

Research Article

The Correlation between Vitamin C Intake, Fiber Intake, and Academic Stress Levels with Anemia Incident among Female Students at the Medicine Faculty of State University of Surabaya

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Abstract: Anemia remains a critical public health problem, particularly among young women, including female university students. Its occurrence is influenced by dietary intake and psychological factors such as academic stress. This study aimed to analyze the relationship between vitamin C intake, fiber intake, academic stress, and anemia incidence among female medical students at Universitas Negeri Surabaya. A cross-sectional analytical observational design was used with 85 respondents selected through proportional stratified random sampling. Vitamin C and fiber intake were assessed using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), academic stress was measured with the Perceived Academic Stress Scale (PASS), and anemia status was determined through hemoglobin measurement using the Easy Touch GCHb device. The Chi-Square test analyzed associations between nutrient intake and anemia, while Fisher's Exact Test examined the relationship between academic stress and anemia. The results showed significant associations between vitamin C intake and anemia ($p < 0.001$), fiber intake and anemia ($p < 0.001$), and academic stress and anemia ($p = 0.003$). Anemia was common among respondents with insufficient vitamin C intake, low fiber intake, and high stress levels. These findings indicate that adequate nutrition and effective stress management are important for reducing anemia risk among female students in this population.

Keywords: Academic stress level; Anemia; Female students; Fiber intake level; Vitamin C intake level.

1. Introduction

Anemia is a condition where hemoglobin levels are below normal, reducing the blood's ability to transport oxygen throughout the body's tissues and disrupting various physiological functions (World Health Organization, 2019). Anemia remains a global public health problem. Globally, the prevalence of anemia in women aged 15–49 years reaches 29.6%, with 16.0% experiencing mild anemia, 12.5% experiencing moderate anemia, and 1% experiencing severe anemia (World Health Organization, 2019). In Indonesia, the prevalence of anemia is higher in women (18%) than in men (14.4%) (Kementerian Kesehatan Republik Indonesia, 2018). In East Java Province, the prevalence of anemia in adolescent girls reaches 40% (Timur, 2023), while the prevalence of anemia in female students in Surabaya City was reported at 26.1% (Solikhah & Hariyanto, 2021).

Female students are a group vulnerable to anemia due to their monthly menstruation and often have a diet that does not meet nutritional needs (Rusman, 2018). Furthermore, academic pressure during college can reduce appetite and lead to changes in eating patterns, increasing the risk of anemia (Rusman, 2018). One group at risk is female medical students. Despite having better knowledge about health and nutrition, the high academic load, busy practicum schedule, and competency demands often lead to irregular eating patterns (Weber, 2019). Research also shows that medical students experience higher academic pressure, which affects their lifestyle, including daily eating patterns.

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Various studies have identified several factors associated with anemia, one of which is vitamin C intake. Vitamin C acts as an enhancer of non-heme iron absorption by reducing iron from the ferric (Fe^{3+}) to ferrous (Fe^{2+}) form, thereby increasing iron absorption in the intestine. Research on midwifery students in Surabaya showed that vitamin C intake that met the Recommended Dietary Intake (RDA) was associated with higher hemoglobin levels (Rakhmawati, 2020). Another study on nursing students in Semarang also reported that low vitamin C intake was associated with low hemoglobin levels (Ardiansyah, 2021).

In addition to vitamin C, fiber intake also plays a role in maintaining hemoglobin levels. Fiber supports digestive health through the formation of short-chain fatty acids (SCFAs) produced by intestinal microbial fermentation, which helps maintain intestinal mucosal integrity and enhance mineral absorption, including iron. Low fiber intake can decrease SCFA production, resulting in suboptimal iron absorption (Meyer & Stasse-Wolthuis, 2020). Long-term decreased iron absorption can inhibit hemoglobin synthesis and increase the risk of anemia (Verediano et al., 2023). On the other hand, excessive fiber consumption can also inhibit iron absorption because insoluble fiber can bind minerals in the digestive tract (Rahayu, 2022). Previous research has shown that low fiber intake is associated with lower hemoglobin levels and an increased incidence of anemia (Rakhmawati, 2020; D. Sari & Nugroho, 2023).

