

Socioeconomic Stress and Health-Related Vulnerability: Evidence from a Multinomial Logistic Analysis of Anemia Severity among Women in the Terai Region

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Abstract

Socioeconomic disadvantage represents a chronic stress context that may shape graded health vulnerability among women.

Aim: This study examines the relationship between socioeconomic stress and health-related vulnerability by analyzing the severity of anemia among women in the Terai region.

Subject and Methods: The study is based on secondary data obtained from the National Family Health Survey (NFHS-5). Women aged 15–49 years residing in the Terai region were included in the analysis. Anemia status was categorized into non-anemic, mild, moderate, and severe anemia. Multinomial logistic regression analysis was applied to examine the association between anemia severity and socioeconomic determinants including wealth index, education level, and place of residence.

Results: Overall, 56.4% of women were anemic, including 25.8% with mild anemia, 28.5% with moderate anemia, and 2.1% with severe anemia. The results revealed a significant socioeconomic gradient in anemia severity. Women in the poorest wealth quintile had significantly higher odds of severe anemia compared with those in the richest quintile (AOR = 2.20, 95% CI: 1.09–4.45). Lower education and rural residence were also associated with increased anemia vulnerability.

Conclusion: The findings indicate that anemia severity among women in the Terai region is closely associated with socioeconomic disadvantage. Public health interventions should therefore address both nutritional improvement and broader socioeconomic inequalities.

Keywords: Socioeconomic stress, Health-related vulnerability, Anemia severity, Multinomial logistic regression, social determinants of health, Women's health, Socioeconomic inequality, Terai region

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1. Introduction:

Anemia remains a pervasive public health concern affecting women worldwide, particularly in socioeconomically marginalized settings. Beyond its clinical implications, anemia is associated with diminished physical endurance, impaired cognitive functioning, and reduced capacity for social and economic participation. In structurally disadvantaged regions, anemia cannot be understood solely as a biomedical condition; rather, it often reflects broader patterns of social and economic vulnerability. The persistence of anemia among women therefore signals not only nutritional insufficiency but also deeply embedded socioeconomic inequities.

Anemia remains a major public health concern globally, particularly among women of reproductive age. According to the World Health Organization (WHO, 2021), approximately one-third of women of reproductive age worldwide are affected by anemia.

The burden is especially pronounced in Asia and South Asia, where nutritional deficiencies, poverty, and unequal access to healthcare continue to contribute to high prevalence rates. A systematic analysis by Kassebaum et al. (2014) and subsequent estimates reported in JAMA Network Open (2018) identified South Asia as one of the regions with the highest burden of anemia among women. India bears one of the largest burdens of anemia globally. According to the National Family Health Survey (NFHS-5, 2019–21), approximately 57% of women aged 15–49 years were found to be anemic, highlighting the persistent nature of the problem despite ongoing public health interventions. Previous studies have further shown that anemia in India is disproportionately concentrated among women from poorer households, those with lower educational attainment, and residents of rural areas (Let et al., 2024; Gore et al., 2024). The Terai region, characterized by socioeconomic disadvantage,

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rural concentration, and limited healthcare accessibility in many areas, is likely to experience a disproportionately high burden of anemia. These observations highlight the need to examine anemia not only as a nutritional disorder but also as a manifestation of broader socioeconomic inequalities. Extensive scholarship demonstrates that health outcomes are systematically patterned along socioeconomic lines. The social determinants of health framework underscores how economic deprivation, limited educational attainment, and restricted access to resources generate structured disparities in health status. Such inequalities are especially pronounced in chronic and nutrition-related conditions, where sustained exposure to disadvantage amplifies biological risk. Women residing in rural and economically constrained environments frequently encounter cumulative barriers—including limited healthcare access, reduced informational resources, and constrained livelihood opportunities—that may intensify the severity of health impairments. From an applied health psychology perspective, socioeconomic disadvantage functions as a chronic stress context that shapes graded health vulnerability. The stress process model posits that prolonged exposure to material strain and environmental constraints produces sustained physiological burden, increasing susceptibility to adverse health outcomes. Over time, cumulative disadvantage may manifest in progressively severe forms of illness. Within this framework, anemia severity may be interpreted not merely as a clinical classification but as an indicator of structured vulnerability arising from persistent socioeconomic stress exposure.

