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Unveiling the Drivers of Anemia: A Multifactorial Analysis

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ABSTRACT

Background: Anemia remains a major public health concern, particularly in developing countries, due to its multifactorial causes and negative impact on individual productivity and quality of life. Identifying the determinants of anemia is essential for improving prevention strategies and targeted interventions. This study aimed to analyze factors associated with anemia among adult outpatients.

Subjects and Method: The cross-sectional analytic study was conducted at Primary Health Care Ronowijayan, Ponorogo, Indonesia. The study population consisted of adult outpatients aged ≥18 years who visited the health center during the study period. A total of 100 participants were selected using an incidental sampling technique. The dependent variable was anemia, defined as hemoglobin level <12 g/dL in women and <13 g/dL in men, measured using a standardized spectrophotometric method. The independent variables included age, gender, body mass index (BMI), and economic status. BMI was calculated based on measured weight and height, while economic status was classified according to the regional minimum wage. Data were analyzed using Chi-square tests for bivariate analysis and multiple logistic regression for multivariate analysis, with a significance level of α = 0.05.

Results: Most participants were aged <40 years (59.0%), female (54.0%), underweight (59.0%), and of low economic status (82.0%). Bivariate analysis showed that only economic status was significantly associated with anemia (OR = 4.87; p = 0.004). Multivariate analysis confirmed that economic status (OR = 6.77; 95% CI = 1.98–23.10; p= 0.002) and BMI (OR = 1.45; 95% CI = 0.78–2.68; p = 0.035) were significantly associated with anemia, while age (OR = 0.87; 95% CI = 0.27 to 1.24; p = 0.792) and gender (OR = 2.65; 95% CI = 0.07 to 0.33; p = 0.064).

Conclusion: Low economic status was significantly associated with an increased risk of anemia among adult outpatients, while body mass index also showed a significant association. Age and gender were not significantly related to anemia. These findings highlight the importance of addressing socioeconomic disparities and nutritional status in anemia prevention and management at the primary health care level.

Keywords: anemia, determinants, factors

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BACKGROUND

Anemia remains a significant public health concern globally and particularly in low- and middle-income countries. Defined as a reduction in haemoglobin concentration below threshold values (for example, < 12 g/dL for non-pregnant women and < 13 g/dL for men), anemia impairs oxygen-carrying capacity of the blood, with consequences including fatigue, reduced work capacity, impaired cognitive function, and increased morbidity (Acharya et al., 2024). The World Health Organization (WHO) estimates that nearly one third of the world's population is affected by some form of anemia, with higher prevalence among women of reproductive age, children, and individuals in resource-constrained settings (Kassebaum, 2016).

In Indonesia, anemia prevalence is still relatively high, with data from Indonesian Basic Health Research report or "*Riset Kesehatan Dasar/ Riskesdas*" 2018 reporting a prevalence of 23.7% in the general population, especially among women and socioeconomically disadvantaged groups. Although numerous studies have identified socioeconomic status and nutritional status as important determinants of anemia, most evidence in Indonesia focuses on specific populations such as pregnant women and adolescents, leaving adult outpatient populations relatively underexplored.

This study addresses an important research gap by focusing on adult outpatients in a primary health care setting in Ponorogo, an area characterized by diverse socio-economic conditions and reliance on primary care services. Local evidence on anemia determinants in Ponorogo is still limited, making it difficult to design targeted and context-specific interventions. Therefore, this study was conducted to analyze the influence of socioeconomic status and nutritional status on anemia among adult outpatients, in order to provide evidence-based recommendations for strengthening anemia prevention and management at the primary health care level.

In adult outpatient populations, anemia may reflect a mix of nutritional deficiencies (such as iron, folate, vitamin B12), chronic diseases, parasitic infections, and socio-economic vulnerabilities. In developing country contexts, anemia often correlates with poverty, low educational attainment, poor dietary quality, and limited access to health services (Ameline et al., 2025; Moradi et al., 2025).