Another factor contributing to anemia is academic stress. Activation of the hypothalamic-pituitary-adrenal (HPA) axis during stressful conditions increases the secretion of the hormone cortisol, which can decrease appetite, alter consumption patterns, increase inflammation, and inhibit red blood cell formation (Wahdaniyah, 2021). Research on medical students at Airlangga University showed that high academic stress is associated with lower hemoglobin levels (Safitri, 2021). Another study reported that students with moderate to high levels of academic stress had a 2.4-fold greater risk of anemia than students with low levels of stress (Dewi, 2020). Furthermore, study stress is also known to affect eating habits, resulting in decreased iron intake (M. Sari, 2022).

However, most previous studies have only examined the relationship between vitamin C, fiber, or academic stress and anemia separately (Ardiansyah, 2021; Rakhmawati, 2020). Scientific evidence examining these three factors simultaneously in female medical students is still limited, thus not providing a comprehensive picture of the nutritional and psychological factors associated with anemia.

Based on these problems, this study used a quantitative design with a cross-sectional approach to analyze the relationship between vitamin C intake, fiber intake, and academic stress levels with the incidence of anemia in female students of the Faculty of Medicine, Surabaya State University. Vitamin C and fiber intake were measured using the Semi Quantitative Food Frequency Questionnaire (SQ-FFQ), academic stress levels were measured using the Perceived Academic Stress Scale (PASS), while hemoglobin levels were measured using the Point of Care Testing (POCT) method.

The contributions of this research include: (1) analyzing the relationship between vitamin C intake, fiber intake, and academic stress levels on the incidence of anemia simultaneously; (2) providing scientific evidence regarding nutritional and psychological factors related to anemia in female students of the Faculty of Medicine; and (3) providing a scientific basis for developing strategies for preventing anemia through improving consumption patterns and managing academic stress.

2. Theoretical Study

Adolescent Girls and Anemia

Adolescent girls are a group vulnerable to anemia due to rapid growth, menstruation, and increased iron requirements during the reproductive period. This condition results in higher nutritional needs, especially for iron and vitamin C, compared to other groups (BKKBN, 2022; World Health Organization, 2021). Anemia is defined as a condition where hemoglobin (Hb) levels are below normal (<12 g/dL in women), resulting in a decreased ability of the blood to transport oxygen to body tissues (World Health Organization, 2024). The impact of anemia on adolescent girls includes decreased concentration, academic achievement, endurance, productivity, and future reproductive health (Kementerian Kesehatan Republik Indonesia, 2018).

Hemoglobin and Factors Affecting It

Hemoglobin is a protein in red blood cells that transports oxygen from the lungs to the tissues and returns carbon dioxide to the lungs (Hall, 2021). Hemoglobin formation is influenced by various factors, such as iron and vitamin C intake, menstrual patterns, nutritional status, and the individual's health condition (World Health Organization, 2024). Hemoglobin levels are generally measured in field studies using the Point of Care Testing (POCT) method with a digital hemoglobinometer due to its practicality and better validity compared to standard laboratory methods (World Health Organization, 2021).

Vitamin C Intake and Hemoglobin Levels

Vitamin C is a water-soluble vitamin that plays a role in increasing the absorption of non-heme iron by reducing Fe^{3+} ions to Fe^{2+} ions, making them more easily absorbed by the intestines (Ardiansyah, 2021). Vitamin C deficiency can inhibit iron absorption and reduce hemoglobin formation, thereby increasing the risk of anemia. Previous research has shown that female students with low vitamin C intake have a higher risk of anemia compared to respondents with recommended intakes (Andriani & Wirjatmadi, 2018; Rakhmawati, 2020).

Fiber Intake and Hemoglobin Levels

Dietary fiber plays a role in maintaining digestive health and maintaining gut microbiome balance. However, excessive fiber consumption, particularly insoluble fiber, can bind iron, reducing its bioavailability and absorption (Gill et al., 2021; Verediano et al., 2023). Conversely, low fiber intake can also reduce the production of short-chain fatty acids (SCFAs), which play a role in maintaining intestinal mucosal integrity and supporting iron absorption (Makki et al., 2018). Previous studies have reported that fiber intake is associated with hemoglobin levels in adolescent girls and female students (Srimaharani, 2017; Syarfaini et al., 2023).

