

Association between anemia, mental health, and nutritional status among junior high school students: a cross-sectional study in Pontianak

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ABSTRACT

Iron deficiency can affect emotional regulation and contribute to symptoms of anxiety, stress, and depression. Poor dietary habits combined with mental health problems may further increase the risk of anemia. This study examined the association between anemia, mental health, and nutritional status among junior high school students in Pontianak. A cross-sectional design was used from May to December 2024 involving 277 students. Data were collected using body mass index (BMI) measurements, hemoglobin screening, and the DASS-Y questionnaire, and were analyzed with Spearman's Rho. Most respondents were female (63.9%), and 90.96% had experienced menstruation. A total of 103 students were underweight, with an average mid-upper arm circumference of 21.48 cm, indicating chronic nutritional risk. Eighty-one students (29.2%) had anemia, predominantly females. Most students had good mental health (below the 50th percentile). No significant associations were found between anemia and mental health ($p = 0.623$) or between anemia and nutritional status ($p = 0.664$). Despite the lack of significant relationships, ongoing nutrition education, regular iron supplementation, counseling support, and routine monitoring of students' nutritional and mental health remain important to maintain and improve overall wellbeing.

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1. INTRODUCTION

Depression, anxiety, and stress have become mental health problems, impacting many people in various parts of the world. Globally, their prevalence rose during the COVID-19 pandemic, particularly for stress and depression in Asia, and later declined after the pandemic [1]. Reported rates reached (28.1%) for depression, (29.57%) for anxiety, and (25.18%) for stress, higher than before February 2020, and were nearly halved afterward [2]. These problems were most common among individuals under 18 and females [3]. In the U.S., however, depression remained significantly higher than pre-pandemic levels (12.4%, 95% CI: 10.6–14.1%), with greater increases among young adults, women, and people with lower socioeconomic status [4]. A systematic literature review also showed rising global anxiety prevalence after SARS-CoV-2 infection, ranging from (16.6%) to (29.6%) across different questionnaires [5]. In Southeast Asia, a high level of

psychological distress persisted a year and a half after the pandemic, particularly among women, non-binary individuals, and low-income groups. In Indonesia, severe or extremely severe anxiety was more prevalent (aOR 1.08 [1.03–1.15]), while depression and stress were less common [6]. Nationally, the 2022 Indonesia National Adolescent Mental Health Survey (I-NAMHS) reported that 1 in 3 adolescents experienced a mental health problem within a year, and 1 in 20 had a mental disorder in the past 12 months, with anxiety being the most frequent [7].

Stress will affect the hypothalamic-pituitary-adrenal (HPA) axis and protein metabolism. Iron deficiency has an influence on the neurological function and development, including the synthesis of emotional control neurotransmitters like dopamine, serotonin, and noradrenaline [8], [9]. Poor myelination and problems in monoamine metabolism influence the neurotransmitter homeostasis (glutamate and γ -Aminobutyric acid (GABA)), resulting in deficits in memory, learning, and behavior, as well as emotional and psychological problems [10].

Proinflammatory cytokines (IL-6) are hypothesized to impact the pathways of iron metabolism under chronic stress conditions, dysregulated cortisol, epigenetic changes, increased cytokines, and proinflammation. Proinflammation results in a change in hepcidin activity during the inflammation period, and eventually increases the risk of iron deficiency associated with chronic stress [11]. Conversely, it is reported that iron deficiency would increase the risk of anxiety disorders [12], [13], depression [13]–[15], and stress [11].

A study in SMPN 17 Tangerang in 2022 found that female adolescents suffered from anemia (40%). Some of the causes of anemia are inadequate knowledge, low maternal education, family income, and eating habits [16]. The low consumption of protein (p : 0.378) and iron (p : 0.087) was identified as a risk factor of anemia, especially among female adolescents [17]. Dietary patterns involving protein and carbohydrate intake, as well as the nutritional status, had a relationship with anemia cases, and malnutrition status would increase the risk of anemia among adolescents by 5.35 times [18]. Besides, stress would change someone's eating habits; the kinds of food they choose would be high in fat and sugar, and low in iron [11]. Nutritional status based on the measurement of upper arm circumference also had a significant relationship with anemia among females [19].

