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Application of the Health Belief Model in Adherence to Iron Supplement Consumption Among Female Students at Universitas Diponegoro

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Abstract
Introduction: Anemia, a deficiency of red blood cells, is common in adolescent girls. The Indonesian government has an iron supplement program targeting school-aged girls. Female university students are not included. Consequently, iron supplement intake depends on individual choices. This study aimed to identify the factors associated with adherence to iron supplement consumption as a preventive measure against anemia among female students at Universitas Diponegoro.
Methods: This was a quantitative study with a cross-sectional approach using interviews and questionnaires. The sample of this study was 384 respondents from 33,156 female students of Universitas Diponegoro in 11 faculties and one vocational school using the proportional sampling method, with the inclusion criteria being active diploma/undergraduate students who consented. This study employed univariate and bivariate analyses using chi-square tests.
Results: The results indicated a significant relationship between iron supplement adherence and knowledge of anemia (p=0.001), knowledge of iron tablet consumption (p=0.001), perceived susceptibility (p=0.001), perceived severity (p=0.001), perceived benefits (p=0.001), perceived barriers (p=0.001), self-efficacy (p=0.001), and cues to action (p=0.001). However, no significant relationships were found between iron supplement adherence and age (p=0.570), level of study (p=0.127), allowance (p=0.958), or place of residence (p=0.793).
Conclusion: Knowledge of anemia, knowledge of iron tablet consumption, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy, and cues to action are associated with iron supplement adherence among female students at Universitas Diponegoro in Semarang.

Keywords: anemia, iron supplement, perceived, adherence, female students.

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Introduction

Anemia occurs when the body has insufficient hemoglobin, leading to oxygen deficiency. It is a serious public health problem worldwide, affecting children, adolescent girls, menstruating women, pregnant women, and postpartum mothers, with iron deficiency being the most common cause.[1] The WHO estimates that about 30% of women aged 15–49 years suffer from anemia globally.[2] In 2019, the World Health Organization (WHO)

recorded an anemia prevalence of 29.9% among women aged 15–49 years. The prevalence declined from 2000 to 2015, plateaued, and began to rise again, with Southeast Asia consistently showing the highest global rates at 42%. In 2019, Indonesia had an anemia prevalence of 23% among women aged 15 and older, higher than in neighboring countries such as Malaysia (21%) and Singapore (22%).[3] Recent international evidence also highlights that anemia continues to affect university-age women worldwide, underscoring the importance of extending prevention efforts beyond adolescence.[4]

To address this, Indonesia launched a national iron supplementation program in 2014, targeting adolescent girls aged 12–18 years. The program distributes one tablet weekly (about 52 per year) through school health units in junior and senior high schools.[5,6] According to the 2018 Basic Health Research (Riskesdas), 76.2% of adolescent girls reported receiving tablets, mostly at school.[7] However, anemia prevalence among adolescents aged 15–24 years still rose sharply from 6.9% in 2007 to 32.0% in 2018.[8–10] More recent data from the 2023 Indonesian Health Survey (SKI) show a steep decline in supplementation after age 18, when school distribution ends: while 72.5% of girls aged 10–18 obtained or received iron tablets, only 42.7% of those aged 19 did so.[11]

The average age of female diploma and undergraduate students in Indonesia ranges from 18 to 24 years, which falls into the late adolescent category (17–25 years).[12,13] The government's iron supplement tablet program does not reach female adolescents (university students) in higher-education institutions. The consumption behavior of iron supplement tablets among female university students is no longer influenced by the government's supplementation program. Instead, they independently determine the frequency and intensity of their iron supplement intake.[14]

Puberty in females generally occurs between the ages of 10 and 16 years; however, reproductive organ development and nutritional needs, including iron, continue until the ages of 21 to 24.[15] It is strongly recommended that females continue taking iron supplements after puberty, as menstruation causes significant iron loss. During menstruation, females need twice as much iron as males, and to restore their physical condition after blood loss, they require three times more iron than males. Females are also ten times more likely to develop anemia.[16,17] Dietary iron intake is often insufficient, especially among those with unbalanced eating patterns or those who follow restrictive diets. Regular supplementation also serves as preparation for the reproductive age, as anemia during pregnancy increases the risk of complications such as low birth weight, stunting, and maternal or infant mortality.[18] Female university students, who tend to have high activity levels, also need to maintain physical endurance to stay healthy, productive, and focused during their campus life. Studies from other contexts also confirm that female university students often exhibit low adherence to iron supplementation and remain a neglected group in anemia prevention programs.[19] This gap highlights female university students as a neglected population group in both policy and research.