Stress Academic to Hemoglobin

Academic stress is a psychological response to learning demands that exceed an individual's adaptive capacity (Mulyadi, 2016). Prolonged stress can increase cortisol levels, disrupt eating patterns, inhibit iron absorption, and decrease erythropoiesis, potentially lowering hemoglobin levels (Wulandari, 2023). Previous research has shown that students with high levels of academic stress have a greater risk of anemia than those with low levels (Dewi, 2020).

Previous Research and Research Gap

Various previous studies have reported the relationship between vitamin C intake and hemoglobin levels, the relationship between fiber intake and the incidence of anemia, and the relationship between academic stress and hemoglobin status separately (Andriani & Wirjatmadi, 2018; Dewi, 2020; Srimaharani, 2017). However, research analyzing these three factors simultaneously in female students of the Faculty of Medicine, State University of Surabaya is still very limited. Therefore, this study aims to analyze the relationship between vitamin C intake, fiber intake, and academic stress levels with hemoglobin levels in female students of the Faculty of Medicine, State University of Surabaya, to provide a more comprehensive picture of the factors associated with the incidence of anemia.

3. Materials and Method

This study is an observational analytical study with a cross-sectional design that aims to analyze the relationship between vitamin C intake levels, fiber intake levels, and academic stress levels with the incidence of anemia in female students of the Faculty of Medicine, State University of Surabaya (UNESA). The study was conducted in April 2026 at the Faculty of Medicine, UNESA, Surabaya. The study population consisted of 310 active female students from the classes of 2024 and 2025, with a sample of 85 respondents selected using a proportional stratified random sampling technique based on the Slovin formula with an additional 10% to anticipate dropout. Respondents who met the inclusion and exclusion criteria were included after providing informed consent.

The independent variables of the study included vitamin C intake, fiber intake, and academic stress levels, while the dependent variable was the incidence of anemia based on hemoglobin levels. Data on vitamin C and fiber intake were collected using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) that described respondents' consumption patterns over the past three months. The data were then analyzed using NutriSurvey software based on the Indonesian Food Composition Table (TKPI) and categorized into insufficient ($<77\%$ RDA) and sufficient ($\geq 77\%$ RDA) referring to Gibson

(Gibson & S, 2005). Academic stress levels were measured using the Perceived Academic Stress Scale (PASS) which consists of 18 questions and classified into low stress (18–45) and high stress (46–90) based on Bedewy and Gabriel (Bedewy & Gabriel, 2015). Hemoglobin levels were measured using the Easy Touch GCHb with the Point of Care Testing (POCT) method through capillary blood samples, then categorized as anemia if the hemoglobin level is <12 g/dL according to WHO criteria (World Health Organization, 2021).

Data were processed through editing, coding, entry, and cleaning stages, then analyzed using IBM SPSS. Univariate analysis was conducted to describe the characteristics of respondents in the form of frequency, percentage, mean $\pm$ standard deviation, or median according to the data distribution. Bivariate analysis was used to determine the relationship between independent variables and the incidence of anemia. The relationship between vitamin C intake and fiber intake with the incidence of anemia was analyzed using the Chi-Square test, while the relationship between academic stress levels and the incidence of anemia was analyzed using Fisher's Exact Test because there were cells with an expected count value of less than 5. All tests used a significance level of $p < 0.05$. Additionally, ethical approval for this research was granted by the Health Research Ethical Clearance Commission at the Faculty of Dental Medicine, Universitas Airlangga, as stated in the ethical approval certificate No. SERT-2026-5296, issued on May 21, 2026.

4. Results and Discussion

Results

This section outlines the study's key findings, beginning with the respondents' demographic profiles. It then details the univariate and bivariate analyses concerning academic stress, fiber and vitamin C consumption, and anemia rates among female medical students at Universitas Negeri Surabaya.