Based on a study conducted in senior high schools in Pontianak in 2023, there were more adolescents with underweight nutritional status than those with overweight (29.9%: 21.4%). This condition could lead to anemia among adolescents, even though some studies showed that there was no relationship between nutritional status and anemia cases [20], [21]. Consumption of iron supplements by adolescents is also important not only to prevent anemia but also to significantly decrease psychiatric problems of patients with iron-deficiency anemia [10].

This study is expected to serve as a basis for improving the regulation and distribution of iron supplementation for adolescents, a program currently targeted at those aged 12-18 years. At present, the implementation is more concentrated in senior high schools, and coverage among junior high school students remains limited. Early adolescents, however, are also vulnerable to iron deficiency due to rapid growth and increased physiological demands. For this reason, the researcher conducted this study to focus specifically on the condition of junior high school students in Pontianak, providing updated data that can support the need to expand iron supplementation and preventive strategies to younger adolescent groups.

2. METHOD

This study used a cross-sectional design to assess anemia status, mental health conditions, and nutritional status among junior high school students at a single point in time. A cross-sectional design was chosen because it allows researchers to measure multiple health indicators simultaneously and examine their associations efficiently. This study was conducted from May to December 2024 and involved 277 eighth-grade students from five junior high schools in Pontianak City, West Kalimantan, Indonesia. The selected schools were those with the largest student populations in each sub-district. The initial sample size was determined using Slovin's formula based on a total student population of 4,767 across the five schools, with a 5% margin of error, resulting in a required sample of 369 students. However, during data collection, 92 (24.9%) parents and students declined the blood examination at the informed consent stage, reducing the final sample to 277 participants. Sampling followed a quota approach to ensure representation from all sub-districts, and participants were recruited based on class level and voluntary participation. In addition, the parents or legal guardians of participants also provide informed consent.

Data collection was carried out in each school from 2 August to 3 September, according to the schedule agreed upon with school administrators. Questionnaire data were obtained through guided interviews, conducted in groups, where the researcher directly facilitated students in completing the paper-based questionnaires. The variables of depression, stress, and anxiety were assessed using a questionnaire of

the Indonesia-Depression Anxiety Stress Scale for Youth (DASS-Y [22]), which has been reported in another study to be valid and reliable [23]. It is comprised of 21 questions that assess students' feelings during the week of the data collection. Each part of the DASS-Y questionnaire contains 7 questions for assessing depression, which are dysphoria, hopelessness, devaluation of life, self deprecation, lack of interest/involvement, anhedonia and inertia; item 3, 5, 10, 13, 16, 17, 21), anxiety (autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious effect; item 2, 4, 7, 9, 15, 19, 20), and stress (chronic nonspecific arousal, difficulty relaxing, nervous arousal, being easily upset/agitated, irritable/over-reactive, and impatience; items 1, 6, 8, 11, 12, 14, 18). Likert scale between 0-3 from every question is summed, with the total score of 0-63. Categorization is based on percentiles, where the 50th percentile shows the average mental health status of the responder. The 90th percentile and above shows high psychological pressure, reflecting more symptoms compared to peers of the same age. The 50th percentile, which indicates good mental health, is scored <33 and the 90th percentile with >52 is categorized as low mental health.

Anemia was assessed using a digital hemoglobin meter for anemia from the brand FamilyDr HB Meter. The data were obtained from hemoglobin (Hb) measurements using blood samples collected from students' fingertips. Hb screening using a hemoglobinometer was considered accurate, showing no significant difference from venous cyanmethemoglobin (gold standard) ($p = 0.651$) [24]. The digital hemoglobinometer showed a negative predictive value (NPV) of (75.8%), sensitivity (89.4%), specificity of (63.6%), and a positive predictive value (PPV) of (82.6%) when compared with the autoanalyzer [25], while the automated hematology analyzer with sodium lauryl sulphate (AHA-SLS) showed significant results ($p: 0.000$) [26]. Therefore, the use of a digital hemoglobinometer is considered suitable for anemia screening, especially at the community level in low-resource settings. According to the World Health Organization (WHO), anemia is indicated by Hb <12 g/dL in females and males aged between 12-45 years old [27]. The variable of nutritional status was measured using body mass index (BMI), with the standard ≥ 25 categorized as overweight and obese, and ≤ 18.5 as underweight. Mid-upper arm circumference (MUAC) was measured using cutoffs of 23 cm for females and 23.5 cm for males. MUAC of the dominant arm was measured at the mid-point between the tip of the shoulder and elbow. Measurements below those numbers are considered at risk of chronic undernutrition [28]. The Kolmogorov-Smirnov test showed that the data were not normally distributed ($p = 0.000 < 0.005$). Therefore, Spearman's Rho correlation analysis was used to examine the relationship between mental health, nutritional status, and anemia.