Universities play a critical role in shaping healthy lifestyles through the Ministry of Health's "Healthy Campus" program, which promotes nutrition education and disease prevention.[20–22] Universitas Diponegoro is one of the pilot universities and has implemented various initiatives, such as regular physical activities, health screenings, and free balanced meals.[23] However, iron supplementation for female students has not yet been included, even though the government's iron tablet program only targets school-aged adolescents and does not extend to universities. This underscores the urgency of investigating the factors influencing iron supplement adherence among female students as evidence for future campus-based intervention.

This study applied the Health Belief Model (HBM) as its theoretical framework. The HBM is widely used to explain preventive health behaviors, including supplement use, because it considers perceived susceptibility, perceived

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severity, perceived benefits, perceived barriers, self-efficacy, and cues to action.[24,25] Using this framework, this study aimed to identify factors associated with iron supplement adherence among female students at Universitas Diponegoro. The novelty of this research lies in its focus on university students, as most previous studies have examined junior and senior high school populations only.

Methods

This study employed a quantitative approach with a cross-sectional design to explore female students' perceptions regarding iron supplement intake as a preventive measure against anemia at Universitas Diponegoro during the odd semester of 2024. The research population included 33,156 female students enrolled in diploma and undergraduate programs across 11 faculties and one vocational school at Universitas Diponegoro. The sample size was calculated using the Lemeshow formula with a proportion of 0.5, a 95% confidence level, and a 5% margin of error, resulting in a minimum requirement of 380 participants. A total of 384 female students were recruited. Sampling was conducted using a non-probability proportional accidental (incidental) sampling method, in which the number of respondents from each faculty and vocational school was proportionally allocated according to the size of each faculty. Participants were selected based on their availability and willingness to participate in the study. Ethics approval for this study was obtained from the Health Research Ethics Committee, Faculty of Public Health, Diponegoro University, and was declared to have passed the ethical review (No. 331/EA/KEPK-FKM/2024). All participants provided informed consent prior to data collection.

This study aimed to examine the relationship between iron supplement adherence and anemia prevention efforts among female students, guided by the Health Belief Model (HBM) framework.[24,25] The HBM constructs included individual characteristics (age, level of study, allowance, and place of residence), knowledge (knowledge of anemia and knowledge of iron supplement tablet consumption), and perceptions (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy, and cues to action). The dependent variable, iron supplement adherence behavior, was categorized into 'adherent' (met all three criteria: ever consumed iron supplement tablets during the study period, consumed iron supplement tablets in the past month, and regularly consumed iron supplement tablets weekly) and 'non-adherent' (did not meet at least one of the three criteria). The independent variables related to individual characteristics include age, which was categorized into '17-21 years' and '22-25 years'; level of study, which was categorized into 'early semesters' and 'final semesters'; allowance, which was categorized into 'high' and 'low'; and place of residence, which was categorized into "with parents" and "not with parents". The independent variables in perceived susceptibility, perceived severity, perceived benefits, and perceived barriers were categorized into 'high' and 'low.' The independent variables, namely knowledge of anemia, knowledge of iron supplement consumption, self-efficacy, and cues to action, were categorized as "good" or "poor."

This study collected data through face-to-face interviews guided by a questionnaire designed by the researcher. To ensure clarity and comprehensibility, the questionnaire was pretested on five female students from Universitas Negeri Semarang (UNNES), who shared similar characteristics with the target respondents, female students at Universitas Diponegoro. Both institutions are public universities located in Semarang, Central Java. This pre-test was conducted solely to assess readability and understanding rather than to establish statistical validity. All variables in this study, both independent and dependent, were tested for normality using the Kolmogorov-Smirnov test. The results showed that all variables had a significance value ($p < 0.05$), which meant that the data were not normally distributed. The data were grouped based on the median values. The analysis included univariate techniques to explore the frequency distribution of each variable and bivariate

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analysis using the chi-square test to assess the relationship between the main variable, iron supplement adherence among female students at Universitas Diponegoro, and all other variables examined in this study.

Results

Table 1 presents the frequency distribution of the univariate analysis of all variables examined in this study. The dependent variable in this study was iron supplement adherence. The independent variables consisted of respondent characteristics and Health Belief Model variables. Regarding the dependent variable, iron supplement adherence among female students at Universitas Diponegoro, 181 female students (47.1%) adhered to iron supplement consumption, while 203 female students (52.9%) did not adhere.

