; peas/legume; western dishes; fried desserts; processed meat/fish; coffee, black coffee; latte; beef and lamb; chicken, duck and goose. PD pattern was identified by high intake of whole grain; orange, red-purple, colour vegetables; sea vegetables; white/light green colour vegetables; dark green vegetables; peas/legume; fruits; dessert and sugary beverages; fish, crab, squid, clams, fish, and other seafood; soy products, as well as low intake of processed meats/fish**.**

3.3 The association of dietary pattern on stress, anxiety, and depression

We next performed the linear regression among the two selected dietary patterns. The data reveals that stress, anxiety, and depression negatively associated with prudent diet pattern (β=-3.312 (95% CI: --5.172 ~ -1.452), p<0.001), (β=-1.622 (95% CI: -2.849 ~ -0.395), p=0.010), (β=-1.270 (95% CI: --2.511 ~ -0.030), p=0.045), respectively. No association was found between stress, anxiety, and depression with western-Indonesian diet. A logistic regression analysis shows that after adjusted by food insecurity, the PD had 22% reduction in the odds of stress (OR= 0.78; 95% CI: 0.67-0.91; p<0.01) and 8% reduction in the odds of anxiety (OR= 0.92; 95% CI: 0.85-0.99; p<0.05) (Figure 1).

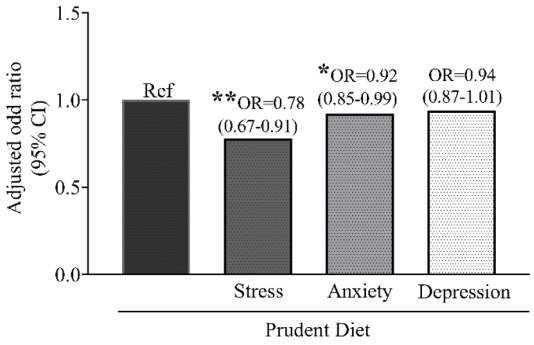

Fig. 1. Odd ratios of stress, anxiety, and depression predicted by prudent-diet adjusted by food insecurity. * p-value<0.05, ** p-value<0.01

4 Discussion

This study investigates the relationship between a prudent-diet and the role of sweet food on the risk of stress, anxiety, and depression among Indonesian students. Our data showed that stress was associated with anxiety and depression among students. Among these students, consumption of a prudent-diet with sweet food was positively associated with the reduction of stress and anxiety levels.

Our study found that the prudent-diet and sweets were associated with a 22% reduction in stress and 8% reduction in anxiety. A PD pattern identified by vegetables; sea vegetables; white/light green colour vegetables; dark green vegetables; peas/legume; fruits; dessert and sugary beverages; fish, crab, squid, clams, fish, and other seafood; soy products as well as low intake processed meats/fish**.** Aligned with epidemiological studies conducted in various countries, a diet rich in vegetables and fruits, whole grains, nuts, legumes, lean protein sources, and low in added sugars may reduce the incidence of anxiety disorders [7]. In addition, nutrient-poor diets, energy-dense, and irregular meals were associated with worse mental health, while a varied diet rich in unprocessed plant foods, fish, and regular meals was associated with better mental health [21]. Among Nordic-older adults, moderate-to-high adherence to the Nordic PD Dietary Pattern may predict better-preserved cognitive functions [8]. Dietary fat reduction may contribute to a negative mood. Adopting PD, which prioritizes healthy fats and carbohydrates, can improve general well-being and reduce depression [22]. A meta-analysis examining the relationship between anxiety symptoms and Omega-3 PUFA treatments revealed that Omega-3 PUFAs may help alleviate clinical anxiety symptoms (at least 2000 mg/day Omega-3 PUFA) [23]. A PD provides a micronutrient source from food. A previous study involving thirty-three adults with Attention-Deficit/Hyperactive Disorder (ADHD) showed that micronutrient supplementation significantly reduced anxiety and stress [24].

We found that dessert and sugary beverages consumption alleviates mental health status such as stress and anxiety. Our findings are consistent with the study that tested 54 participants aged 18-49 years old. This study supported the evidence that high-energy foods have a suppressive effect on stress-associated glucocorticoid reactivity, which aligns with the comfort food hypothesis, suggesting that people are driven to eat appetizing foods to reduce the negative effects of stress exposure [25]. Regular stressors trigger excessive consumption of highly appetizing foods through various pathways, such as modified brain signalling of glucocorticoid, relaxin-3, ghrelin, and serotonin. Sucrose contributes to reducing stress, presumably through activities in the brain (e.g., plasticity in brain reward regions) and the periphery (e.g., glucocorticoid receptor signalling in adipose tissue) [16]. Stress may stimulate sweet food consumption through several mechanisms, which can reduce stress among students. Notably, sweet food may have a positive effect as a stress-coping mechanism. Nonetheless, eating behaviour, including sweets, was associated with the mental health symptoms among obese population due to long-term effects of sweet food consumption [26]. Previous research suggests that there is a non-directional relationship between sugar and mental health. Besides, a third factor such as inadequate intake of micronutrients may simultaneously increase sugar intake and increase susceptibility to mental health [14]. Hence, dietary management is a key strategy which should be implemented by students to promote their mental health, especially those with food insecurity.

The limitations of the study should be considered before interpreting the results. First, the cross-sectional design indicates that we cannot establish a cause-effect relationship. Second, our study population is Indonesian students, thus the results may not reflect the broader Indonesian population. Moreover, since the data collection relies on self-reports, there could be information bias due to students' reporting.

5 Conclusion

A prudent-diet, incorporating desserts and sugary beverages, was found to be protective against stress and anxiety among Indonesian students. Dietary management is a key strategy which should be adopted by students to promote their mental health, especially those experiencing food insecurity.

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