One of the major determinants of anemia is socio-economic status (SES). Studies consistently show that individuals with lower SES (often indicated by lower household income, less education, or lower occupational status) have higher odds of anemia. For example, in a multi-country analysis, wealth index and educational level explained nearly 99 % of the wealth-based inequality in anemia prevalence, with lower wealth strongly associated with higher anemia (Moradi et al., 2025). Similarly, research in adolescent girls in rural India found that those from families with lower monthly income were 2.8 times more likely to be anemic (Gore et al., 2024).

Another determinant often explored is nutritional status, frequently proxied by body mass index (BMI). The relationship between BMI and anemia is complex and somewhat inconsistent across studies. In some settings, underweight individuals are at higher risk of anemia, likely reflecting nutritional deficiencies and catabolic states. For instance, in Myanmar, severely underweight and underweight women had higher odds of anemia (Acharya et al., 2024). Conversely, overweight and obese individuals may have lower risk of anemia in certain contexts, though other studies suggest obesity itself may impair iron absorption and elevate anemia risk. The dual burden of malnutrition (underweight and overweight) in transitional economies complicates the picture. Given that BMI is a simple anthropometric measure often captured in outpatient clinics, its inclusion as a potential predictor of anemia is logical in a study of adult outpatients (Alshwaiyat et al., 2021).

Age and gender are additional important factors to consider. While much research emphasises women of reproductive age due to menstrual blood losses and pregnancy-related demands, adult men and older adults also face anemia risk from chronic disease, nutritional deficiencies, and socio-economic factors. In a Zimbabwean national survey, older age (35–49 years) was associated with higher odds of anemia among women (Chemhaka et al., 2025). Gender differences may reflect both biological (e.g., menstrual or reproductive losses in women) and socio-cultural (access to nutritious foods, health services) aspects. In outpatient settings, accounting for both age and gender enables a more complete understanding of anemia determinants across adult patient populations (Wacka et al., 2023).

In the Indonesian context (and by extension in local primary health care settings such as the one in this study), while national data on adult outpatients may be limited, the relevance of socio-economic status, nutritional status, and demographic factors remains high (Mulyanto et al., 2019). Nutritional transitions, persistent income inequality, and rising non-communicable disease burdens (which may themselves contribute to anemia via chronic inflammation or renal disease) make the study of anemia determinants especially timely. Moreover, primary health care centres serve as first-line points of contact for many adult patients, and identifying modifiable factors (such as nutrition status and SES) can facilitate early interventions (Yu et al., 2025).

The operationalisation of anemia in outpatient settings often uses haemoglobin measured via spectrophotometry or other standardised laboratory methods, as described in our study methods. Using BMI, age, gender, and economic status as independent variables aligns with both existing literature and the clinical realities of outpatient data collection. Given that adult outpatients frequently present with comorbidities (e.g., hypertension, diabetes, renal disease) and are embedded in socio-economically variable populations, assessing how these demographic, anthropometric, and economic factors associate with anemia can inform screening and preventive strategies.

However, evidence on anemia determinants among adult outpatients in primary care settings remains limited, particularly in Indonesia. Existing studies mainly focus on pregnant women and adolescents, while adult outpatient populations—who often present with complex comorbidities and socio-economic variability are underrepresented. Given these considerations, the aim of this study was to analyse factors associated with anemia among adult outpatients.

SUBJECTS AND METHOD

1. Study Design

This cross-sectional study was conducted at Primary Health Care Ronowijayan, Ponorogo, East Java, Indonesia. The study was conducted from 1 September - 15 Oktober 2025.

2. Population and Sample

The population consisted of outpatients who visited the clinic. The sample size was determined using the single population proportion formula based on Stanley Lemeshow's sampling technique. Since the estimated proportion of the study variable was unknown, a prevalence rate (p) of 50% was used, with a 95% confidence level (Z = 1.96) and a 10% margin of error (d = 0.1). Based on this calculation, the required sample size was 96 participants. However, we fulfill the sample up until 100. The population was chosen from hospital outpatients using an incidental sampling technique. Inclusion criteria were participants who were equal or more than 18 years old and have participants were adult outpatients aged ≥18 years who visited Primary Health Care Ronowijayan Ponorogo during the study period and were willing to participate. All participants had their haemoglobin levels measured using spectrophotometry.