The respondent characteristic variables included age, level of study, allowance, and place of residence. The univariate analysis of the age variable showed that the age range of female students at Universitas Diponegoro was between 17 and 25 years. The normality test for age indicated a non-normal distribution; therefore, the median value of 21 years was used as the category threshold. The majority of respondents were aged 17–21 years (67.2%), while 32.8% were aged 22–25. The univariate analysis of the level of study variable showed that female students were in semesters 1, 3, 5, and 7. Most respondents were in the final semesters (semesters 5 and 7), accounting for 59.1%, compared to those in the early semesters (semesters 1 and 3), who accounted for 40.9%. The univariate analysis of the place of residence variable showed that the majority of female students lived in the "not with parents" category (77.9%), while 22.1% lived in the "with parents" category.

The univariate analysis of the allowance variable showed that female students' monthly allowances ranged from IDR 500,000 to IDR 4,000,000. The normality test showed that the allowance was not normally distributed, and the median value of IDR 1,600,000 was used as the threshold. Most respondents had a low allowance (≤ IDR 1,600,000), accounting for 52.3%, while 47.7% had a high allowance (> IDR 1,600,000). The analysis of the residence variable showed that most female students lived away from their parents (77.9%) compared to those who lived with their parents (22.1%).

The Health Belief Model variables included knowledge of anemia, knowledge of iron supplements, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy, and cues to action. The univariate analysis of the knowledge of anemia variable indicated a non-normal distribution; therefore, a median score of 5 was used as the threshold. The majority of female students had poor anemia knowledge (76.6%), compared to those with good knowledge (23.4%). For the knowledge of iron supplement consumption variable, a similar approach was used with a median score of 5, showing that 57.6% of the respondents had poor knowledge, while 42.4% had good knowledge.

The univariate analysis of perceived susceptibility indicated a non-normal distribution; thus, a median score of 4 was used as the threshold. Most respondents had a low perceived susceptibility (59.1%), while 40.9% had a high perceived susceptibility. The univariate analysis of perceived severity also showed a non-normal distribution, with a median threshold score of 4. A total of 52.9% of female students had low perceived severity, whereas 47.1% had high perceived severity.

The analysis of perceived benefits showed a non-normal distribution with a median threshold of 5. Most female students had low perceived benefits (65.4%), whereas 34.6% had high perceived benefits. For perceived barriers, the normality test also showed a non-normal distribution, and a threshold score of 6.5 was applied. The distribution was even, with 50.0% of the participants having low perceived barriers and 50.0% having high perceived barriers.

The analysis of self-efficacy showed a non-normal distribution, and a median score of 4 was used as the threshold. Most

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respondents had low self-efficacy (53.4%) compared with those with high self-efficacy (46.6%). For cues to action, the data were also not normally distributed, with a threshold score of four. A total of 59.1% of female students reported weak cues to action, whereas 40.9% had strong cues to action.

Table 2 presents the bivariate analysis results of the independent variables, including respondent characteristics and Health Belief Model variables, in relation to the dependent variable, iron supplement adherence. The bivariate analysis indicated no significant associations (p-value > 0.05) between respondent characteristics, namely age (p = 0.570), level of study (p = 0.678), allowance (p = 0.958), and place of residence (p = 0.793), and iron supplement adherence. However, significant associations were found between the Health Belief Model variables, including knowledge of anemia (p = 0.001), knowledge of iron supplement consumption (p = 0.001), perceived susceptibility (p = 0.001), perceived severity (p = 0.001), perceived benefits (p = 0.001), perceived barriers (p = 0.001), self-efficacy (p = 0.001), and cues to action (p = 0.001), and iron supplement adherence.

Based on the bivariate data, it was found that for the age variable, the majority of respondents who were non-adherent to iron supplement consumption were aged 17–21 years (53.9%), while the majority of those who were adherent were aged 22–25 years (49.2%). For the level of study variable, the majority of non-adherent respondents were in the final semesters (53.7%), while the majority of adherent respondents were in the early semesters (48.4%). For the allowance variable, the majority of non-adherent respondents had a high allowance (53.0%), whereas the majority of adherent respondents had a low allowance (47.3%). For the place of residence variable, the majority of non-adherent respondents lived with their parents (54.1%), whereas the majority of adherent respondents lived apart from their parents (47.5%).

For the knowledge of anemia variable, the majority of non-adherent respondents had poor knowledge (66.3%), while the majority of adherent respondents had good knowledge (91.1%). For the knowledge of iron supplement consumption variable, the majority of non-adherent respondents had poor knowledge (70.1%), while the majority of adherent respondents had good knowledge (70.6%). For the perceived susceptibility variable, most nonadherent respondents had low perceived susceptibility (67.4%), while most adherent respondents had high perceived susceptibility (68.2%). For the perceived severity variable, the majority of non-adherent respondents had low perceived severity (67.5%), whereas the majority of adherent respondents had high perceived severity (63.5%).