Although previous studies have documented the prevalence and determinants of anemia among women, comparatively limited attention has been directed toward examining whether anemia severity follows a systematic socioeconomic gradient within specific regional contexts. Moreover, few investigations have explicitly situated anemia severity within an applied health psychology framework emphasizing chronic stress and cumulative disadvantage. Focusing on women in the Terai region, the present study addresses this gap by modeling anemia severity as a categorical outcome and assessing its association with key socioeconomic indicators by employing a multinomial logistic regression approach, the study seeks to determine whether graded levels of anemia reflect patterned socioeconomic stress exposure rather than random biomedical variation.

Literature Review:

Anemia remains a pervasive public health challenge for women in low- and middle-income contexts, with prevalence and severity differentials reflecting complex socioeconomic influences (Let et al., 2024; Sunuwar et al., 2020). Empirical evidence consistently shows that socioeconomic disadvantage—including low wealth status, limited education, and rural

residence—is associated with higher anemia prevalence, suggesting that structural determinants shape patterns of nutritional vulnerability (Let et al., 2024; Gore et al., 2024). However, most existing studies focus on the binary presence of anemia (anemic vs. non-anemic), overlooking the graded distribution of severity that may hold deeper insight into underlying processes of chronic stress and social marginalization. A growing body of evidence demonstrates that anemia among women is strongly associated with socioeconomic disadvantage. Rahman et al. (2016) reported that women from poorer households in South Asia experienced substantially higher anemia prevalence than women from wealthier households. Similarly, Sunuwar et al. (2020), in a multi-country South Asian analysis, identified low socioeconomic status, limited educational attainment, and rural residence as significant predictors of anemia among women of reproductive age. Evidence from India further supports these findings. Let et al. (2024) reported persistently higher anemia prevalence among socioeconomically disadvantaged women across aspirational districts of India, while Gore et al. (2024) documented elevated anemia burden among adolescent girls from poorer households in rural India. Harding et al. (2018) also demonstrated that inadequate nutritional status and restricted access to healthcare resources significantly increased anemia vulnerability among women. Collectively, these studies suggest that poverty, educational disadvantage, poor nutritional status, and rural residence constitute important risk factors that contribute to both the occurrence and severity of anemia.

From an applied health psychology perspective, chronic socioeconomic disadvantage can be conceptualized as a sustained stressor that contributes to cumulative physiological burden and health vulnerability. The stress process model posits that prolonged exposure to material deprivation and constrained living conditions generates persistent psychological and physiological strain, which in turn exacerbates susceptibility to adverse health outcomes over time. When such stressors accumulate, they are theorized to manifest not merely in health incidence but in severity gradients, wherein more disadvantaged individuals demonstrate disproportionately severe outcomes. In the context of anemia, this perspective implies that severity levels (severe, moderate, mild) may not simply reflect random variations in clinical measures, but instead articulate patterned vulnerability rooted in prolonged socioeconomic stress exposure. The cumulative disadvantage framework further underscores this interpretation by suggesting that intersecting forms of disadvantage—such as poverty, limited education, and residence in resource-depleted environments—compound over the life course to produce systematic gradients in health. This theoretical lens aligns with findings that women in economically constrained settings, including rural areas, are more likely to experience social and environmental stressors

that constrain access to nutritional resources, healthcare, and informational capital, thereby heightening their risk of more severe anemia (Let et al., 2024; Singh et al., 2019). Although these studies illustrate significant associations between socioeconomic markers and anemia outcomes, few have explicitly examined how severity itself may reflect accumulated stress and social marginalization. Consequently, a critical gap remains in integrating applied health psychology theory with empirical investigations of anemia severity. Understanding severity as an expression of structured vulnerability—and not merely an outcome to be predicted—offers a richer interpretive framework that connects social context, psychological stress processes, and health outcomes. By modeling anemia severity as an categorical outcome and situating its patterning within socioeconomic stress frameworks, the present study contributes to this emergent line of inquiry, particularly within regional contexts like the Terai region where layered disadvantage may intensify health vulnerability.

2. Methods:

3.1 Study Design and Data Source:

This study employed a cross-sectional analytical design using secondary data from the National Family Health Survey (NFHS-5, 2019–21), India's fifth nationally representative Demographic and Health Survey. NFHS-5 was conducted under the stewardship of the Ministry of Health and Family Welfare, Government of India, and coordinated by the International Institute for Population Sciences. NFHS-5 employed a stratified two-stage cluster sampling design. In rural areas, villages were selected as primary sampling units (PSUs), while Census Enumeration Blocks served as PSUs in urban areas. Households were selected through systematic sampling within each PSU. The survey collected extensive socio-demographic, health, and biomarker data, including hemoglobin measurements for women aged 15–49 years.

