Original Research Article

Socioeconomic Inequalities in Quality Antenatal Care Utilization and Childhood Birth Weight in Ghana

.ABSTRACT

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| --- |
| **Background:** Child health and development in sub-Saharan Africa (SSA) are critical issues. Despite the attainment of universal antenatal care (ANC) coverage in Ghana, the utilization of high-quality ANC remains challenging for pregnant women regardless of their socioeconomic status. This inequality in utilizing quality ANC leads to adverse birth outcomes. To address this issue, this study examined socioeconomic inequalities in the utilization of ANC and its impact on childhood birth weight in Ghana.  **Methods:** Data were obtained from the 2007 and 2017 Ghana Maternal Health Surveys (GMHS). The pregnant woman's visits to the antenatal clinic and the content of care she received were used as measures of quality ANC. CC and CI were constructed to measure the magnitude and trends of socioeconomic inequalities. The total differential approach was used to decompose the contributions of various factors of inequalities. Finally, the Khb rescaling method was used to examine the relative impact of socioeconomic variables mediating the total effect of ANC utilization on birth weight.  **Results:** This study revealed minimal pro-poor socioeconomic inequalities in the utilization of quality ANC in Ghana. Furthermore, the study showed that underutilization of quality ANC increased the odds of delivering low birth weight babies, with socioeconomic factors mediating 27.2% of this effect.  **Conclusions:** Ensuring more equitable policies and programs targeted at promoting health literacy in pregnant women can further prevent vulnerable pregnant women from persistently falling through the ANC inequality crack and help minimize the incidence of low birth weight in Ghana. |

*Keywords: [Quality antenatal, inequalities, birth-weight, Decomposition, Ghana}*

1. INTRODUCTION

The issue of child health and development in sub-Saharan Africa (SSA) is a significant concern. The high prevalence of malnutrition and infectious diseases within this region presents survival challenges for both mothers and children. As enshrined in the SDGs 3.2, to end preventable deaths of newborns by reducing neonatal mortality to at least as low as 12 per 1,000 live births by 2030, and the World Health Assembly’s (WHA) target of a 30% reduction in low-birth-weight by the end of 2025, concerns have arisen that these objectives might not be realized within the stipulated timeframe in Ghana.

With the consistent increase in antenatal care coverage in Ghana **[1]**, it is highly expected that adverse childhood birth outcomes resulting from low uptake of antenatal care should have declined to their barest minimum level but consequently, it has been reported that infant deaths occur every fifteen minutes in Ghana, with more than 21,000 fatalities recorded annually **[2]**. According to Siramaneerat et al. **[3]**, these tragic events stem from low-birth-weight resulting from inequalities in access to quality ANC.

Furthermore, despite Ghana’s high ANC coverage, interest and uptake among marginalized pregnant women have remained low **[4]**. Evidence further suggests that despite all attempts made toward universal ANC coverage in low-middle-income countries, inequalities in interest, uptake and providing ANC services exist **[5]**. In most cases, pregnant women from low socioeconomic households are disproportionately affected by these inequalities and consequently, will experience adverse birth outcomes **[6].**

Few studies have analyzed socioeconomic inequalities in various measures of ANC utilization in Ghana **[7, 8]**. The closet of the studies related to the present research are Novignon et al. **[9]**, who measured the utilization of four or more ANC visits in Ghana. However, because the quality of ANC (the outcome variable) of the study is binary, the value of the *CI* is unlikely to liebetween the normal bounds of −1 and +. Novignon et al. **[9]** in their estimation failed to account for this change.

Consequently, while Fenny et al. **[10]** investigating trends and determinants of inequality in ANC timing and the number of ANC visits captured gap in Novignon et al. **[9]** vividly but also failed to disentangle changes occurring within the elasticities of the decomposed CI. The interactions of these elasticities could lead to a positive or negative effect of the CI depending on the magnitude of their dispersions. Thus, Fenny et al. **[10]** only considered the marginal effect of each of the socioeconomic variables on quality ANC which does not explain entirely the sensitivity of quality antenatal care to each of the socioeconomic variables.