For the perceived benefit variable, the majority of non-adherent respondents had low perceived benefits (70.1%), while the majority of adherent respondents had high perceived benefits (79.7%). For the perceived barriers variable, most non-adherent respondents had high perceived barriers (65.1%), while most adherent respondents had low perceived barriers (59.4%). For the self-efficacy variable, the majority of non-adherent respondents had low self-efficacy (66.8%), whereas the majority of adherent respondents had high self-efficacy (63.1%). For the cues to action variable, the majority of non-adherent respondents had weak cues to action (66.1%), whereas the majority of adherent respondents had strong cues to action (66.2%).

Table 1. Univariate Distribution of Research Variables

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Respondent Characteristics	Total	Percentage
Adherence to Iron Tablet Consumption		
Adherent	181	47.1%
Non-adherent	203	52.9%
Age		
17-21 years	258	67.2%
22-25 years	126	32.8%
Level of Study		
Early semester	310	80.7%
Final semester	74	19.3%
Allowance		
High	138	47.7%
Low	201	52.3%
Place of Residence		
With parents	85	22.1%
Not with parents	299	77.9%
Knowledge of Anemia		
Good	90	23,4%
Poor	294	76.6%
Knowledge of Iron Tablet Consumption		
Good	163	42.4%
Poor	221	57.6%
Perceived Susceptibility		
High	157	40.9%
Low	227	59.1%
Perceived Severity		
High	181	47.1%
Low	203	52.9%
Perceived Benefits		
High	133	34.6%
Low	251	65.4%
Perceived Barriers		
High	192	50.0%
Low	192	50.0%
Self-efficacy		
High	179	46.6%
Low	205	53.4%
Cues to Action		
Strong	157	40.9%
Weak	227	59.1%

Table 2. Bivariate Analysis Between Iron Supplement Adherence and Independent Variables

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Variables	Adherence to Iron tablet Consumption				Total		p-value
	Adherent		Non-adherent				
	F	%	F	%	F	%	
Age							
17-21 years	119	46.1%	139	53.9%	258	100%	0.570
22-25 years	62	49.2%	64	50.8%	126	100%	
Level of Study							
Early semester	76	48.4%	81	51.6%	157	100%	0.678
Final semester	105	46.3%	122	53.7%	227	100%	
Allowance							
High	86	47.0%	97	53.0%	183	100%	0.958
Low	95	47.3%	106	52.7%	201	100%	
Place of Residence							
With parents	39	45.9%	46	54.1%	85	100%	0.793
Not with parents	142	47.5%	157	52.5%	299	100%	
Knowledge of Anemia							
Good	82	91.1%	8	8.9%	90	100%	0.001
Poor	99	33.7%	195	66.3%	294	100%	
Knowledge of Iron Tablet Consumption							
Good	115	70.6%	48	29.4%	163	100%	0.001
Poor	66	29.9%	155	70.1%	221	100%	
Perceived Susceptibility							
High	107	68.2%	50	31.8%	157	100%	0.001
Low	74	32.6%	153	67.4%	227	100%	
Perceived Severity							
High	115	63.5%	66	36.5%	181	100%	0.001
Low	66	32.5%	137	67.5%	203	100%	
Perceived Benefits							
High	106	79.7%	27	20.3%	133	100%	0.001
Low	75	29.9%	176	70.1%	251	100%	
Perceived Barriers							
High	67	34.9%	125	65.1%	192	100%	0.001
Low	114	59.4%	78	40.6%	192	100%	
Self-efficacy							
High	113	63.1%	66	36.9%	179	100%	0.001
Low	68	33.2%	137	66.8%	205	100%	
Cues to Action							
Strong	104	66.2%	53	33.8%	157	100%	0.001
Weak	77	33.9%	150	66.1%	227	100%	

Discussion

Adherence to Iron Tablet Consumption

This study showed that more than half of the respondents (52.9%) were non-adherent to iron supplement consumption, with only 47.1% reporting consistent weekly use. Interestingly, while 63.8% had consumed iron supplements during their time at Universitas Diponegoro and 62.8% had taken them in the past month, this did

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not translate into regular weekly adherence. This discrepancy suggests that occasional or short-term intake does not develop into sustained behavior, which is crucial for preventing anemia. These findings reinforce the need to address barriers to long-term adherence, especially in university populations that no longer receive supplements through school-based programs.