For the present analysis, the dataset was geographically restricted to clusters located within the Terai belt using cluster identification codes. Thus, the analytic sample represents women residing specifically in the Terai ecological region rather than entire states.

2.2. Study Population

The study included women aged 15–49 years residing in the Terai region with valid hemoglobin measurements. Respondents with missing data on anemia status or key explanatory variables were excluded from the final analytic sample.

The NFHS-5 employed a stratified two-stage sampling design. In rural areas, villages were selected as Primary Sampling Units (PSUs), whereas Census Enumeration Blocks (CEBs) served as PSUs in urban areas. Households within each PSU were selected using systematic random sampling. The present analysis was

restricted to women aged 15–49 years residing in the Terai region who had complete information on anemia status and relevant socioeconomic variables.

2.3. Measures

2.3.1. Dependent Variable

Anemia severity was determined using hemoglobin concentration (g/dL) obtained through standardized capillary blood testing conducted during NFHS-5 fieldwork. Following WHO-recommended clinical cut-offs, anemia was categorized into four ordered levels: severe anemia, moderate anemia, mild anemia, and non-anemic status. The outcome variable was treated as ordinal to reflect graded biological vulnerability.

3.3.2 Independent Variables

Socioeconomic position was operationalized using: Household wealth quintile (asset-based wealth index constructed by NFHS-5)

Educational attainment (no education, primary, secondary, higher)

Place of residence (rural/urban classification within the Terai region)

2.3.2. Covariate

Age (in completed years) was included as a control variable to account for life-course variation in anemia risk.

3. Statistical Analysis

All statistical analyses were performed using data from the National Family Health Survey (NFHS-5, 2019–21), restricted to clusters located in the Terai region. Sampling weights were applied to account for unequal probabilities of selection and non-response, thereby ensuring representativeness of women aged 15–49 years in the study region.

The complex survey design of NFHS-5 was accounted for by incorporating:

Women's individual sampling weights

Clustering at the Primary Sampling Unit (PSU) level

Stratification as defined in the survey design

Weighted descriptive statistics were computed to summarize socio-demographic characteristics and the distribution of anemia severity. Continuous variables were presented as weighted means with standard errors, whereas categorical variables were expressed as weighted percentages. Design-adjusted chi-square tests were used to examine bivariate associations between socioeconomic variables and anemia severity.

To assess the independent association between socioeconomic position and graded anemia severity, weighted multinomial logistic regression was employed, using the non-anemic category as the reference group. Two models were estimated. Model 1 adjusted for wealth index, age, educational attainment, and place of residence. Model 2 additionally included body mass index (BMI) to assess the contribution of nutritional status to socioeconomic disparities in anemia severity.

Although anemia severity categories are inherently ordered, multinomial logistic regression was selected because it does not require the proportional odds

assumption imposed by ordinal logistic regression. This approach allows category-specific estimation of associations and provides greater flexibility in examining differential effects across anemia severity levels.

All analyses were conducted using IBM SPSS Statistics (Complex Samples module), Version 24.

4. Multinomial Logistic Regression Results:

A multinomial logistic regression analysis was performed to assess the association between socioeconomic factors and varying levels of anemia severity, using “not anemic” as the reference category. In Model 1, which adjusted for wealth index, educational attainment, place of residence, and age, a pronounced socioeconomic gradient in severe anemia was observed. Women in the poorest wealth quintile exhibited significantly higher odds of severe anemia compared to those in the richest quintile (AOR = 2.20, $p < .05$). This finding suggests that women from economically disadvantaged households were more

than twice as likely to experience severe anemia relative to their wealthiest counterparts, even after controlling for key demographic characteristics.

Model 2 extended this analysis by additionally adjusting for body mass index (BMI) to account for nutritional vulnerability. Following the inclusion of BMI, the association between wealth and severe anemia remained statistically significant. However, the magnitude of the effect was modestly attenuated, with the adjusted odds ratio for women in the poorest quintile decreasing from 2.20 in Model 1 to 1.95 in Model 2. This attenuation indicates that nutritional status partially contributes to the observed socioeconomic disparities in severe anemia, although a substantial independent effect of poverty persists.

Furthermore, BMI demonstrated a statistically significant association with severe anemia in Model 2 ($p = 0.043$), underscoring the independent role of nutritional status in shaping anemia risk.