Finally, in addressing the inequality gap in quality ANC utilization, the strand in the literature have focused more of their attention on the inequalities in the frequency of ANC visits as opposed to the content of ANC contacts as an indicator of quality ANC utilization **[9, 10]**. The implication is that quality should not depend solely on the frequency of contact.

Moving on, the literature on low-birth-weight suggested a sluggish pace of low-birth-weight reduction at Ghana's national, regional, and district levels. For instance, Appiah et al. **[11]** reported that 24.5% of newborns from 233 mothers were low-birth-weight babies. Compounding this issue, Afaya et al. **[12]** reported that socioeconomic and demographic factors accounted for a 23.7% incidence of low-birth-weight among singleton newborn babies. While Agbeno et al. **[13]** concluded that approximately 27.6% of all low-birth-weight babies who were admitted to tertiary hospitals in Ghana died.

In the literature, most studies have estimated the influence of ANC utilization on birth weight, focusing primarily on establishing significant causality between quality ANC and birth weight in Ghana **[6, 11]**. These authors were unable to determine the relative impact of the presence of socioeconomic variables mediating the total effect of ANC utilization on birth weight. This study filled this gap.

The closest is Banchani & Tenkorang **[14]** but they failed to analyze the mediation effects of socioeconomic variables on quality ANC utilization. This is important because, in logistic regression, the mediated variables may affect themselves i.e. its scale when considering how different the coefficients or the odds ratios are **[15]**.

The remainder of the paper is organized as follows: section 2 reviews the literature; section 3 describes the methodology; section 4 presents the results and section 5 the discussion; and finally, section 6 provides details on the study's conclusions and policy implications.

2. LITERATURE REVIEW

**2.1 Introduction**

Theoretically, personal choices and behavioral differences between social classes in seeking health may result in socioeconomic-related health inequalities. These choices may influence mothers’ attitudes toward antenatal care utilization and consequently affect birth outcomes **[16]**.

**2.2 Socioeconomic inequalities in quality ANC utilization in Ghana**

Socioeconomic inequalities have been found to impact the utilization of quality antenatal care in Ghana **[17]**. Additionally, it has been shown that women who are poor, uneducated, and living in rural areas are prone to underutilizing ANC services **[18]**. Few studies have analyzed socioeconomic inequalities in various measures of ANC utilization in Ghana. For instance, Asamoah et al. **[19]** and Asamoah & Agardh [**7]** drew on the maternal healthcare utilization data from the Ghana Demographic and Health Surveys (GDHS) from 1988 to 2008, found that the wealth-related inequality and inequality in parity in the utilization of antenatal care has increased significantly over time.

Furthermore, Amo-Adjei et al. **[20]** using DHS data from the 5th round of surveys from 59 low-middle-income countries, concluded that controlling for known covariates there are significant wealth and educational differences in quality antenatal care usage among pregnant women. And Arsenault et al. **[1]** in assessing quality antenatal care with wealth-related inequalities across 91 low-middle- income countries, using fix regression and relative indices of inequality, they found that quality antenatal care have high levels of substantial coverage of 86.6% but relatively lower and inequitable levels i.e., 53.8%, of usage. Even though Amo-Adjei et al. **[20]** and Arsenault et al. **[1]** used the same indicators for quality antenatal care as this study, their methods of analysis and dataset differ greatly from this study; this may significantly produce varying results.

Novignon et al. [**9]** measured the utilization of four or more antenatal care (ANC) visits in Ghana using CC and CI, in addition to decomposition techniques. They found that wealth-related inequality in ANC visits decreased between 2003 and 2014 and attributed this reduction to universal NHIS coverage. Also using the same data; 2003, 2008, and 2014 GDHS. Fenny et al. **[10]** applying Wagstaff and Erreygers indices and decomposition techniques, they also found a substantial decrease in pro-rich inequality between 2003 and 2014 in the timing of the first antenatal visit and the number of antenatal visits (4+). Most recently, Ekholuenetale et al. **[8]** estimated the prevalence and socioeconomic inequalities of eight or more ANC contacts in Ghana and reported that women from rich households had greater coverage of eight or more ANC contacts.

