

The impact of female literacy and poverty on malnutrition in sub-Saharan Africa

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Abstract

Malnutrition remains a major public health challenge in sub-Saharan Africa (SSA), where high levels of poverty and limited female literacy continue to influence maternal and child nutrition outcomes. Female literacy can improve household nutrition through better health knowledge, childcare practices, and access to health services, yet its association with poverty and malnutrition at the regional level remains insufficiently examined. This study investigates the association between female literacy, poverty, and key malnutrition indicators in SSA using aggregated data from the World Bank World Development Indicators covering the period 2000-2019. Multiple linear regression, lagged regression models, and first-difference analysis were employed to assess both current and temporal associations. The results indicate that poverty is the strongest predictor of maternal anemia, while higher female literacy is significantly associated with lower prevalence of child stunting and underweight. Specifically, a ten-percentage point increase in female literacy is associated with a 4.11 percentage point reduction in child stunting and a 2.04 percentage point reduction in child underweight prevalence. These findings also suggest that while improvements in female literacy contribute to better child nutrition outcomes, reducing maternal anemia requires broader strategies that address poverty, food insecurity, and access to healthcare. Overall, coordinated efforts that improve female literacy alongside poverty reduction are essential for improving maternal and child nutrition outcomes in SSA.

Keywords: Female literacy; Child stunting; Maternal anemia; Poverty; Sub-Saharan Africa; Lagged Regression; Socioeconomic determinants

Introduction

Malnutrition remains a major public health challenge in sub-Saharan Africa (SSA), disproportionately affecting women of reproductive age and children under five years (WHO, 2023; Global Nutrition Report, 2022; Headey et al., 2020). Maternal anemia and child undernutrition represent two of the most persistent nutrition concerns in the region. Recent estimates indicate that approximately 40-43% of women aged 15-49 years in sub-Saharan Africa (SSA) suffer from anemia, largely due to iron deficiency, infectious diseases, and inadequate dietary intake (Mare et al., 2023; Global Nutrition Report, 2022). Among children under five years, undernutrition is also widespread, with nearly one-third experiencing stunting and roughly one-fifth classified as underweight (Ricci et al., 2026; Riwa et al., 2025; Seretew et al., 2024; Ahmed et al., 2023; Adedokun and Yaya, 2021). Maternal anemia increases the risk of pregnancy complications and maternal mortality, while child undernutrition contributes to impaired cognitive development, weakened immunity, and increased childhood morbidity and mortality (Global Nutrition Report, 2022; Headey et al., 2020).

These nutrition outcomes are influenced not only by biological factors but also by broader socioeconomic conditions such as poverty, food insecurity, and limited access to health information (Ricci et al., 2026; Paulo et al., 2024; Headey et al., 2020; Bliznashka et al., 2021). Household dietary choices and food consumption patterns in many African communities are often shaped by both cultural preferences and economic constraints, which can influence access to diverse sources of protein and micronutrients (Olunusi et al., 2023). In low-income households, these constraints often limit dietary diversity and reduce the availability of nutrient-rich foods, thereby increasing vulnerability to malnutrition. In many parts of SSA, households experiencing poverty often have limited access to diverse and nutritious foods, healthcare services, and sanitation infrastructure, which can worsen malnutrition risks (Headey et al., 2020; Paulo et al., 2024). Women in households with limited educational opportunities may also lack access to information related to nutrition, hygiene, and maternal health practices, which can affect feeding practices and child health outcomes (Bliznashka et al., 2021; Kumeh et al., 2020). Consequently, structural inequalities linked to poverty and limited female literacy can reinforce patterns of malnutrition across generations.

Although SSA has made progress in expanding girls' access to education, female literacy levels remain lower than global averages (World Bank, 2024b). Adult female literacy in the region is

estimated at approximately 62%, compared with global female literacy levels exceeding 85% (UNESCO Institute for Statistics, 2024). Gender disparities also persist, with male literacy rates estimated at about 74% compared with approximately 62% among women (UNESCO Institute for Statistics, 2024). In this study, female literacy refers specifically to the ability of women aged 15 years and above to read and write, which differs from broader measures of educational attainment such as years of schooling. Limited literacy can restrict women's ability to interpret health information, understand nutrition guidance, and effectively utilize healthcare services, which may influence maternal and child nutrition outcomes (Paulo et al., 2024; James et al., 2023; Bliznashka et al., 2021; Yaya et al., 2020).