3. Study Variables

The dependent variables were anemia. The independent variables were age, gender, BMI, and economy status.

4. Operational Definition of Variables

Anemia was defined based on haemoglobin (Hb) levels measured using spectrophotometry. It was categorized as anemia if Hb <12 g/dL for women and <13 g/dL for men, and non-anemia if Hb ≥12 g/dL for women and ≥13 g/dL for men (WHO standard).

Age was defined as the participant's age in completed years obtained from medical records. It was categorized into <40 years and ≥40 years. Scale: categorical.

Gender was defined as the biological sex of the participant as recorded in medical records, categorized as male and female. Scale: categorical.

Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m²). Weight and height were measured using calibrated digital scales and stadiometers. BMI was categorized into underweight (<18.5 kg/m²), normal (18.5–24.9 kg/m²), and overweight/ obesity (≥25 kg/m²) according to WHO classification. Scale: categorical.

Economic Status was defined based on the participant's average monthly income. It was categorized into low and high based on the regional minimum wage (UMR) of Ponorogo. Participants with income below the UMR were classified as low economic status, while those equal to or above the UMR were classified as high economic status. Scale: categorical.

5. Study Instruments

Body weight was measured using a digital scale (accuracy ±0.1 kg) and height using a stadiometer (accuracy ±0.1 cm). Instruments were calibrated daily before measurement. Participants were measured without shoes and wearing light clothing, and BMI was calculated as kg/m². Hemoglobin levels were measured using a standardized spectrophotometric method with a calibrated hematology analyzer. Blood samples were collected by trained health personnel following standard procedures.Data on age and gender were obtained from medical records. Economic status was assessed using a structured questionnaire on monthly income administered by trained enumerators.

6. Data analysis

Analyses were performed in Stata 18 (StataCorp, College Station, TX) with two-tailed α= 0.05. Descriptive statistics summarized sample characteristics. Bivariate associations were tested with Chi Square. Multiple logistic regression examined the association between independent variables with dependent variable.

7. Research Ethics

The study protocol was approved by the Ethical Clearance Committee on human rights related to research involving human subjects with the registration number No. 012/E-KEPK/STIKES/BHM/ XI/2025

RESULTS

1. Sample Characteristics

Most of the participants were aged <40 years (59.0%) and female (54.0%). The majority had an underweight body mass index (59.0%) and came from a low economic status (82.0%) (table 1).

Table 1. Sample characteristics (categorical data)

Characteristics	Category	Frequency	Percentage
Age	<40 years old	59	59.0%
	≥40 years old	41	41.0%
Gender	Female	54	54.0%
	Male	46	46.0%
BMI	Underweight	59	59.0%
	Normal	28	28.0%
	Overweight or Obesity	13	13.0%
Economic Status	Low	82	82.0%
	High	18	18.0%

2. Bivariate Analysis

Age was not significantly associated with anemia (OR = 0.87; p = 0.755). Participants aged ≥40 years had a slightly higher proportion of anemia (21%) compared to those aged <40 years (19%), but the difference was not statistically significant. Gender was also not significantly associated with anemia (OR = 0.36; p = 0.451). Although anemia appeared slightly more common among males (16%) than females (15%), the difference was not significant. Body mass index (BMI) showed no significant association with anemia (OR = 1.58; p = 0.115). Participants with underweight status tended to have a higher proportion of anemia (15%) than those with normal (10%) or overweight/obesity status (6%), but this association did not reach statistical significance. Economic status was significantly associated with anemia (OR = 4.87; p = 0.004). Participants with low economic status had a higher proportion of anemia (20.0%) compared to those with high economic status (11.0%). This difference was statistically significant (OR = 4.87; p = 0.004), indicating that individuals with low economic status had a greater likelihood of experiencing anemia (Table 2).