Age

Age refers to the amount of time a person has lived from birth, as defined by the Kamus Besar Bahasa Indonesia (the official dictionary of the Indonesian language).[26] The average age of female university students in Indonesia ranges from 18 to 24 years, which falls into the category of late adolescence.[12] At this stage, female students are expected to manage their own health decisions, yet emotional instability and identity exploration may interfere with consistent preventive practices, consistent with Hall's "storm and stress" theory.[27,28]

In this study, no significant association was found between age and adherence (p=0.570), similar to the findings of Rahayuningtyas (2021).[29] This suggests that biological maturity alone does not guarantee healthier behavior, as health knowledge and decision-making may be shaped more strongly by environmental and social factors.[24,25] However, age alone cannot be used as a benchmark for one's understanding of health-related practices, as knowledge can be acquired dynamically through experience, social environment, and other factors. Emphasis on increasing health education and promotion among younger age groups is crucial in shaping health behaviors such as adherence to iron tablet consumption.[30]

Level of study

This study found no significant association between the level of study and adherence to iron tablet consumption (p=0.678). Although education is generally expected to improve health awareness and preventive behavior.[31–34] The results suggest that advancing semester levels do not necessarily lead to greater adherence.[35,36] In fact, more non-adherent respondents were in their final semesters, possibly due to academic pressure and reduced focus on personal health during thesis preparation.[28] This contrasts with theoretical expectations that higher education exposure supports better health practices, implying that academic demands may outweigh the potential benefits of increased knowledge. The lack of previous research on university students limits direct comparison; however, this study highlights that the level of study should not be assumed as a protective factor for adherence. Universities need to integrate health education across disciplines to address this gap.

Allowance

Allowance, as a proxy for economic resources, was also not significantly associated with adherence (p=0.958). Although greater financial resources could theoretically facilitate access to supplements and nutritious food.[37–39] This study found that more adherent students reported lower allowances, while non-adherent students tended to have higher allowances. This counterintuitive finding may reflect the prioritization of expenses, with higher-allowance students possibly allocating spending to lifestyle choices rather than supplementation. As most students remain financially dependent on their parents, allowance may not directly predict supplement adherence.[39] The absence of comparable studies among university students limits further discussion, but these findings highlight that financial capacity alone does not ensure preventive health behaviors, pointing to the need for targeted health promotion regardless of socioeconomic status.

Place of residence

No significant relationship was observed between the place of residence and adherence (p=0.793). Theoretically, students living with their parents should receive stronger family support and reminders.[40–44] This study found that more adherent respondents lived apart from their parents. This suggests that direct

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supervision may not guarantee actual consumption, particularly if parental awareness of anemia prevention is limited.[38,45] Conversely, independent living may foster self-responsibility, which can enhance adherence. The mixed pattern highlights that family reminders must be coupled with adequate health literacy to be effective in improving adherence. As specific studies on university students are scarce, these results underscore the need for interventions that strengthen both family awareness and student self-management strategies.

Knowledge of anemia

Knowledge is a fundamental determinant of health behavior, defined as the result of "knowing" that arises after individuals perceive an object through their senses.[46,47] In the Health Belief Model (HBM), knowledge functions as a modifying factor influencing perceived susceptibility, severity, and subsequent adherence to preventive actions.[30,48,49] In this study, knowledge of anemia included understanding its definition, symptoms, causes, and health or productivity impact. The findings showed a significant relationship between knowledge of anemia and adherence (p=0.001). Poor knowledge was reflected in several aspects: 56.5% did not know that frequent fast-food consumption increases the risk of anemia, 56.0% were unaware that spinach contains iron that may help prevent anemia, and 52.9% did not recognize fatigue as a common symptom. Conversely, good knowledge was observed in some areas: 89.3% correctly defined anemia as a reduction in red blood cells or hemoglobin, 72.9% recognized that diarrhea is not a symptom, and 66.9% stated that anemia is defined as Hb <12 g/dl and can be prevented by iron supplementation.

These results are consistent with prior studies, including Nasir (2024, p=0.000) and Riana (2018, p=0.014), which also reported significant associations between knowledge of anemia and iron tablet adherence.[50,51] Similarly, Tirthawati (2020) found that awareness of anemia was positively correlated with the frequency of iron tablet consumption.[52] However, unlike those studies focusing on school adolescents, the present study highlights that university students continue to demonstrate fragmented knowledge. This finding is supported by MDPI (2024), which reported that young adults often retain only conceptual definitions while lacking applied knowledge for daily practice.[53] These results underscore the need for more targeted and context-specific health promotion in higher education institutions.