3. RESULTS AND DISCUSSION

The subjects of this research were 177 female students (63.9%) and 100 male students (36.1%), with 13-year-old students dominating the sample with 205 students (74%). Based on the BMI, it was found that 131 students had normal nutritional status (47.3%), but malnutrition was still observed in 103 students who were categorized as thin (37.2%). The least number was overweight students, which were observed at 43 students (15.5%). Looking at the measurement of arm, the average was 21.48 cm which indicated the risk of chronic undernutrition. If broken down by sex, then 62 (62.6%) of the male students had a MUAC <23.5 cm, and 119 female students (66.9%) had a MUAC <23, similar risk patterns. The result of Hb screening showed that on average the Hb was 13.08 g/dL. There were 81 students (29.2%) who had anemia, consisting of 65 female students and 16 male students. The observation of mental health condition of the students through DASS-Y questionnaire showed that in general the junior high school students in Pontianak were mentally healthy with low risk of depression, anxiety, and stress in 135 students (48.7%), moderate risk in 117 students (42.2%), and high risk in 25 students (9.0%). When observed based on each mental health problem, it was found that 28 students (10.1%) had depression, 27 students (9.7%) had anxiety, and 23 students (8.3%) had stress.

Based on the number of students with anemia cases, it occurred more on female students than on male students. The risk of anemia in female adolescents could be observed from their menstruation history. Of 177 female students, 161 students (90.96%) had gotten their first period. 36 female students (22.36%) reported they did not have regular periods every month. Most students had menarche at the age of 11 (62 students). There were 65 students who had menstrual periods for 2 years, and 90 students menstruated for 7 days every month. Menstruation that lasts for 4-7 days would result in 30-80 ml blood loss per day, along with iron, which in the long run would cause the risk of iron-deficiency anemia in female adolescents [29]. A previous study had found a significant correlation between menstrual cycle and anemia cases [29], [30]. Most female adolescents who suffered from anemia had hypermenorrhea cycle (>8 days), making them to change menstrual pads 5-6 times per day. Although conflicting findings regarding the association between anemia and menstruation (menarche, bleeding quantity, duration, and regularity of cycle) are still reported, it remains important to consider interventions that reduce menstrual blood loss and their impact on iron loss, especially in severe cases [25]. This menstrual problem could be caused by anatomical problems like uterine

structural anomalies or hormonal imbalance caused by lifestyle habits such as physical activity and dieting, hypothyroidism, hyperprolactinemia or microprolactinoma, a noncancerous pituitary gland tumor, which could lead to an increase of anxiety, stress, and the risk of depression in the students [31].

Based on the data in Table 1, the relationship between anemia and students' mental health was that most students with no anemia had good mental health (33.6%), and this was not different from students with anemia (15.2%). As for the students with anemia, only 8 (2.9%) had bad mental health. The significance test showed no relationship between anemia and mental health status among junior high school students ($p = 0.623 > 0.05$). The correlation coefficient was -0.030 , indicating a negative and very weak association.

Table 1. The relationship between anemia and mental health DASS-Y

Anemia status	Good n (%)	Average n (%)	Low n (%)	Total n
Not anemia	93 (33.6)	86 (31.0)	17 (6.1)	196
Anemia	42 (15.2)	31 (11.2)	8 (2.9)	81
Total	135 (48.7)	117 (42.2)	25 (9.0)	277

Note. Spearman's correlation showed no relationship between anemia and mental health status, $p = .623$, $r_s = -.030$

Anemia cases in adolescents based on other studies also showed a significant correlation with mental health problems even though this study showed no significant relationship between the two. Depression, anxiety, and stress were experienced by Generation-Z adolescents who had anemia, with symptoms like nervousness, excessive anxiety, and unfounded fear. Depression as a response to mental health problems was also suffered by adolescents with anemia, like feelings of hopelessness, enthusiasm loss, and low self-worth, especially those who were facing medical problems [32]. Lack of ferritin (the iron serum) and transferrin in males, as with female, iron deficiency is positively associated with an increased risk of depression [33], [34]. This could be influenced by neurotransmitter synthesis and dysregulation ability, which affects hormone such as dopamine, serotonin, and norepinephrine hormone.