Table 2. Determinants of Anemia (an analysis by Chi Square)

Variable	Anemia				OR	p
	No		Yes			
	N	%	N	%		
Age						
<40 years old	40	40.0	19	19.0	0.87	0.755
≥40 years old	29	29.0	21	21.0		
Gender						
Female	39	39.0	15	15.0	0.36	0.451
Male	30	30.0	16	16.0		
BMI						
Underweight	44	44.0	15	15.0	1.58	0.115
Normal	18	18.0	10	10.0		
Overweight or Obesity	7	7.0	6	6.0		
Economic Status						
Low	62	62.0	20	20.0	4.87	0.004
High	7	7.0	11	11.0		

3. Multivariate analysis

Age was not significantly associated with the outcome (OR = 0.87; 95% CI = 0.27–1.24; p= 0.792). Gender showed no statistically significant relationship with the outcome (OR = 2.65; 95% CI = 0.93–7.52; p = 0.064). Body mass index (BMI) was positively associated with the outcome and reached statistical significance (OR = 1.45; 95% CI = 0.78–2.68; p = 0.035), indicating that a higher BMI increased the likelihood of the outcome.

Economic status was also significantly associated with the outcome (OR= 6.77; 95% CI= 1.98–23.10; p= 0.002), suggesting that individuals with higher economic status had a greater likelihood of experiencing the outcome (table 3).

Table 3. The result of multiple logistic regression analysis

Independent Variables	OR	CI (95%)		p
		Lower Limit	Upper Limit	
Age	0.87	0.27	1.24	0.792
Gender	2.65	0.93	7.52	0.064
BMI	1.45	0.78	2.68	0.035
Economic Status	6.77	1.98	23.10	0.002

DISCUSSION

In this study of adult outpatients at a primary health care centre in Ponorogo, we found that economic status and BMI were significantly associated with anemia. Specifically, individuals of low economic status had a markedly higher odds of anemia and higher BMI was also positively associated with anemia. By contrast, age and gender were not significant predictors. These findings can be considered in light of theoretical frameworks on social determinants of health, nutritional status and anemia aetiology, as well as compared with previous empirical studies.

First, the strong association between low economic status and anemia reinforces the theory that socio-economic disadvantage constitutes a structural determinant of health outcomes, including nutritional deficiencies and blood disorders (Al Kaabi et al., 2023). According to the social-ecological model, upstream factors such as income, education and occupational status influence intermediate determinants (food access, dietary quality, health care access, living environment) which in turn affect biological outcomes such as hemoglobin levels and anemia risk (Link & Phelan, 1995). In our study, participants belonging to the low economic status category had higher anemia prevalence compared with the high economic status group. This aligns with a recent study by Moradi et al. (2025) documented that lower wealth index was significantly associated with higher anemia prevalence across multiple countries. Similarly, Lopes et al. (2022) found in Brazilian adults that low socioeconomic status was a factor related to increased prevalence of anemia. These parallels support that poverty or low socio-economic position indeed increases anemia risk, likely through pathways such as food and micronutrient insecurity, poorer diet quality, higher burden of infection or chronic disease, and limited access to health services.

Second, our finding regarding BMI is somewhat more complex and invites deeper interpretation. We found that higher BMI (overweight or obese category) was associated with increased odds of anemia. This contradicts some prior studies which found a lower risk of anemia among overweight or obese individuals. Acharya et al. (2024)

reported that in a Myanmar sample, overweight/obese women had higher hemoglobin levels and lower anemia risk (AOR for overweight women was lower). Qin et al. (2013) in China also found that overweight/obese women had lower prevalence of anemia (PR = 0.59; 95% CI 0.43–0.79) compared to normal weight. On the other hand, Kamruzzaman (2021) find mixed or even inverse patterns, in Bangladesh found underweight women had higher anemia risk, and overweight had lower risk though results were inconsistent. Our result which stated that higher BMI associated with higher anemia riskmay reflect particularities of our outpatient population and setting: since many overweight/obese individuals may have comorbidities like chronic inflammation, metabolic syndrome or renal disease, which can lead to anemia of chronic disease rather than purely nutritional anemia. Moreover, nutrient-poor diets in overweight people (so-called "hidden hunger" or micronutrient deficiency despite excess calories) could contribute to low iron or folate despite higher BMI. This is consistent with some studies that highlight inflammation-mediated hypo-iron status in obesity (Qin et al., 2013). Thus, our finding contributes to the emerging view that the relationship between BMI and anemia is not unidirectional and may depend on underlying context (nutritional transition, comorbid disease burden, dietary quality) rather than BMI per se.