Knowledge of iron tablet consumption

Knowledge of iron tablet consumption refers to understanding the composition, recommended dosage, side effects and their management, and benefits of iron supplementation.[54,55] Adequate knowledge enables students to apply correct practices, while misconceptions reduce adherence. In this study, a significant association was observed between iron supplement knowledge and adherence (p=0.001). Major gaps were identified: 78.4% did not know that iron tablets are best taken at night to minimize nausea, 75.0% were unaware that they contain 400 µg folic acid, and 74.0% did not know that post-meal intake may reduce side effects. In contrast, 79.9% knew that supplementation is not limited to adolescence, 75.0% acknowledged that side effects vary, and 65.9% knew that vitamin C improves absorption.

This result supports Riana (2018), who reported a significant relationship between iron supplement knowledge and adherence (p=0.017).[51] Few studies have investigated this variable in university students, but findings from younger populations suggest that knowledge strongly influences adherence. The novelty of this study lies in its demonstration that knowledge deficits persist even among students in higher education, particularly regarding timing and side-effect management. As highlighted by MDPI (2024), incomplete supplement knowledge undermines self-efficacy and long-term compliance.[53]

Perceived susceptibility

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Perceived susceptibility in the HBM refers to an individual's belief regarding their vulnerability to a health condition, in this case, anemia. Higher perceived susceptibility was associated with greater adherence to treatment. Conversely, lower perceived susceptibility correlated with lower adherence.[56] In this study, many respondents underestimated their risk of anemia: 75.0% did not feel at risk despite disliking vegetables, 74.0% felt safe even though they often experienced fatigue, and 60.4% felt no risk despite rarely consuming meat. At the same time, 79.9% of respondents who had previously been diagnosed with anemia perceived themselves as vulnerable, as did those who frequently consumed fast food (75.0%) and who those self-identified as less healthy (65.9%). This contrast illustrates inconsistent perceptions of risk, where prior experience of illness or obvious risk factors prompted concern, but everyday lifestyle behaviors were not considered threatening.

The association between perceived susceptibility and adherence was statistically significant (p=0.001), consistent with Lismiana (2021), who also found susceptibility to be a strong predictor of adherence (p=0.000).[57] While previous studies on secondary school adolescents emphasized general awareness, the present study highlights that even university students often fail to recognize behavioral risk factors. This finding indicates that health promotion strategies cannot rely solely on past diagnoses or family history but must also highlight lifestyle-related risks (e.g., diet, stress, and activity patterns). A limitation of this study is that susceptibility perceptions were self-reported, which may have been influenced by recall bias or socially desirable responses. Nonetheless, the results suggest that targeted education at the university level should integrate risk-awareness components into nutrition curricula and campus health campaigns, emphasizing common daily behaviors that elevate the risk of anemia. These results reinforce the Health Belief Model, which highlights that individuals who believe they are vulnerable to a disease are more likely to adopt preventive actions, such as consistently consuming iron tablets to avoid anemia.[25,58]

Perceived severity

Perceived severity refers to the belief about the seriousness of anemia and its potential health, academic performance, and reproductive consequences. Higher perceived severity was associated with greater adherence to iron supplementation. Conversely, lower perceived severity correlated with lower adherence.[25] In this study, 78.4% of respondents believed that untreated anemia would not cause serious complications, 60.4% thought it would not affect overall health, and 56.5% believed that anemia would resolve spontaneously. However, the majority acknowledged certain serious impacts, such as interference with learning concentration (79.9%), anemia being a dangerous disease (72.9%), and reduced productivity (66.9%).

A similar finding was reported in a recent study of female undergraduates in Asia, which emphasized that downplaying the seriousness of anemia was strongly linked with lower supplement adherence.[59] When individuals are aware of the seriousness of a disease, they tend to have a stronger perception of its severity and are more likely to take preventive actions to avoid contracting it.[60] These findings align with the Health Belief Model, which highlights perceived severity as a determinant that can motivate individuals to engage in preventive behaviors, such as regularly consuming iron tablets to prevent anemia.[25]

Perceived benefit

Perceived benefits represent the belief that taking iron tablets will improve health outcomes and reduce the risk of anemia. Higher perceived benefits were associated with greater adherence. Conversely, lower perceived benefits correlated with lower adherence.[25] In this study, 75.0% of respondents felt that iron tablets would not help relieve menstrual fatigue, 74.0% thought they would not improve productivity, and 63.8% doubted they would increase energy. In contrast,

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benefits were acknowledged by others: 79.9% agreed that iron tablets prevent anemia, 75.0% believed they improve concentration, and 64.8% agreed that they help treat anemia.