The distribution of anemia severity across wealth quintiles is illustrated in Fig. 1.

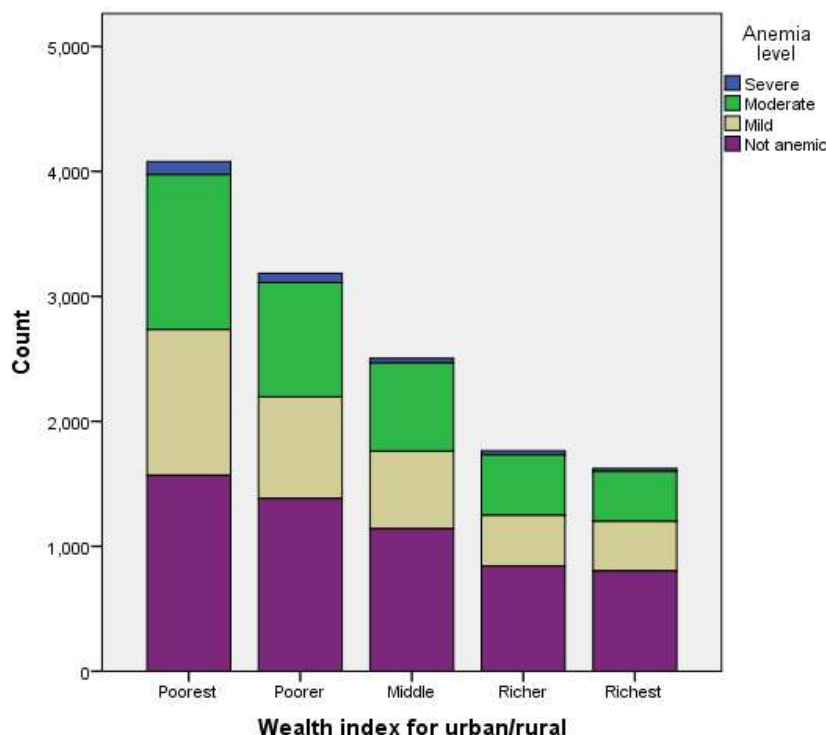


Fig. 1. Count of anemia severity (non-anemic, mild, moderate, and severe) across wealth quintiles among women in the Terai region. The figure illustrates a clear socioeconomic gradient, with higher proportions of moderate and severe anemia observed among women from poorer households.

A clear socioeconomic gradient is observed, with women in poorer households exhibiting a higher proportion of moderate and severe anemia compared to those in the richest quintile.

The predicted probability of anemia across wealth index categories is presented in Fig. 2.

The predicted probability plot illustrates the relationship between household wealth status and the likelihood of anemia among women in the Terai region. The graph presents the mean predicted probability of anemia across different wealth index categories derived from the multinomial logistic regression model.

The pattern indicates a socioeconomic gradient in anemia risk. Women belonging to lower wealth categories demonstrate relatively higher predicted probabilities of anemia compared with those in higher wealth groups. This trend suggests that economic disadvantage may increase vulnerability to nutritional and health-related deficiencies that contribute to anemia.

These findings are consistent with the regression results, which show elevated adjusted odds ratios for poorer wealth categories relative to the richest group. The predicted probability graph therefore provides a visual representation of the socioeconomic disparity in anemia risk within the study population.

The multinomial logistic regression estimates for severe anemia are presented in Table 1.

Table 1: Multinomial Logistic Regression Estimates for Severe Anemia (Model 1 and 2)

Variable	Model 1 AOR (95% CI)	Model 2 AOR (95% CI)
Age (continuous)	1.011 (0.988–1.034)	1.015 (0.992–1.039)
BMI (continuous)	-	0.964 (0.930–0.999)
Wealth (Ref: Richest)		
Poorest	2.197 (1.085–4.449)	1.948 (0.953–3.979)
Poorer	1.859 (0.920–3.756)	1.708 (0.841–3.467)
Middle	1.654 (0.802–3.411)	1.548 (0.749–3.198)
Richer	2.049 (0.992–4.230)	1.957 (0.947–4.043)
Education (Ref: Higher)		
No education	1.589 (0.897–2.814)	1.567 (0.885–2.775)
Primary	1.197 (0.647–2.214)	1.188 (0.642–2.196)
Secondary	1.021 (0.581–1.793)	1.017 (0.579–1.785)
Residence (Ref: Rural)		
Urban	0.499 (0.285–0.873)	0.509 (0.290–0.891)

In Model 1, women in the poorest wealth quintile had significantly higher odds of severe anemia compared to those in the richest quintile (AOR = 2.20, 95% CI: 1.09–4.45). Residence was also significantly associated with severe anemia.