Respondent Characteristics

Table 1. Distribution of Respondents According to Their Characteristics

Category	n (%)
Age	
17 years	1 (1.2%)
18 years	12 (14.1%)
19 years old	44 (51.8%)
20 years	28 (32.9%)
Study program	
Medical	18 (21.2%)
Midwifery	20 (23.5%)
Nursing	23 (27.1%)
Physiotherapy	21 (24.7%)
Dentistry	3 (3.5%)
Consumption of Supplements	
Yes	39 (45.9%)
No	46 (54.1%)

Source: Primary Data, 2026

Univariate Analysis

Vitamin C Intake Levels

The respondents had a mean vitamin C intake of 58.19 ± 15.52 mg/day, while the median intake was 56.70 mg/day. Vitamin C consumption ranged from 28.50 to 87.70 mg/day. Overall, the majority of respondents consumed less vitamin C than the amount recommended by the Recommended Dietary Allowance (RDA).

Table 2
Vitamin C Intake Levels

Vitamin C Intake Levels	n (%)
Less ($<77\%$ RDA)	53 (62,4%)
Sufficient ($\geq 77\%$ RDA)	32 (37,6%)

Source: Primary Data, 2026

Fiber Intake Level

The respondents had a mean fiber intake of 16.30 ± 9.15 g/day, while the median intake was 12.30 g/day. Fiber consumption ranged from 4.30 to 32.20 g/day. Overall, the majority of respondents consumed less fiber than the amount recommended by the Recommended Dietary Allowance (RDA).

Table 3
Fiber Intake Level

Fiber Intake Level	n (%)
Less (<77% RDA)	56 (65,9%)
Sufficient ($\geq 77\%$ RDA)	29 (34,1%)

Source: Primary Data, 2026

Academic Stress Levels

The respondents had a mean academic stress score of 58.72 ± 8.17 , while the median score was 60.00. Academic stress scores ranged from 26 to 74. Overall, the majority of respondents experienced a high level of academic stress.

Table 4
Academic Stress Levels

Academic Stress Levels	n (%)
Low (score 18-45)	6 (7,1%)
High (score 46-90)	79 (92,9%)

Source: Primary Data, 2026

Anemia Incident

The respondents had a mean hemoglobin level of 11.77 ± 1.82 g/dL, while the median level was 11.60 g/dL. On the whole, the prevalence of anemia was observed in the majority of the respondents.

Table 5
Anemia Incident

Anemia Incident	n (%)
Anemia (Hb <12 g/dL)	51 (60%)
No Anemia (Hb ≥ 12 g/dL)	34 (40%)

Source: Primary Data, 2026

Bivariate Analysis

The Relationship Between Vitamin C Intake and the Prevalence of Anemia

Table 6 outlines the association between vitamin C consumption and the prevalence of anemia among female medical students at the State University of Surabaya. The largest proportion of anemia cases was observed among respondents with low vitamin C intake, accounting for 49 individuals (57.6%). Based on the Chi-Square test results, a significant association was found between vitamin C intake and the incidence of anemia (Pearson Chi-Square = 61.779; $p < 0.001$). Additionally, the Phi and Cramer's V value of 0.853 demonstrated a very strong relationship between these two variables.

Table 6
Association of Vitamin C Intake with Anemia Incidence

Vitamin C Intake Levels	Anemia Incident		P-value
	Yes	No	
Less (<77% RDA)	49 (57,6%)	4 (4,7%)	<0.001
Sufficient ($\geq 77\%$ RDA)	2 (2,4%)	30 (35,3%)	

Source: Primary Data, 2026

Association Between Fiber Consumption and Anemia Occurrence

Table 7 outlines the association between fiber consumption and the prevalence of anemia among female medical students at Universitas Negeri Surabaya. The largest proportion of anemia cases was observed among respondents with low fiber intake, accounting for 50 individuals (58.8%). Based on the Chi-Square test results, a significant association was found between fiber intake and the incidence of anemia (Pearson Chi-Square = 58.656; $p < 0.001$). Additionally, the Phi and Cramer's V value of 0.831 demonstrated a very strong relationship between these two variables.