This could also happen because the early stage of anemia starts from the lack of blood cells that bring oxygen to the brain and throughout the body, which leads to some symptoms like fatigue and weakness, losing happiness and feelings of sadness often observed in depressed people; furthermore, risk of anemia could increase as depression symptoms develop [35]. Eventually, anemia and mental health problems in students would influence their learning achievement because of low concentration, physical problems, reduced adaptive skill, and diminished capability to control learning pressure [36]. Although our findings showed no association between anemia and mental health status, other studies report similar results, possibly due to coping mechanisms and the 120-day lifespan of red blood cells, with younger individuals having faster physiological recovery. In addition, relying only on Hb to assess anemia may be insufficient to reveal potential links with anxiety [37]. Moreover, stress has been negatively linked to Hb levels. No relationships were observed between anxiety and ferritin after adjusting for key variables (body mass index (BMI), menstruation, iron intake, and coffee or tea consumption), and serum iron was unrelated to iron intake but declined with higher BMI [38]. These results highlight the complex interplay of physiological and behavioral factors influencing iron status. Even though no correlation was found, observation and appropriate intervention on the students with risk of mental health need to be given, including providing counseling. The use of digital platforms for children's and adolescent health services could be a good be a beneficial tool for early prevention [39] or by doing physical activities, like aerobic which is believed to lift mood and cognitive function while yoga and tai chi can support stress management and emotional regulation [40].

On the other hand, another factor that causes anemia is adolescents' nutritional status. Furthermore, based on the correlation test between nutritional status and anemia in Table 2, it was found that 42 students (51.9%) had normal nutritional status, compared to 31 students (38.3%) with anemia who were underweight. 81 students without anemia (45.4%) had normal nutritional status, followed by 72 students (36.7%) having nutritional status underweight. Based on Spearman's correlation test, the p-value was 0.664 (> 0.05), indicating no correlation between nutritional status and anemia. The correlation coefficient was -0.028 , showing a negative and very weak relationship.

Based on the study that had been conducted, it was shown that there was no correlation between nutritional status and anemia in junior high school students. This result is similar to the previous study that showed no correlation between BMI and Hb levels in adolescent girls [19], [21]. Menstrual blood loss and MUAC became the main factor of anemia case, aside of iron consumption [19]. Iron consumption could be influenced by high consumption of antinutrient tannin that can lower the absorption of iron from food [41]. Tea is one of the drinks that contain tannin with concentration of 5-15%, and its consumption is considerably

high for people aged 11-20 years old, around 1,25 cup/day [42]. Another factor that causes anemia is the consumption of low-protein food [18], low variety of food consumed causes a deficiency of other micro-minerals that help iron absorption [17].

One of the ways to control the risk of anemia, which influences mental health, is by monitoring the nutritional intake (variety of irregular meals, and animal food sources), supplement intake rich in iron, sleeping habits, and fatigue [10], [19], [43]–[45]. Excessive dieting influenced by adolescent body image today has become one of the risk factors for anemia [46]. However, a previous study showed that iron intake did not have a correlation with the Hb level and body image [47].

This research has several limitations. The cross-sectional design restricts causal inference, particularly regarding the interplay between iron status and mental health. The reliance on Hb as the sole biomarker may overlook subclinical iron deficiency, limiting diagnostic sensitivity, and the absence of additional biochemical indicators, such as ferritin, C-reactive protein (CRP), or transferrin saturation, prevents differentiation between iron deficiency anemia and anemia of inflammation. Self-reported dietary intake and menstrual characteristics may introduce recall and reporting bias, while psychosocial factors that could influence mental health outcomes were not comprehensively measured.