In Model 2, after adjusting for body mass index (BMI), the magnitude of the wealth effect was attenuated (AOR = 1.95, 95% CI: 0.95–3.98) and became marginally significant. BMI was independently associated with severe anemia (AOR = 0.96, 95% CI: 0.93–0.99, $p = .043$). The association between residence and severe anemia remained statistically significant across both models. The attenuation of the wealth effect after adjustment for BMI suggests partial nutritional mediation.

5. Discussion

The present study examined socioeconomic disparities in anemia severity among women in the Terai region using multinomial logistic regression analysis. The findings revealed a clear socioeconomic gradient in

severe anemia, with women from poorer households facing a substantially greater risk compared with their wealthier counterparts. These results reinforce the growing body of evidence suggesting that anemia is not merely a nutritional disorder but also a manifestation of broader socioeconomic disadvantage. A key finding of the study was the significantly higher likelihood of severe anemia among women in the poorest wealth quintile. This observation is consistent with previous research from India and South Asia, which has documented a strong association between poverty and anemia among women of reproductive age (Rahman et al., 2016; Sunuwar et al., 2020; Let et al., 2024). Women living in economically deprived households often experience food insecurity, poor dietary diversity, inadequate access to healthcare services, and lower health awareness, all of which contribute to increased vulnerability to anemia. The findings therefore support the social determinants of health perspective, which emphasizes the role of socioeconomic conditions in shaping health outcomes.

The attenuation of the wealth effect following adjustment for BMI suggests that nutritional status partially contributes to the observed socioeconomic disparities in severe anemia. This finding is consistent with earlier studies reporting that undernutrition and poor nutritional status remain important pathways linking poverty with anemia among women (Harding et al., 2018; Let et al., 2024). However, the persistence of the socioeconomic gradient even after accounting for BMI indicates that factors beyond nutrition—including healthcare access, living conditions, and broader social disadvantage—continue to influence anemia severity.

The results also highlight the importance of educational attainment and place of residence in shaping anemia vulnerability. Previous studies have shown that women with limited education are less likely to possess adequate knowledge regarding nutrition, dietary practices, and healthcare utilization, thereby increasing their risk of anemia (Balarajan et al., 2011; Gore et al., 2024). Similarly, women residing in rural areas frequently encounter barriers related to healthcare accessibility and availability of nutritional resources, which may further exacerbate health inequalities.

From an applied health psychology perspective, the findings provide support for the stress process and cumulative disadvantage frameworks. Persistent exposure to socioeconomic hardship may generate chronic stress and resource constraints that accumulate over time, resulting in progressively poorer health outcomes. Within this context, severe anemia may be viewed as an expression of structured vulnerability arising from long-term socioeconomic disadvantage rather than solely as a biomedical condition.

Although anemia severity categories are inherently ordered, multinomial logistic regression was employed to avoid the proportional odds assumption required by ordinal regression models. This approach enabled the estimation of category-specific associations and provided greater flexibility in examining differential socioeconomic effects across anemia severity levels.

Overall, the findings underscore the need for integrated public health strategies that extend beyond nutritional supplementation alone. Policies aimed at reducing poverty, improving educational opportunities, strengthening healthcare access, and addressing broader social determinants of health are likely to play an important role in reducing the burden of anemia among women in the Terai region.

6. Limitations

This study is based on cross-sectional survey data, which limits causal interpretation of the associations between socioeconomic indicators and anemia severity. The analysis is restricted to the variables available in the dataset and may not fully capture all contextual or behavioral determinants influencing women's nutritional status.

8. Conclusion

Anemia among women in the Terai region is not merely a nutritional concern but also a reflection of underlying socioeconomic disadvantage. The findings indicate that women from economically deprived households face a substantially greater risk of severe anemia, highlighting the persistent influence of social and economic inequalities on health outcomes. Although nutritional status partially explains this relationship, the continued effect of poverty after adjustment suggests the presence of broader structural determinants that shape women's vulnerability. Addressing the burden of anemia therefore requires a comprehensive approach that extends beyond clinical management to include nutrition-sensitive policies, improved access to healthcare services, and targeted interventions for socioeconomically disadvantaged populations. Such efforts are essential for reducing health inequalities and improving the well-being of women in the region.

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