A growing body of research highlights the role of maternal literacy and education in improving child nutrition outcomes across SSA. Cross-country analyses using Demographic and Health Survey data across 31 SSA countries show that children born to mothers with no formal education are significantly more likely to be stunted or underweight than those whose mothers have completed secondary education (Adedokun and Yaya, 2021). Evidence from northern Nigeria similarly shows that stunting rates are significantly higher among children of mothers without formal education (Sufiyan, 2012). Similarly, studies conducted in Malawi, Tanzania, and Zimbabwe demonstrates that increases in maternal education are associated with reductions in child stunting and underweight prevalence (Makoka, 2013). Research from Ethiopia and other East African countries also confirms that maternal education improves child feeding practices, dietary diversity, and healthcare utilization (Seretew et al., 2024). These improvements occur because educated women are more likely to adopt improved hygiene practices, access health services, and make informed decisions about childcare and nutrition (Hjertholm et al., 2025; Aboagye et al., 2024; Bliznashka et al., 2021).

However, the relationship between female literacy and nutrition outcomes does not operate independently of economic conditions. Poverty remains a major structural determinant of malnutrition in SSA because it restricts households' ability to access adequate food, healthcare services, and sanitation facilities (Paulo et al., 2024; Headey et al., 2020). Women living in economically disadvantaged households often face multiple overlapping constraints, including limited educational opportunities, reduced employment prospects, and restricted access to healthcare services. These combined disadvantages can create reinforcing cycles in which

poverty and low literacy jointly contribute to persistent maternal anemia and child undernutrition (Bezie et al., 2025; Gebremichael et al., 2025; Mare et al., 2023; Adedokun and Yaya, 2021).

Despite the growing literature on maternal education and child nutrition, many studies focus on individual countries or household-level surveys, this limits understanding of broader regional trends across SSA. Few studies have examined the combined association between female literacy, poverty, and malnutrition indicators at the regional level over an extended period. Understanding these relationships is particularly important because SSA continues to experience some of the highest rates of maternal anemia and child under nutrition globally despite ongoing education and health interventions (Global Nutrition Report, 2022).

This study therefore examines the association between female literacy, poverty, and key nutrition indicators across SSA using aggregated World Bank data from 2000 to 2019. Specifically, the study focuses on three major nutrition outcomes: anemia prevalence among women aged 15-49 years, child stunting prevalence, and child underweight prevalence. Analyzing trends and regression relationships between these variables, the study aims to better understand how improvements in female literacy and changes in poverty levels relate to nutrition outcomes in the region.

To guide this analysis, the study addresses the following research questions: (1) What are the trends in female literacy, poverty, and malnutrition indicators in SSA between 2000 and 2019? (2) Is there a statistical association between female literacy and key malnutrition outcomes (maternal anemia, child stunting and underweight) in SSA? (3) To what extent does poverty influence these nutrition outcomes relative to female literacy? This study answers these questions and contributes to understanding how improvements in women's literacy and reductions in poverty may jointly influence maternal and child nutrition outcomes in SSA.

Methods

Data source

This study examines trends in female education and health indicators in SSA over 20 years (2000-2019). The analysis relies on aggregated regional data for sub-Saharan Africa (SSA) obtained from the World Bank's World Development Indicators (WDI) database, which compiles internationally comparable development indicators reported by national statistical systems and international agencies (World Bank, 2024a). The WDI dataset provides standardized

time-series indicators on education, poverty, and health outcomes, allowing consistent comparison of regional trends across countries over time.

Annual regional values for SSA were extracted for the period 2000-2019, and only indicators with complete observations were included to maintain consistency across models. The dataset includes key indicators across three categories. Female literacy rates are measured using adult female literacy, defined as the percentage of women aged 15 years and above who can read and write. Health and nutrition outcomes include the prevalence of anemia among women aged 15-49, stunting prevalence (height-for-age) in children under five, and underweight prevalence (weight-for-age) in children under five. Additionally, the study incorporates poverty indicators to assess economic conditions that influence health and education trends. Poverty is measured using the poverty headcount ratio at \$2.15 per day (2017 purchasing power parity), representing the percentage of the population living below the international extreme poverty line. Using regional aggregate indicators allows the study to examine long-term macro-level associations between education, poverty, and nutrition outcomes across SSA.

Data analysis approach

To address the research objectives, the study employs a combination of descriptive, correlation, and regression analyses to examine the association between female literacy, poverty, and key nutrition outcomes like anemia prevalence, stunting, and underweight prevalence.