The use of quota sampling, although practical for school-based research, may introduce selection bias and limit representativeness, and sampling confined to eighth-grade students further narrows external validity. Measurements of MUAC and Hb were taken at a single time point, which may not capture physiological and dietary variations over time. Despite these limitations, schools can strengthen nutrition education, conduct routine anemia screening with follow-up, ensuring consistent iron supplementation. They can also provide counseling for students with early mental health symptoms, promote healthy lifestyle habits, and involve parents in monitoring eating patterns and overall well-being. In addition, it is very important to explore and increase students' knowledge, attitude, and practice regarding anemia and its prevention

Table 2. Correlation between nutritional status and anemia

Nutritional status	Not anemia (≥ 12 g/dL)	Anemia (< 12 g/dL)	Total
	n (%)	n (%)	n
Normal	89 (32.1)	42 (15.2)	131
Overweight	35 (12.6)	8 (2.9)	43
Underweight	72 (26.0)	31 (11.2)	103
Total	196 (70.8)	81 (29.2)	277

Note: Spearman's correlation showed no significant association between nutritional status and anemia, $p = .664$, $r_s = -.028$.

4. CONCLUSION

The study found no significant relationship between anemia, mental health, and nutritional status among junior high school students in Pontianak, with most students showed normal Hb levels, good mental well-being, and adequate nutritional status. Even so, continued efforts are needed to strengthen nutrition education, promote consumption of iron-rich foods, ensure regular distribution and monitoring of iron supplements, and provide counseling for students with early signs of mental health concerns. Routine monitoring of nutritional status, support from schools and parents in developing healthy eating habits, and consistent mental health programs remain essential to maintain and improve students' overall health.

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AUTHOR CONTRIBUTIONS STATEMENT

This study was conducted through the collaboration of all authors, each of whom made substantial contributions according to the CRediT taxonomy.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
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Iit Fitrianingrum	✓	✓	✓	✓		✓		✓	✓	✓	✓			
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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper. Authors state no conflict of interest.

INFORMED CONSENT

Informed consent for participation in this study was obtained from the school authorities acting as guardians of the students, as well as from the students themselves and their parents.

ETHICAL APPROVAL

This research was conducted in accordance with ethical research guidelines and the principles of the Helsinki Declaration. Ethical approval was obtained from the Faculty of Medicine, Tanjungpura University (Approval No. 4437/UN22.9/PG/2024).

DATA AVAILABILITY

The datasets generated and analyzed during the current study are not publicly available due to privacy considerations but are available from the corresponding author upon reasonable request.

REFERENCES

- [1] H. Daniali, M. Martinussen, and M. A. Flaten, "A global meta-analysis of depression, anxiety, and stress before and during a COVID-19," *Health Psychology*, vol. 42, no. 2, pp. 124–138, 2023, doi: 10.1037/hea0001259.supp.
- [2] S. Mahmud, M. Nayem, and D. Abdul, "The global prevalence of depression, anxiety, stress, and insomnia among general population during COVID-19 pandemic: a systematic review and meta-analysis," *Trends in Psychology*, vol. 31, no. 1, pp. 125–152, 2023, doi: 10.1007/s43076-021-00116-9.
- [3] I. M. Alqahtani *et al.*, "Prevalence of depression, anxiety, and stress among the general population during COVID-19 pandemic: a systematic review," *Journal of Family Medicine and Primary Care*, vol. 12, pp. 1030–1037, 2023, doi: 10.4103/jfmpc.jfmpc.
- [4] Y. Jiang, W. Deng, and M. Zhao, "Influence of the COVID-19 pandemic on the prevalence of depression in U.S. adults: evidence from NHANES," *Scientific Reports*, vol. 15, no. 3107, pp. 1–10, 2025, doi: 10.1038/s41598-025-87593-5.
- [5] J. Burkauskas, I. Branchi, S. Pallanti, and K. Domschke, "Anxiety in post-COVID-19 syndrome – prevalence, mechanisms and treatment," *Neuroscience Applied*, vol. 3, no. 2024, p. 103932, 2024, doi: 10.1016/j.nsa.2023.103932.
- [6] W. W. Y. Tay, J. Jesuthasan, K. S. Wan, T. Ong, and F. Mustapha, "Eighteen months into the COVID-19 pandemic: the prevalence of depression, anxiety, and stress symptoms in Southeast Asia and the associated demographic factors," *Front Public Health*, vol. 10:863323., 2022, doi: 10.3389/fpubh.2022.863323.
- [7] Center for Reproductive Health, University of Queensland, & Johns Hopkins Bloomberg School of Public Health. Indonesia – National Adolescent Mental Health Survey (I-NAMHS) Report. Center for Reproductive Health, 2022.
- [8] F. Fekih-Romdhane and H. A. Jahrami, "Iron deficiency and psychiatric disorders," in *Brain-Iron Cross Talk. Nutritional Neurosciences*, W. Mohamed, N. L. Brogazzi, and R. M. Kostrzewa, Eds., Singapore: Springer Nature Singapore, 2023, pp. 229–245. doi: 10.1007/978-981-19-7327-7_11.
- [9] H. E. Shah *et al.*, "Iron deficiency-induced changes in the hippocampus, corpus striatum, and monoamines levels that lead to anxiety, depression, sleep disorders, and psychotic disorders," *Cureus*, vol. 13, no. 9, p. e18138, 2021, doi: 10.7759/cureus.18138.
- [10] H. Lee, H. Chao, W. Huang, S. C. Chen, and H. Yang, "Psychiatric disorders risk in patients with iron deficiency anemia and association with iron supplementation medications: a nationwide database analysis," *BMC Psychiatry*, vol. 20, no. 216, pp. 1–9, 2020, doi: 10.1186/s12888-020-02621-0.
- [11] B. M. Reid and M. K. Georgieff, "The interaction between psychological stress and iron status on early-life neurodevelopmental outcomes," *Nutrients*, vol. 15, no. 3798, pp. 1–15, 2023, doi: 10.3390/nu15173798.
- [12] J. Kim and M. Wessling-Resnick, "Iron and mechanisms of emotional behavior," *The Journal of Nutritional Biochemistry*, vol. 25, no. 11, pp. 1101–1107, 2015, doi: 10.1016/j.jnutbio.2014.07.003.Iron.
- [13] Q. Wu, Q. Ren, J. Meng, W. Gao, and Y. Chang, "Brain iron homeostasis and mental disorders," *Antioxidants (Basel)*, vol. 12, no. 11, p. 1997, 2023, doi: 10.3390/antiox12111997.