Third, our non-significant findings for age and gender deserve commentary. We observed that age and gender were not statistically significant. In many studies of anemia, women of reproductive age and older adults show higher anemia prevalence. However, our outpatient sample may differ: for women, the cut-off for anemia was already set at the haemoglobin level (<12 g/dL for women, <13 g/dL for men) but menstrual/pregnancy factors may be less relevant among our adult outpatient (≥18 years) non-pregnant sample. Some studies in older adults show that community and regional factors may overshadow gender or age effects (Greenblum et al., 2022). Thus, in our setting, socio-economic and nutritional/anthropometric factors may play a stronger role than demographic factors. We should however interpret the gender result cautiously, the p value of 0.064 suggests a trend that might become significant with larger sample size.

Fourth, when comparing our results to the theoretical model linking socio-economic factors, nutritional status, and anemia, our findings align well with the conceptual pathway. Low economic status may lead to poor dietary diversity, micronutrient deficiency, infection risk, and thus anemia (Ernawati et al., 2021). Similarly, abnormal BMI (whether under- or overweight) may reflect poor nutrition quality or comorbid states that contribute to anemia. The interplay of these factors in outpatient populations suggests that screening efforts and interventions should consider both socio-economic and anthropometric measures. For example, even in individuals with high BMI (who may be presumed to be nutritionally adequate), the risk of anemia may still exist because of hidden micronutrient deficiencies or chronic disease mediated anemia (Chen et al., 2024; Kimmons et al., 2006). Our results thus extend the theoretical framework by highlighting this complex interaction in an adult outpatient Indonesian context.

In terms of policy and practice implications, our results suggest that primary health care centres such as the one in Ronowijayan should integrate socio-economic screening (e.g., income or economic status questions) and anthropometric assessment (BMI) into routine anemia risk assessment. Patients identified as low economic status or with high/abnormal BMI should be prioritised for hemoglobin measurement, dietary counselling (including micronutrient intake), and infection or comorbidity screening. Moreover, public health programmes should target socio-economically disadvantaged adults (not only pregnant women or children) for anemia prevention, including subsidised iron/micronutrient supplementation, enhanced food security initiatives and education on diet diversity. Considering BMI-related findings, policies should emphasise not only undernutrition but also micronutrient adequacy among overweight or obese individuals (hidden hunger). Designing interventions that challenge the assumption that overweight status equals nutritional sufficiency is key.

Our study has several limitations that should be acknowledged. First, the cross-sectional design means that causal relationships cannot be inferred; we can identify associations but not directionality. Second, our use of haemoglobin level alone to define anemia does not allow differentiation of anaemia's aetiologies (iron deficiency, chronic disease, haemoglobinopathies); other biomarkers such as serum ferritin, transferrin saturation or hepcidin were not measured. Third, our sample was drawn from a single primary health care centre and selected via incidental sampling, which limits generalisability to other settings or the general population. Fourth, economic status was categorised based on monthly income but may not fully capture socio-economic position (assets, education, occupation). Fifth, although we measured BMI, we did not account for diet quality, inflammation markers or infection status, all of which may modulate the relationship between BMI and anemia.

In conclusion, low economic status and higher BMI emerged as significant determinants of anemia among adult outpatients in this primary health care setting, while age and gender did not show statistically significant associations. These findings underscore the need for comprehensive anemia screening and intervention programs that go beyond traditional risk groups, and incorporate socio-economic and anthropometric indicators. Health policy should prioritise adults of disadvantaged economic status and reconsider nutritional strategies for overweight/obese individuals with potential micronutrient deficiencies, strengthening the capacity of primary care to identify and manage anemia risk within this population.

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CONFLICT OF INTEREST

There are no conflicts of interest.

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