The descriptive analysis examined trends in female literacy and nutritional indicators over the period 2000-2019 using aggregated regional indicators for SSA. To explore associations among variables, pairwise correlations were calculated using Pearson correlation coefficients to assess the strength and direction of relationships between female literacy and key nutritional outcomes, including anemia prevalence, stunting, and underweight prevalence. Pearson correlation was selected because all variables are continuous percentage indicators and preliminary inspection suggested approximately linear relationships among them.

Statistical significance is determined using p-values, which indicate whether the observed relationships are meaningful. To quantify the influence of female literacy and poverty on nutritional outcomes, this study employs multiple linear regression analysis. Multicollinearity was assessed using the Variance Inflation Factor (VIF). The results indicated moderate correlation between female literacy and poverty (VIF = 4.33), which falls within the acceptable

threshold for regression analysis. Therefore, both variables were retained in the regression models.

The models were evaluated based on Adjusted R², F-statistics, and p-values, confirming their explanatory power and statistical significance. Diagnostic checks confirmed that key regression assumptions, including linearity, normality, and homoscedasticity, were met, ensuring the reliability of the results. Residual plots and normality tests were used to verify these assumptions prior to interpreting the regression results.

To strengthen the temporal interpretation of relationships and address concerns of simultaneity or reverse causation, lagged regression models were also estimated. These models use a one-year lag on the predictors (female literacy and poverty), allowing us to test whether changes in changes in female literacy and poverty in the previous year predict current health outcomes. A one-year lag was selected to capture short-term temporal associations between socioeconomic changes and nutrition outcomes while maintaining sufficient observations for the time series analysis. This approach provides a stronger basis for assessing directional relationships over time.

In addition, the study includes first-difference (FD) models as a robustness check to account for possible spurious correlations due to trending variables. First-differencing transforms the data to focus on year-to-year changes, thereby removing long-term trends and testing whether short-term fluctuations in female literacy and poverty are associated with corresponding changes in health outcomes.

The use of standard linear regression, lagged predictors, and first-difference models together enables a nuanced and temporally informed understanding of how female education and poverty relate to nutrition outcomes. While the analysis does not claim causality in a strict econometric sense, it provides compelling evidence for directional associations, particularly in the context of persistent poverty and education disparities. Although the time series is relatively short, the use of lagged and first-difference models helps strengthen temporal interpretation and reduce risks of spurious correlations.

All statistical analyses were conducted in R software (version 4.3.1) using the `readxl`, `dplyr`, `ggplot2`, `car`, `tidyr`, `reshape2` and `modelsummary` packages.

Results

Trends in female literacy and nutritional outcomes

This section examines temporal trends using aggregated regional indicators for SSA (2000-2019) to highlight rates of improvement or stagnation. As shown in Figure 1, female literacy (% of females ages 15 and above) has steadily increased over the years while the poverty headcount ratio (at \$2.15 a day, 2017 PPP) (% of population) has declined.

Similarly, the figure shows a sharp decline in all three nutritional outcomes of concern. The prevalence of anemia among women of reproductive age (% of women ages 15-49), stunting (height-for-age, % of children under 5), and underweight (weight-for-age, % of children under 5) have all decreased over time.