- [14] B. A. L. Milligen, N. Vogelzangs, J. H. Smit, and B. W. J. H. Penninx, "Hemoglobin levels in persons with depressive and/or anxiety disorders," *Journal of Psychosomatic Research*, vol. 76, no. 4, pp. 317–321, 2014, doi: 10.1016/j.jpsychores.2014.01.004.
- [15] F. Alkhalidi, "Relationship between iron deficiency anemia and depressive disorder in Iraqi sample patients," *Journal Applied Hematology*, vol. 15, pp. 215–218, 2024, doi: 10.4103/joah.joah.
- [16] E. S. Dewi, R. Mardhiati, and N. Musniati, "Factors associated with the incidence of anemia in girls at SMPN 17 Tangerang in 2022," *Jurnal Biomedika dan Kesehatan*, vol. 6, no. 1, pp. 13–25, 2023, doi: 10.18051/JBiomedKes.2023.v6.13-25.
- [17] Jumiayati, T. Wahyu W, A. Krisnasary, and R. Yulianti, "Anemia among adolescent girls: its association with protein and iron intake," *Media Gizi Indonesia (National Nutrition Journal)*, vol. 18, no. 1SP, pp. 14–20, 2023, doi: 10.20473/mgi.v18i1sp.14-20.
- [18] K. Pibriyanti, L. Zahro, S. K. Ummah, L. Luthfiya, and F. K. Sari, "Macronutrient, nutritional status, and anemia incidence in adolescents at Islamic boarding school," *Jurnal Gizi Klinik Indonesia*, vol. 18, no. 2, pp. 97–103, 2021, doi: 10.22146/ijcn.63122.
- [19] P. Sari, D. M. D. Herawati, M. Dhamayanti, and D. Hilmanto, "Anemia among adolescent girls in West Java, Indonesia: related factors and consequences on the quality of life," *Nutrients*, vol. 14, no. 18, pp. 1–13, 2022, doi: 10.3390/nu14183777.
- [20] H. Monika, A. Djogo, and Y. M. K. Letor, "The association between nutritional status and anemia in adolescent girls in Kupang city: a cross-sectional study in the international virtual conference on nursing," in *KnE Life Sciences*, 2022, pp. 909–919, doi: 10.18502/cls.v7i2.10391.
- [21] R. P. Sari, E. Maria, L. Silaban, and Y. A. Merry, "Correlation of hemoglobin levels with nutritional status in adolescent girls: a health promotion perspective," *Jurnal Promosi Kesehatan Indonesia*, vol. 18, no. 2, pp. 109–115, 2023, doi: 10.14710/jpki.18.2.109-115.
- [22] M. Szabo, P. F. Lovibond, and J. V. Luciano, "Development and psychometric properties of the dass-youth (dass-y): an extension of the depression anxiety stress scales (DASS) to adolescents and children," *Frontiers in Psychology*, vol. 13, no. 766890, pp. 1–16, 2022, doi: 10.3389/fpsyg.2022.766890.
- [23] R. Sarfika, H. Malini, A. L. Wicaksana, B. P. Wenny, I. M. Moh, and Y. Saifudin, "Cross cultural adaptation and psychometric evaluation of the Indonesian version of the depression anxiety stress scales for youth," *Heliyon*, vol. 10, no. 19, p. e38830, 2024, doi: 10.1016/j.heliyon.2024.e38830.
- [24] M. Lailla, Zainiar, and A. Fitri, "Comparison of the results of digital hemoglobin examination with the results of hemoglobin examination using cyanmethemoglobin (in Bahasa: *Perbandingan hasil pemeriksaan hemoglobin secara digital terhadap hasil pemeriksaan hemoglobin secara cyanmethemoglobin*)," *Jurnal Pengelolaan Laboratorium Pendidikan*, vol. 3, no. 2, pp. 63–68, 2021, doi: 10.14710/jplp.3.2.63-68.
- [25] M. Toppo, D. K. Pal, D. Gour, V. Melwani, M. Dubey, and A. Mishra, "Comparison of performance of digital hemoglobinometer over automated hematology analyzer for hemoglobin estimation and its user _ friendliness among the pregnant women in selected district hospitals of Madhya Pradesh," *Indian Journal of Community Medicine*, vol. 44, pp. 31–34, 2019, doi: 10.4103/ijcm.IJCM.
- [26] F. Illanangtyas, N. Lailly, I. Sukarni, and W. Widarsih, "The differences in the results of haemoglobin level examinations in female adolescents using digital and automated hematology analyzer methods," *Food Research*, vol. 7, no. Suppl.1, pp. 283–288, 2023, doi: 10.26656/fr.2017.7(S1).10.
- [27] WHO, *Guideline on haemoglobin cutoffs to define anaemia in individuals and populations*. Geneva: World Health Organization, 2024.