Table 7. Association of Fiber Intake with Anemia Incidence

Fiber Intake Level	Anemia Incident		<i>P-value</i>
	Yes	No	
Less (<77% RDA)	50 (58,8%)	6 (7,1%)	<0,001
Sufficient ($\geq$ 77% AKG)	1 (1,2%)	28 (32,9%)	

Source: Primary Data, 2026

Correlation Between Academic Stress and Anemia Incidence

Table 8 summarizes the relationship between academic stress and the prevalence of anemia among female medical students at Universitas Negeri Surabaya. The largest proportion of anemia cases was observed among respondents with high academic stress, accounting for 51 individuals (60.0%). Based on the Chi-Square test results, a significant association was found between academic stress and the incidence of anemia (Pearson Chi-Square = 9.684; $p = 0.002$). As two cells (50%) Since the expected cell count was less than 5, Fisher's Exact Test was utilized to validate the findings, yielding a p -value of 0.003. Additionally, the Phi coefficient (-0.338) and Cramer's V value (0.338) indicated a moderate association between the two variables.

Table 8. Association of Academic Stress with Anemia Incidence.

Academic Stress Level	Anemia Incident		<i>P-value</i>
	Yes	No	
Low	0 (0%)	6 (7%)	<0.001
High	51 (60%)	28 (33%)	

Source: Primary Data, 2026

DISCUSSION

Respondent Characteristics

Initial data regarding the respondents were gathered to outline the study population and determine characteristics potentially linked to anemia prevalence. The majority of respondents were in early adulthood, which physiologically has higher iron requirements. This condition is particularly prevalent in women due to blood loss during menstruation, which occurs cyclically every month. If this iron requirement is not balanced with adequate intake, the risk of anemia increases. In addition to age and gender, supplement consumption was also an important characteristic in this study. Some respondents were known to be taking iron supplements or iron tablets. These supplements help meet daily iron requirements and support hemoglobin formation. However, not all respondents took them regularly, resulting in uneven protective effects against anemia. This suggests that adherence to supplement consumption is also a crucial factor in anemia prevention.

Academic demands often leave female students with limited time to maintain healthy eating habits, resulting in irregular meal patterns and inadequate dietary variety. As a result, they may experience inadequate daily nutrient consumption, especially concerning essential elements like iron, vitamin C, and dietary fiber. These dietary habits may contribute to an imbalance in nutritional intake and increase the risk of anemia. This condition can ultimately affect hemoglobin status. Overall, the respondents' characteristics serve as important background factors that may affect the relationship between the variables examined in this study and the incidence of anemia.

The Relationship Between Vitamin C Intake and the Prevalence of Anemia

The findings demonstrated a significant association between vitamin C intake and the prevalence of anemia among female students. Specifically, anemia was more common among participants with inadequate vitamin C consumption compared to those with sufficient intake. This highlight underscores the critical role of vitamin C in supporting hemoglobin synthesis via its involvement in iron metabolism, where it promotes the intestinal absorption of non-heme iron by converting ferric iron. Vitamin C facilitates the intestinal absorption of non-heme iron by converting ferric iron (Fe^{3+}) into its more bioavailable ferrous form (Fe^{2+}), thereby enhancing iron utilization in the body. Furthermore, vitamin C acts as an antioxidant, preventing iron oxidation, thereby increasing its availability for erythropoiesis.

Vitamin C deficiency will result in suboptimal iron absorption and potentially lower hemoglobin levels. The insufficient vitamin C intake among participants may stem from a low consumption of fresh fruits and vegetables. Dietary patterns dominated by processed foods and lacking in micronutrient-dense options likely exacerbate this issue. These results

align with previous research by Syarfaini, which indicated that inadequate fruit and vegetable intake elevates the risk of developing anemia (Syarfaini et al., 2023).

However, a portion of the respondents with low vitamin C intake remained non-anemic. This indicates that anemia is not dictated by a single variable alone, but is instead a multifactorial condition. Other factors such as iron reserves, supplement consumption, and other nutritional intake also play a role in maintaining hemoglobin levels. Therefore, vitamin C is an important, but not the sole, determinant of anemia.

Association of Fiber Intake with Anemia Incidence

The present study revealed a significant association between fiber intake and the prevalence of anemia among female students. Specifically, those with inadequate fiber consumption exhibited a higher rate of anemia compared to their counterparts with sufficient intake. These findings suggest that dietary fiber may indirectly influence iron status through its effects on intestinal health. Adequate fiber intake supports the maintenance of a healthy gut microbiota, which is essential for nutrient metabolism. During fermentation, gut microbes generate short-chain fatty acids (SCFAs) that lower intestinal pH, thereby enhancing iron solubility and promoting its absorption. Conversely, inadequate fiber consumption can disrupt the gut microbiota balance and trigger elevated production of hepcidin, a hormone that restricts iron absorption in the intestines (Srimaharani, 2017).