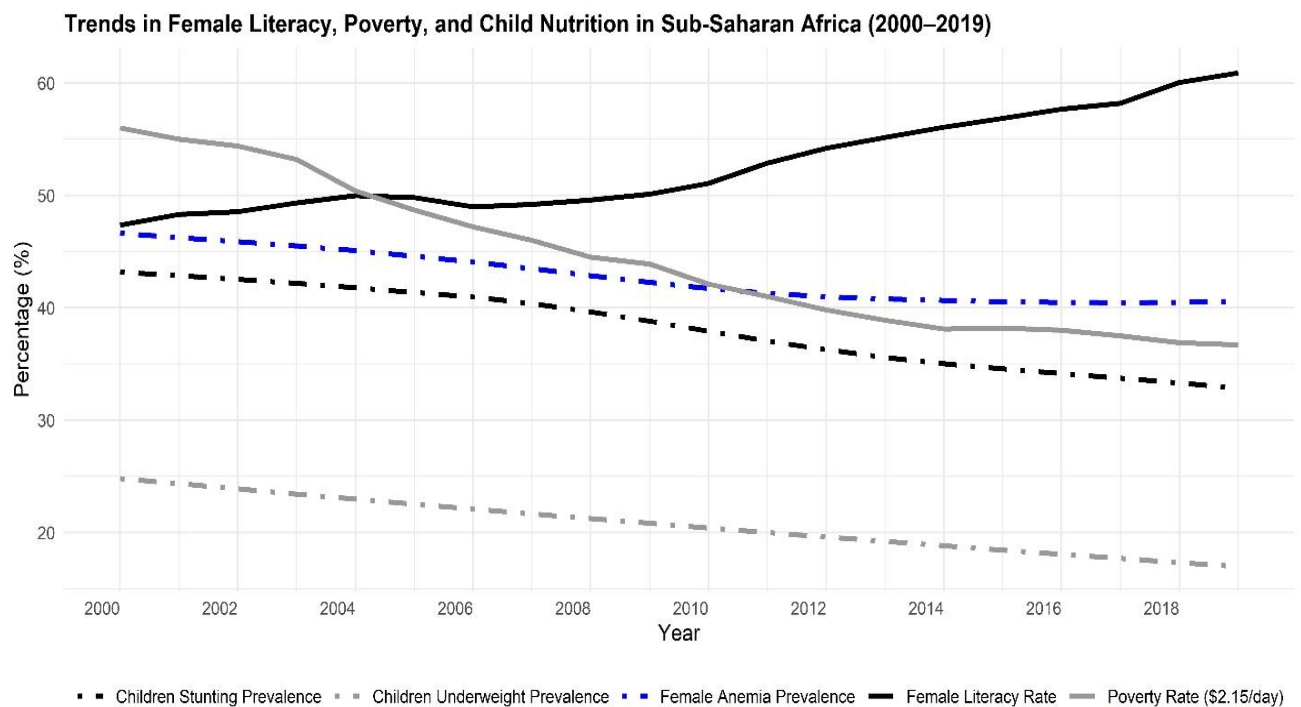


Figure 1. Line graphs showing trends for health outcomes, female literacy and poverty over time

Correlation analysis

To examine whether female literacy is statistically linked to nutritional outcomes, correlation analysis was conducted, as shown in Figure 2. The results indicate a negative correlation between female literacy and anemia prevalence, suggesting that higher female literacy rates over

time are associated with lower anemia prevalence among women. Similarly, female literacy also negatively correlates with child stunting and underweight rates, indicating that improvements in female literacy is associated with lower child malnutrition. In contrast, poverty levels show a strong positive correlation with all health outcomes, meaning that higher poverty rates are associated with increased prevalence of underweight, stunting, and anemia among children and women.

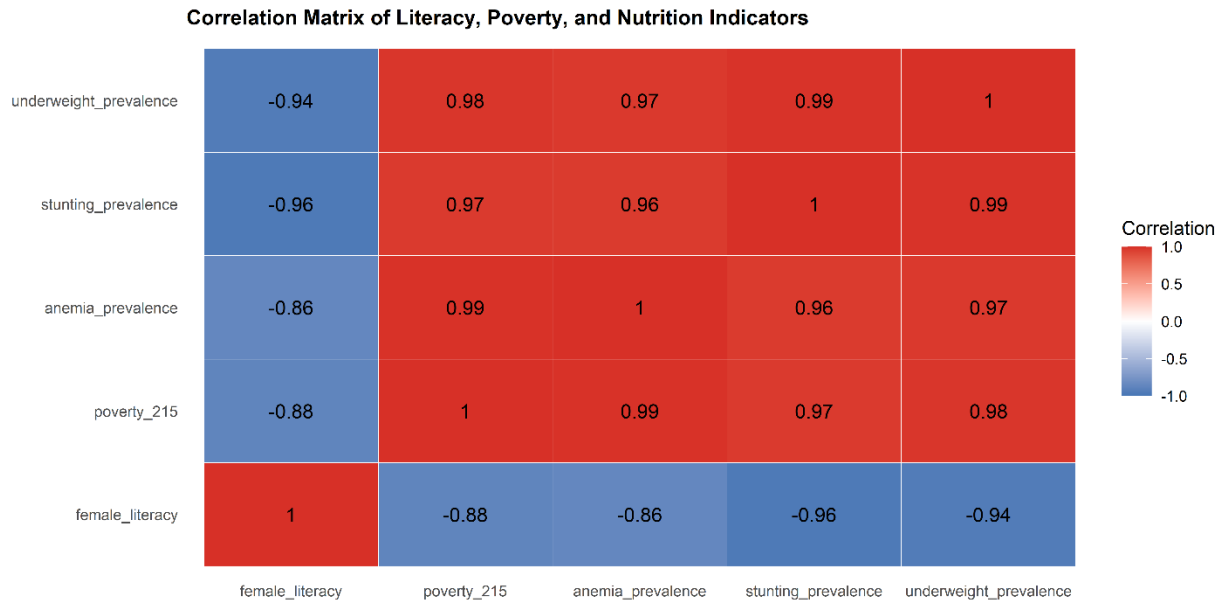


Figure 2. Heatmap of Pearson correlation coefficients among variables

Regression analysis

To assess the relationship between female literacy, poverty, and health outcomes, first multiple linear regression analysis was employed. The results for anemia prevalence, stunting prevalence, and underweight prevalence are presented in Table 1. For anemia prevalence in women, poverty emerged as the only significant predictor ($p < 0.001$), indicating that higher poverty levels are associated with increased anemia prevalence. Female literacy was not statistically significant, suggesting that other factors beyond literacy may play a stronger role in anemia outcomes.