- [28] C. A. Nogueira-de-Almeida, P. Ruffo, E. Z. Martinez, and F. da V. Ued, "Cutoff points of mid-upper arm circumference (MUAC) for diagnosis of adolescent obesity : a systematic review with meta-analysis and mosta tape proposal MUAC cutoff for diagnosis of adolescent obesity," *Global Pediatrics*, vol. 8, no. 100135, pp. 1–7, 2024, doi: 10.1016/j.gped.2024.100135.
- [29] C. M. Julianti, F. Realita, and E. Sutrisminah, "The relationship between menstrual patterns and the incidence of anemia in young girls at SMPN 1 Tanjung, Brebes Regency," *Jurnal Ilmiah Sultan Agung*, no. September, pp. 404–412, 2024.
- [30] A. Dineti, D. Maryani, Y. Purnama, Asmariyah, and K. Dewiani, "The relationship of menstrual patterns with anemia in adolescent women in coastal areas Bengkulu City," *Jurnal Surya Medika*, vol. 8, no. 3, pp. 86–91, 2022, doi: 10.33084/jsm.v8i3.4503.
- [31] T. K. Çetin and Z. K. Sarılar, "Evaluation of heavy menstrual bleeding in adolescents," *Journal Clinical Research Pediatric Endocrinology*, vol. Feb 20, pp. 11–19. Epub ahead of print, 2025, doi: 10.4274/jcrpe.galenos.2025.2024-11-19.
- [32] D. Yuliyawati, V. N. Putri, and S. C. Salsabila, "The effect of anemia on mental health in Gen Z adolescents at the Ministry of Health Polytechnic of Malang (in Bahasa: *Pengaruh anemia terhadap kesehatan mental pada remaja gen z poltekkes Kemenkes Malang*)," *Jurnal Studi Keperawatan*, vol. 5, no. 5, pp. 1–4, 2024.
- [33] C. Y. Leung and M. Kyung, "Associations of iron deficiency and depressive symptoms among young adult males and females: NHANES 2017 to 2020," *Preventive Medicine Reports*, vol. 37, no. December 2023, p. 102549, 2024, doi: 10.1016/j.pmedr.2023.102549.
- [34] A. A. Hassan, H. Y. Alharbi, and I. Adam, "Serum ferritin and iron deficiency in adolescent schoolchildren with depression in northern Sudan: unmatched case-control study," *Psychiatry*, vol. 16, no. 1622027, pp. 1–8, 2025, doi: 10.3389/fpsyg.2025.1622027.
- [35] C. Liu, R. Zhou, X. Peng, T. Zhu, W. Wei, and X. Hao, "Relationship between depressive symptoms and anemia among the middle-aged and elderly: a cohort study over 4-year period," *BMC Psychiatry*, vol. 23, no. 572, pp. 1–12, 2023, doi: 10.1186/s12888-023-05047-6.
- [36] N. I. Aderita and S. Ningsih, "The relationship between levels and mental health and learning achievement of high school students," *Jurnal Penelitian Keperawatan*, vol. 10, no. 1, pp. 97–104, 2024, doi: 10.32660/jpk.v10i1.728.
- [37] U. P. Kinayungan, "The relationship between anemia and anxiety disorders among adolescent girls in Bekasi district, Indonesia: a cross-sectional study," *Journal of Community Mental Health and Public Policy*, vol. 7, no. 2, pp. 147–155, 2025, doi: 10.51602/cmhp.v7i2.236.
- [38] H. A. Almasmoum, M. S. Iqbal, A. Aljaadi, K. Ghafouri, and A. H. Qasem, "Prevalence of undiagnosed iron deficiency anemia and associated factors among female undergraduate medical students in Makkah, Saudi Arabia," *Cureus*, vol. 15, no. 12: e50046, pp. 4–13, 2023, doi: 10.7759/cureus.50046.
- [39] C. Wani, L. McCann, M. Lennon, and C. Radu, "Digital mental health interventions for adolescents in low- and middle-income countries : scoping review," *Journal of Medical Internet Research*, vol. 26, no. e51376, pp. 1–20, 2024, doi: 10.2196/51376.
- [40] Z. Li, J. Li, J. Kong, Z. Li, R. Wang, and F. Jiang, "Adolescent mental health interventions: a narrative review of the positive effects of physical activity and implementation strategies," *Frontiers in Psychology*, vol. 15, p. 1433698, 2024, doi: 10.3389/fpsyg.2024.1433698.
- [41] M. Lazrak *et al.*, "Tea consumption reduces iron bioavailability from nafeedta in nonanemic women and women with iron deficiency anemia : stable iron isotope studies in Morocco," *Journal of Nutrition*, vol. 151, no. 9, pp. 2714–2720, 2021, doi: 10.1093/jn/nxab159.
- [42] H. Praselia *et al.*, "A study of tea consumption pattern in Indonesia toward sustainable product diversification," *Biopropal Industri*, vol. 11, no. 2, pp. 107–118, 2020, doi: 10.36974/jbi.v11i2.6249.