A significant association was found (p=0.001), in line with Lismiana (2021), who reported similar findings in adolescents (p=0.010).[57] However, unlike school populations, where benefits are often framed in terms of preventing anemia alone, this study reveals that university students question the broader functional benefits (productivity, energy), which may reduce motivation to adhere. This skepticism may be reinforced by limited counseling on how iron tablets alleviate symptoms beyond anemia prevention alone. When a health behavior is believed to bring benefits in reducing disease risk, individuals are more likely to adopt that behavior.[61] According to the Health Belief Model, perceived benefits serve as one of the determinants that encourage individuals to engage in health-promoting behaviors. Understanding the advantages of iron tablet consumption helps reinforce the motivation to comply, and this can be further strengthened through educational efforts and dissemination of relevant information.[25]

Perceived barrier

Perceived barriers reflect the obstacles that hinder adherence to iron tablet consumption. In this study, it refers to female students' views on the challenges that prevent them from consistently consuming iron supplements. Lower perceived barriers were associated with greater adherence, whereas higher perceived barriers were correlated with lower adherence.[62] In this study, the most frequently cited barriers were lack of information post-schooling (76.8%), perception that consumption was monotonous (65.6%), and unpleasant tablet odor (65.4%). Conversely, more than two-thirds of the participants reported no nausea and easy access to supplements, indicating that barriers were not uniformly experienced. In addition, some items reflected that respondents did not perceive significant barriers: 69.3% reported not feeling nauseous when consuming iron tablets, 66.7% stated that iron tablets were easy to find in nearby pharmacies, and 60.2% felt that consuming iron tablets was not troublesome. A lower perception of barriers may encourage better adherence to treatment.

A significant association was found between barriers and adherence (p=0.001), consistent with Chusna (2021, p=0.003).[63] Perceived barriers are closely related to the individual's evaluation process when deciding whether to adopt a health behavior.[64] According to the Health Belief Model, perceived barriers serve as one of the key determinants that influence individuals' decisions to engage in health behaviors based on their evaluation of the difficulties they may face. In this study, the most commonly reported barriers among female students included a lack of information about iron tablet consumption after graduating from school, the monotony of weekly tablet intake, and the unpleasant fishy odor of the tablets.[25] University-level interventions could address these barriers by integrating anemia education into student orientation and providing continuous access to reminders and supplements through campus clinics. Simplifying messages, such as myth-busting campaigns about smell or monotony, can also reduce psychological barriers.

Self-efficacy

Self-efficacy refers to confidence in one's ability to adhere to iron tablet consumption, despite obstacles. In this study, it was related to whether female students believed they could consistently take iron supplements despite obstacles. Higher self-efficacy was associated with greater adherence, while lower self-efficacy correlated with lower adherence.[65] In this study, many respondents expressed doubt about their ability to remember to take iron supplements independently (74.7%). Furthermore, 63.0% of respondents doubted their ability to consume iron supplements regularly once a week, and 60.7% were unsure whether they could continue consuming them despite experiencing side effects. This

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study also found that respondents had relatively high self-efficacy: 78.9% were confident that they could overcome the side effects of iron tablet consumption, 73.2% felt capable of overcoming all obstacles to consumption, and 66.9% reported that they would continue consuming iron tablets regularly even if they were not currently anemic. Confidence is a key determinant of adherence.

Self-efficacy was significantly associated with adherence (p=0.001), aligning with Chusna (2021, p=0.000).[63] Female students who do not adhere to iron tablet consumption often have negative initial impressions or experiences of side effects that vary from person to person, such as nausea and vomiting. These experiences influence their willingness to continue the regimen.[66] This finding is supported by Bandura's theory (1997), describes self-efficacy as a person's confidence in their capacity to plan and carry out actions necessary for controlling health-related behaviors.[67]

Cues to action

Cues to action are triggers that prompt health-related behaviors. Cues to action are internal or external factors that trigger individuals to adopt health behaviors. These may include reminders, social encouragement and health campaigns. Internal cues came from within, such as personal perceptions to avoid anemia, while external cues included influences such as government regulations, family habits and peer encouragement. Higher cues to action were associated with greater adherence, whereas lower cues were correlated with lower adherence.[24] In this study, many respondents felt that family recommendations to consume iron supplements did not motivate them to do so (78.4%). Additionally, 56.5% of respondents felt that peer recommendations had no effect, and 56.0% felt that government recommendations did not influence iron supplement consumption. Cues to action were also evident from the results: 89.3% of respondents had heard information related to anemia, 72.9% reported that health workers advised them to consume iron tablets, and 66.9% had received information about iron tablet consumption and anemia symptoms, which encouraged adherence to iron tablet consumption. These external cues may play an important role in prompting preventive behaviors.