In contrast, both female literacy and poverty were significant predictors of stunting and underweight prevalence in children below 5 years. Higher poverty rates were associated with increased prevalence, while higher female literacy was linked to lower stunting and underweight rates. These findings suggest that educational interventions could help mitigate child malnutrition, though economic conditions remain a major determinant.

Table 1. Multiple Linear Regression results for health outcomes

| Predictors | | Estimate | Std. Error | t-value | Pr(> t) |
|---------------------------------|------------------------------|----------|------------|---------|-------------|
| Anemia (Adj. R2 = 0.98) | Intercept | 25.44 | 2.2 | 11.57 | 1.76e-09*** |
| | Female Literacy | 0.031 | 0.028 | 1.12 | 0.279 |
| | Poverty Rate (\$2.15/day) | 0.353 | 0.018 | 19.64 | 4.03e-13*** |
| Stunting (Adj. R2 = 0.99) | Intercept | 47.16 | 3.15 | 14.96 | 3.23e-11*** |
| | Female Literacy | -0.411 | 0.04 | -10.31 | 9.88e-09*** |
| | Poverty Rate (\$2.15/day) | 0.287 | 0.026 | 11.13 | 3.15e-09*** |
| Underweight (Adj. R2 = 0.99) | Intercept | 20.64 | 1.84 | 11.23 | 2.75e-09*** |
| | Female Literacy | -0.204 | 0.023 | -8.79 | 9.94e-08*** |
| | Poverty Rate (\$2.15/day) | 0.244 | 0.015 | 16.28 | 8.43e-12*** |

To strengthen the temporal interpretation of these findings and account for the time it may take for improvements in literacy and an economic condition to influence health, a lagged regression analysis was conducted using a one-year lag on the predictors. The lagged results (Table 2) confirm the robustness of the earlier models. Poverty in the previous year remained a strong and significant predictor of all three health outcomes. Female literacy (lagged) continued to show a significant protective effect against stunting and underweight prevalence, indicating that improvements in women’s literacy can yield measurable benefits for child nutrition within a relatively short period.

Interestingly, lagged female literacy was also positively associated with anemia prevalence in the lag model. While counterintuitive, this may reflect increased health awareness, screening, or reporting among more educated women, or it may signal a need to address other causes of anemia that are not mitigated by literacy alone, such as food insecurity or disease burden.

Together, these regression results highlight the persistent and immediate effects of poverty on malnutrition and affirm the intergenerational benefits of female literacy, particularly for child health. The use of lagged predictors adds analytical depth and addresses concerns of simultaneity or spurious correlation due to time trends.

Table 2. Lagged Regression results for health outcomes (Dependent variable = Current Year Outcome; Predictors = Prior Year)

| Outcome | Predictor | Estimate | Std. Error | t-value | p-value |
|-------------|-----------------------|----------|------------|---------|-------------|
| Anemia | Intercept | 20.99 | 1.97 | 10.67 | 1.11e-08*** |
| | Female Literacy (t-1) | 0.097 | 0.026 | 3.79 | 0.0016** |
| | Poverty Rate (t-1) | 0.368 | 0.015 | 24.00 | <2e-13*** |
| Stunting | Intercept | 40.50 | 3.83 | 10.59 | 1.24e-08*** |
| | Female Literacy (t-1) | -0.338 | 0.050 | -6.79 | 4.34e-06*** |
| | Poverty Rate (t-1) | 0.337 | 0.030 | 11.31 | 4.81e-09*** |
| Underweight | Intercept | 19.24 | 1.96 | 9.80 | 3.62e-08*** |
| | Female Literacy (t-1) | -0.187 | 0.026 | -7.32 | 1.71e-06*** |
| | Poverty Rate (t-1) | 0.247 | 0.015 | 16.11 | 2.61e-11*** |

Note: All models use a one-year lag for predictors. Significance levels: ***p < 0.001, **p < 0.01. Adjusted R² for models: Anemia = 0.9905, Stunting = 0.9869, Underweight = 0.9922.