Additionally, insufficient fiber consumption may reflect a low intake of plant-based foods, such as fruits, vegetables, and legumes, which are vital sources of various essential vitamins and minerals. A dietary pattern lacking these nutrient-rich foods may compromise overall nutritional status and contribute to an increased likelihood of developing anemia. These results align with research by Syarfaini, which showed that a low-fiber diet is associated with lower hemoglobin levels (Syarfaini et al., 2023). However, it's important to note that excessive fiber consumption can also inhibit iron absorption through the mineral binding mechanism of certain fiber components. Therefore, fiber consumption should be adjusted to daily needs to provide optimal benefits without disrupting iron availability in the body.

Association of Academic Stress with Anemia Incidence

The findings demonstrated a significant association between academic stress and the prevalence of anemia among the participants. Anemia was more commonly observed in individuals with high levels of academic stress compared to those experiencing lower stress levels. These results imply that psychological conditions can have an impact on physiological functions in the body. Academic stress is generally caused by the burden of assignments, exam pressure, and the demands of academic achievement. This condition triggers an increase in the hormone cortisol, which can affect the body's metabolism, including appetite regulation and nutrient absorption. Individuals with high levels of stress tend to experience changes in eating patterns, such as decreased meal frequency or increased consumption of unhealthy foods (Barseli et al., 2020).

These dietary changes can lead to suboptimal intake of essential nutrients, including iron and vitamin C. Consequently, hemoglobin production is disrupted and the risk of anemia increases. Accordingly, academic stress does not only affect psychological well-being but may also influence nutritional status and physical health conditions. Nevertheless, anemia was not present in all respondents with high stress levels. This indicates that certain protective factors, such as the use of nutritional supplements and sufficient dietary intake, may help preserve hemoglobin levels. These results align with previous studies by Aprianti, Sari, and Husna, which indicated that stress can increase the risk of anemia, though its impact is also modulated by other contributing factors (Aprianti et al., 2021; M. Sari & Husna, 2021).

Overall, the findings of this study indicate that anemia is a condition influenced by multiple factors. The interplay of insufficient vitamin C intake, low fiber consumption, and high academic stress may collectively elevate the risk of anemia among female students. Therefore, effective prevention requires a holistic strategy that includes improving dietary balance as well as implementing appropriate stress management techniques.

6. Conclusion

This study shows that most female students of the Faculty of Medicine, State University of Surabaya have low levels of vitamin C intake (62.4%), low levels of fiber intake (65.9%), high levels of academic stress (92.9%), and experience anemia (60.0%). The results of the analysis showed a significant relationship between the level of vitamin C intake ($p < 0.001$), the level of fiber intake ($p < 0.001$), and the level of academic stress ($p = 0.003$) with the incidence of anemia. Most respondents with low levels of vitamin C intake (57.6%), low levels

of fiber intake (58.8%), and high levels of academic stress (60.0%) experienced anemia, while the proportion of anemia incidence was much lower in respondents with sufficient vitamin C and fiber intake and no anemia incidence was found in respondents with low levels of academic stress. These findings are in line with the objectives of the study, which is to analyze the relationship between the level of vitamin C intake, the level of fiber intake, and the level of academic stress with the incidence of anemia in female students of the Faculty of Medicine, State University of Surabaya, thus indicating that nutritional factors and psychological factors play a role in the incidence of anemia. The results of this study contribute to strengthening the evidence regarding the importance of adequate vitamin C and fiber intake and academic stress management as part of anemia prevention efforts in female students. Therefore, educational institutions are expected to develop nutrition education programs, hemoglobin status monitoring, and stress management programs to support student health and academic achievement. This study has limitations due to its cross-sectional design, which cannot explain causal relationships, and the use of the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) as a measurement method for dietary intake, which relies on respondents' memory and has the potential to introduce recall bias. Therefore, further research is recommended to use a longitudinal or cohort design and consider other variables, such as menstrual patterns, sleep quality, physical activity, nutritional status, and other nutrient intakes, to obtain a more comprehensive understanding of the factors associated with anemia in female students.

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