The chi-square test for this variable resulted in a p-value of 0.001, indicating a significant relationship between cues to action and adherence to iron tablet consumption among female students at Universitas Diponegoro. According to the Health Belief Model (HBM), cues to action are internal or external stimuli that trigger individuals to adopt health behaviors.[68] In this study, cues were specifically categorized into information access, healthcare support, government support, parental involvement, and peer encouragement. The findings of this study are in line with those of Rahayuningtyas (2021), who found a significant relationship between information access and iron tablet adherence among female students (p = 0.004).[29] Similar results were also reported in studies highlighting the importance of support from healthcare professionals. These include Rahayuningtyas (2021) with a p-value of 0.003, Fatimah (2020) with p = 0.031, Nurjanah (2023) with p = 0.000, and Novita (2021) with p = 0.004.[29,66,69,70] Healthcare professionals play a key role in providing education and raising awareness among female students about anemia, iron supplementation, and other adolescent health concerns.[71]

Government involvement is also a vital external factor supporting iron tablet consumption. Since 2014, the Indonesian government has launched a supplementation program targeting female adolescents to prevent anemia. Because anemia poses long-term health risks, early prevention is crucial, especially during adolescence when menstruation begins.[72] Between 2007 and 2018, the prevalence of anemia among school-aged adolescents (aged 5–14 years) in Indonesia declined, particularly after the implementation of the government's supplementation program in 2014. However, anemia prevalence among female students aged 15 to 24 has continued to rise, partly due to the absence

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of government-provided supplementation in this age group.[14]

Other studies have also shown a relationship between family support and adherence to iron tablet consumption among adolescent girls. Rahayuningtyas (2021) reported a significant association with a p-value of 0.000, while Hafsah (2023) reported a p-value of 0.005.[29,73] Research focusing on parental support has also confirmed this relationship. Nurjanah (2023) and Novita (2021) found significant relationships, with p-values of 0.000 and 0.011, respectively.[66,70] Family support, particularly from parents, plays a role in monitoring iron tablet consumption at home.[74] Female students who receive strong family support are more likely to adhere to iron tablet consumption and thus have a lower risk of developing anemia.[41]

Other consistent findings also show a relationship between peer support and adherence to iron tablet intake. Rahayuningtyas (2021) and Hafsah (2023) both reported significant relationships with p-values of 0.000.[29,73] Peers are one of the influential factors in adolescents' lives, often acting as social companions, classmates, or individuals with similar interests and age.[75,76] They play an important role in the personal lives of adolescents due to a sense of shared experience and emotional connection. Peers are often considered more understanding or empathetic than parents and can provide support or encouragement in decision-making.[77] Peer support helps female students stay consistent in following iron tablet consumption routines.[78] Based on these findings, it is clear that cues to action, including support from family and peers, are related to female students' adherence to iron tablet consumption.

Conclusion

This study found no significant relationship between respondent characteristics (age, level of study, allowance, and place of residence) and adherence to iron tablet consumption among female students at Universitas Diponegoro, while all Health Belief Model variables (perceived susceptibility, severity, benefits, barriers, self-efficacy, and cues to action) showed significant associations. Several top negative findings were identified: 56.5% of respondents did not know that daily fast-food consumption increases the risk of anemia (knowledge of anemia); 78.4% were unaware that iron tablets are best taken at night to reduce side effects (knowledge of iron supplement consumption); 75.0% did not feel at risk of anemia even though they disliked eating vegetables (susceptibility); 78.4% believed that untreated anemia would not cause serious complications (severity); 75.0% believed that iron tablet consumption would not help relieve menstrual fatigue (benefits); 76.8% felt they lacked information about iron supplement consumption after school graduation (barriers); 74.7% were unsure about their ability to remember to take iron tablets independently (self-efficacy); and 78.4% stated that encouragement from family members who take iron tablets did not motivate them (cues to action).

These results highlight the predominance of negative perceptions as key barriers to adherence, emphasizing the need to strengthen health literacy and implement targeted interventions for female university students. The integration of iron supplementation education and access into campus-based health promotion, such as the Healthy Campus initiative, could include digital reminders, peer support, and counseling tailored to university students. This study was limited by its single-site setting and cross-sectional design. Future research should involve multiple universities and other designs to explore additional behavioral and environmental factors that influence adherence.

Ethics approval

This study was reviewed and approved by the Health Research Ethics Committee of the Faculty of Public Health, Universitas Diponegoro (ethics approval No: 331/EA/KEPK-FKM/2024).

Availability of data and materials

The data collected during fieldwork and analyzed throughout the study cannot be publicly shared due to a privacy

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protection agreement between the author and respondents but are available from the corresponding author upon request.

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Author Contribution

DA analyzed and interpreted all data obtained from the respondents during the research. PN and NH corrected all the data that had been analyzed and interpreted and were the main contributors to writing this manuscript. All authors have read and agreed to the final manuscript.

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