First-Difference robustness checks

To ensure the associations observed in the lagged regressions were not artifacts of shared time trends, I conducted first-difference (FD) regression models. These models estimate the effect of year-to-year changes in female literacy and poverty on changes in anemia, stunting, and underweight prevalence.

As shown in Table 3, changes in poverty levels were significantly associated with changes in anemia and underweight, consistent with our earlier findings. However, female literacy showed weaker effects in the differenced models and was not a significant predictor for stunting. The relatively low adjusted R² values for the stunting model, indicate that year-to-year changes in female literacy and poverty explain only a small share of short-term variation in stunting prevalence. This suggests that short-term fluctuations in these variables may not fully capture the underlying drivers of nutrition outcomes, which are often shaped by longer-term structural and socioeconomic conditions. Consequently, the stronger associations observed in the OLS and lagged models are more consistent with the gradual nature of improvements in child nutrition outcomes.

Nevertheless, the consistency of poverty as a significant predictor across modeling strategies reinforces its role as a key determinant of malnutrition. These results also suggest that improvements in female literacy may take longer to translate into measurable nutrition outcomes, and that its effects are better captured in lagged frameworks.

Table 3. First-Difference regression results

| Outcome | Predictor | Estimate | Std. Error | p-value |
|------------------|------------|----------|------------|---------|
| Anemia (FD) | Δ Literacy | +0.119 | 0.068 | 0.103 |
| | Δ Poverty | +0.192 | 0.062 | 0.007** |
| Stunting (FD) | Δ Literacy | -0.130 | 0.072 | 0.091+ |
| | Δ Poverty | +0.066 | 0.065 | 0.328 |
| Underweight (FD) | Δ Literacy | +0.019 | 0.009 | 0.066+ |
| | Δ Poverty | +0.026 | 0.009 | 0.009** |

Note: Significance: + $p < 0.10$, ** $p < 0.01$; FD = First Difference model; Δ = Change from previous year. Adjusted R² for models: Anemia = 0.450, Stunting = 0.087, Underweight = 0.459.

Discussion

The findings reveal that poverty is the strongest and most consistent predictor of adverse nutrition outcomes, while female literacy plays a protective role in reducing child malnutrition. These results align with a growing body of evidence emphasizing the impact of poverty on nutrition and health outcomes, particularly in low- and middle-income countries (Headey et al., 2020). Our results demonstrate a strong inverse relationship between female literacy and child malnutrition in sub-Saharan Africa (SSA), corroborating patterns observed in prior research. Several studies have documented that maternal education and literacy are strongly associated with improved child growth and nutrition indicators across low-income settings (Adedokun and Yaya, 2021; Kumeh et al., 2020). Educated women are more likely to adopt positive health behaviors, access medical services in a timely manner, and make informed decisions about diet, hygiene, and childcare (Bliznashka et al., 2021; Peyman and Abdollahi, 2016). A recent cross-sectional study across 31 SSA countries found that children born to mothers with no formal education were significantly more likely to be stunted or underweight than those whose mothers

had completed secondary education (Adedokun and Yaya, 2021). Similarly, studies by Aboagye et al. (2024) and Paulo et al. (2024) highlight the central role of women's empowerment and education in shaping dietary diversity and child nutrition outcomes. Recent analyses further show that maternal literacy and numeracy are key structural drivers of improvements in child nutrition and dietary adequacy in developing regions (Ferber and Baten, 2024; Kumeh et al., 2020). Generally, countries and communities with higher female literacy rates report significantly better health and nutrition outcomes for women and children (Population Reference Bureau, 2011). These patterns illustrate how female education influences nutrition outcomes not only through individual behavior but also through structural advantages, such as greater access to information, resources, and decision-making autonomy within the household and community.

Health knowledge and literacy

Our regression results show that female literacy is significantly associated with reductions in child stunting and underweight, confirming its protective role in nutrition outcomes. Specifically, our lagged model indicates that even a one-year increase in female literacy predicts measurable improvements in child nutrition. This finding is consistent with research suggesting that maternal education improves women's health literacy, which in turn influences feeding practices, hygiene behaviors, and preventive healthcare utilization (Bliznashka et al., 2021; Kumeh et al., 2020). This likely reflects the role of education in improving women's knowledge and awareness, particularly in areas of nutrition, hygiene, and disease prevention. Such knowledge can translate into healthier behaviors, including appropriate maternal nutrition, exclusive breastfeeding practices, and timely immunization for children. Evidence from multiple African settings indicates that mothers with higher literacy levels are more likely to adopt recommended infant feeding practices and preventive health behaviors that support child growth and development (Paulo et al., 2024; Yaya et al., 2020). Peyman and Abdollahi (2016) further explain that health literacy enhances women's self-efficacy in making informed health decisions, suggesting that improving female literacy can empower mothers to adopt better nutrition and childcare practices.