- [43] M. Khatun *et al.*, “Iron deficiency anemia and its association with food habits and mental health among university students,” *Journal of Biosciences and Public Health*, vol. 1, no. 2, pp. 59–71, 2025, doi: 10.5455/JBPH.2025.10.
- [44] M. Asrullah *et al.*, “Sleep quality, depression, and the risk of anaemia in adolescents aged 10–19 years during one year of the COVID-19 pandemic in Indonesia,” *Stress and Health*, vol. 41, no. 3:e70046, pp. 1–13, 2025, doi: 10.1002/smi.70046.
- [45] S. Kedir *et al.*, “Hemoglobin level and common mental disorder among school adolescent girls in central Ethiopia : structural equation model,” *Maternal and Child Nutrition*, vol. 21, no. e13760, pp. 1–11, 2025, doi: 10.1111/mcn.13760.
- [46] R. M. Hutasuhut and Supriati, “Relationship between body image and dietary status with anemia in adolescent girl in Dusun III Bakaran Batu Village Batang Kuis District Deli Serdang Regency,” *Science Midwifery*, vol. 10, no. 2, pp. 974–979, 2022.
- [47] Anisa, R. A. Ayuningtyas, F. F. Jauharany, and J. T. Isworo, “Relationship between body image and adequacy of iron intake with hemoglobin levels in adolescent females,” *Journal Gizi Pangan*, vol. 18, no. 28, pp. 16–18, 2023, doi: 10.25182/jgp.2023.18.Supp.1.16-18.

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