Consistent with our findings, research in Ghana has shown that education-based interventions can drive meaningful changes in dietary habits (Ghadirian et al., 2022). In a participatory video intervention among female Ghanaian adolescents, participants modified their eating habits, encouraged their families to adopt improved nutrition practices, and even influenced school food

policies. These findings show how strengthening women's knowledge and agency can produce spillover effects that extend beyond individual households to community nutrition environments.

Maternal healthcare and decision-making

Our findings show that higher female literacy is significantly associated with lower rates of child stunting and underweight. Although our analysis does not directly measure maternal healthcare utilization, prior studies suggest that education influences women's use of maternal health services and childcare practices (Makoka, 2013; Population Reference Bureau, 2011). These mechanisms may partly explain the association observed between female literacy and improved child nutrition outcomes. For example, educated mothers are more likely to access health information, adopt improved infant feeding practices, and utilize maternal health services, all of which contribute to improved child nutrition outcomes (Paulo et al., 2024; Adedokun and Yaya, 2021; Bliznashka et al., 2021). Empirical evidence also indicates that maternal education is strongly associated with increased antenatal care utilization and facility-based delivery across many African countries, which indirectly improves child survival and nutrition outcomes (Ahmed et al., 2023).

Similarly, a study analyzing the Nigerian Demographic and Health Survey (NDHS) found that education was strongly associated with increased antenatal visits and a higher likelihood of delivering in a health facility, even after accounting for socio-economic factors (Umar, 2017). This suggests that investing in girls' education can improve maternal and child health outcomes by increasing access to and utilization of healthcare services.

Economic empowerment and household nutrition

The protective effect of female literacy on child nutrition found in our analysis also reflects broader socioeconomic benefits that education offers. Education expands economic opportunities and increases household income, thereby reducing poverty-driven malnutrition. Literate women are more likely to participate in the workforce, earn income, and contribute to household food security (Olunusi, 2024a). Recent global analyses further highlight that women's education contributes significantly to improvements in household food security, dietary diversity, and child nutritional outcomes (Paulo et al., 2024; Ukonu et al., 2024). Research suggests that even one extra year of schooling can increase a woman's earnings by approximately 10% on average

(Global Partnership for Education, 2018). With greater financial resources and autonomy, educated mothers can afford more nutritious foods, maintain better sanitation, and invest in their children's well-being, thereby breaking the cycle of poverty-induced malnutrition.

These combined benefits (health knowledge, access to medical services, and improved economic capacity) explain why higher female education correlates with better nutrition and health outcomes across SSA.

Delaying early pregnancy and improving child health

Although maternal age and early marriage were not directly measured in this study, the observed association between female literacy and reduced child malnutrition may partly be explained by delayed childbearing and improved maternal preparedness, as suggested in previous research (Kumeh et al., 2020; Marphatia et al., 2020; Yaya et al., 2020). Studies show that literate women are more likely to access health information and family planning resources, which can influence reproductive decisions and maternal health practices (Ahmed et al., 2023; Meherali et al., 2021). Education has also been shown to delay age at marriage and first pregnancy, thereby improving both maternal and child health outcomes (Marphatia et al., 2020). Additionally, children born to adolescent mothers' face significantly higher risks of stunting and malnutrition compared with those born to women in their twenties or older (Adedokun and Yaya, 2021). These pathways suggest that keeping girls in school may indirectly contribute to improved child nutrition through delayed childbearing and better maternal health preparedness.

Regional patterns and comparative evidence

There is a clear trend linking higher female literacy with lower malnutrition rates across SSA. In countries where over 80 percent of young women are literate, such as Ghana, stunting rates among children are approximately 15 to 20 percent, well below the African regional average (Global Nutrition Report, 2022; World Bank, 2024b). Conversely, in Niger, where adult female literacy is below 35 percent and female youth literacy is only about 40 percent, child stunting remains alarmingly high, ranging from 40 to 50 percent (Trading Economics, 2024; World Bank, 2024b).

There are also substantial within-region and within-country variation. For instance, an analysis by Seretew et al. (2024) covering 36 SSA countries found that stunting prevalence ranged from as low as 16 percent in Gabon, a country with higher urbanization and female literacy, to over 50

percent in Burundi, which struggles with extreme poverty and the lasting effects of past conflicts. These contrasts highlight that the intensity of improving literacy and reducing poverty is relative to the region's specific needs.

For example, regions afflicted by conflict or extreme poverty, such as the Sahel and parts of Central Africa, continue to experience persistently high rates of child undernutrition, even when educational access improves. This suggests that schooling alone may not be sufficient to overcome structural drivers of malnutrition when food insecurity, conflict, and limited healthcare access persist (Olunusi, 2024b; Seretew et al., 2024; Adedokun and Yaya, 2021; Headey et al., 2020). Therefore, while female literacy is a powerful tool for improving child nutrition, it must be complemented by broader poverty reduction, food security policies, and enhanced healthcare access to create a lasting impact.

Model insights and policy implications

Our analysis quantifies this relationship, showing that a ten-percentage point increase in female literacy is associated with a 4.11 percentage point reduction in child stunting and a 2.04 percentage point reduction in child underweight rates, both statistically significant. Similarly, regions with higher female literacy rates also exhibited lower maternal anemia prevalence. This aligns with studies showing that women in low literacy communities are at higher risk of anemia compared to those in more educated environments (Mare et al., 2023).

In addition to the baseline regressions, our lagged models reinforced the significance of female literacy for reducing child malnutrition. The one-year lag results showed that previous-year improvements in literacy were associated with lower stunting and underweight prevalence in the current year, suggesting that education may have both immediate and short-term cumulative benefits. This aligns with prior research highlighting that maternal knowledge and health-seeking behaviors often develop gradually through sustained exposure to education (Meherali et al., 2021; Peyman and Abdollahi, 2016). Interestingly, lagged female literacy was positively associated with maternal anemia, which may reflect increased screening or awareness rather than a true rise in incidence (Bliznashka et al., 2021). In contrast, our first-difference models produced more conservative estimates, with weaker associations between literacy and nutrition outcomes. This likely reflects the time it takes for educational impacts to manifest. Yet, the direction of associations remained stable across models, reinforcing our overall conclusion that

education improves child health while poverty continues to exert an immediate influence, especially on maternal anemia (Headey et al., 2020; Makoka, 2013).

Nonetheless, education interacts with other socioeconomic determinants of health. In many cases, higher female literacy is associated with improved household income, greater access to healthcare services, and better living conditions, all of which contribute to improved nutrition and health outcomes (Bliznashka et al., 2021; Headey et al., 2020). While our models controlled for poverty, other relevant factors such as healthcare access, sanitation, and maternal age could not be included due to data limitations.

A further limitation of this study is the use of aggregated regional data for SSA over a 20-year period (2000-2019), which results in a relatively small number of observations for time-series analysis. Although the models provide useful insight into long-term associations between female literacy, poverty, and nutrition outcomes, the limited sample size may affect the precision of coefficient estimates. Future research using country-level panel data would allow more detailed analysis of these relationships and improve statistical power.

Despite these limitations, female literacy remained a significant predictor of lower child stunting and underweight rates. In contrast, poverty emerged as the strongest predictor of maternal anemia, suggesting that food security, healthcare access, and broader economic conditions play a critical role in addressing maternal malnutrition. Taken together, these findings suggest that while poverty reduction remains essential for addressing maternal malnutrition, strengthening female literacy can generate intergenerational benefits for child nutrition and health across SSA.

Conclusion

This study examined the relationships between female literacy, poverty, and key nutrition indicators in SSA using aggregated data from 2000-2019. The findings show that poverty is the strongest predictor of maternal anemia, while higher female literacy is significantly associated with lower rates of child stunting and underweight. These results highlight the important role of both economic conditions and women's education in shaping nutritional outcomes in the region. The analysis further demonstrates that improvements in female literacy are linked to measurable gains in child nutrition outcomes, whereas maternal anemia remains strongly influenced by poverty-related factors. This suggests that reducing malnutrition in SSA requires coordinated strategies that address both structural economic inequalities and educational opportunities for women. Strengthening female literacy and expanding educational opportunities for girls,

particularly the completion of secondary schooling may therefore represent an important pathway for improving child nutrition outcomes, as previous research indicates that higher levels of maternal education produce stronger and more sustained nutrition benefits. At the same time, the substantial regional variation in literacy, poverty, and nutrition outcomes across SSA highlights the need for context-specific interventions. Evidence from other settings suggests that education-focused initiatives are most effective when combined with direct nutrition and health support programs. In summary, these findings emphasize the importance of integrated strategies that combine investments in female literacy, poverty reduction, and targeted nutrition interventions to achieve sustained improvements in maternal and child nutrition in SSA.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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