Based on these reviews, they failed to disentangle changes occurring within the elasticities of the decomposed CI. The interactions of these elasticities could lead to a positive or negative effect of the CI depending on the magnitude of their dispersions. Thus, the mean and the coefficient of the socioeconomic variables could change between 2007 and 2017, which could offset each other and will have consequences in its contribution to the CI. This study used the **“total differential approach”** a proposed solution by Wagstaff et al. **[21]** to address this limitation. This method allows for changes occurring in the means, regression parameters, and concentration indices of the socioeconomic variables.

Finally, it is worth noting that in addressing the inequality gap the previous studies **[8,9,10]** were limited to reducing inequities that exist in the frequency of ANC visits. This study differs from the studies discussed above in these distinct ways. This study combined the guidelines developed by the Framework of the Lancet Global Health Commission under the High-quality Healthcare Systems **[22]**. And the WHO’s recommendations on quality antenatal care for better pregnancy outcomes in 2016 **[23]**. Thus the study used (i) the frequency of ANC visits, (ii) the trimester of the first ANC visits and (iii) the content of care received at ANC visits as a measure of quality ANC utilization.

**2.3 Socioeconomic variables mediating the effect of quality ANC on childhood birth weight**

The debate on the efficacy of quality antenatal care as a primary or secondary interceder in minimizing the incidence of low birth weight is inconclusive **[24].** While Zhou et al. **[6]** believe that ANC has the opposite relationship with LBW. Lu & Halfon [**25]** refuted this assertion.

In Ghana, the issue of birth weight should be a public health concern because birth weight is a strong predictor of infant survival and a person’s personality. Mohammed et al. **[26]** estimated the low-birth-weight prevalence to be 9.2% from Ghana’s fourth round Multiple Indicator Cluster Survey (MICS). In addition, Banchani & Tenkorang **[14]** using data from the Ghana Maternal Health Survey (2017), they estimated the influence of antenatal care utilization on birth weight by applying a complementary log-log model. They established a significant strong causal relationship between quality ANC and birth weight. They further explained that adequate utilization of antenatal care services, including timing, contacts, and content, provided significant protection against adverse pregnancy outcomes.

Appiah et al. **[11]** revealed that out of 62.2% of women who attended antenatal care 4+ times before delivery, 70.0% did not receive all ANC content. This has resulted in 24.5% of LBW babies being born to these women. They highlighted that despite high coverage of recommended ANC visits, factors such as marital status, religion, and educational level contributed to the high negative birth outcomes. Amponsah-Tabi et al. **[27]** also revealed that poor or average-quality ANC utilization is associated with adverse pregnancy outcomes such as anemia, preeclampsia, and low birth weight. An assumption from these studies is that there are socioeconomic mediating factors at play while pregnant women with inadequate antenatal visits may not receive the most benefits associated with quality ANC services **[6].**

These researchers collectively emphasized the need to address socioeconomic inequalities in using ANC to improve Ghana's maternal and child health outcomes. However, they do not specifically address how socioeconomic factors mediate the impact of quality antenatal care on childhood birth weight in Ghana. Thus, it has become necessary for this research to define the ultimate mediating role of socioeconomic factors in the total effect of quality ANC on childhood birth weight.

The closest is Banchani & Tenkorang **[14]** who suggested that certain socioeconomic factors are important predictors of the effect of quality ANC on birth weight in Ghana. However, they failed to analyze the mediation effects. Earlier studies like Hayes & Preacher **[15]** asserted that adding more independent variables to a logistic model affects its scale. This implies that in logistic regression, the mediated variables may affect themselves when considering how different the coefficients or the odds ratios are. Therefore, in addressing this gap left by Banchani & Tenkorang [**14],** this study applied the ‘Khb’ rescaling method to fix the scale of the reduced model in examining the intervening role of socioeconomic factors on the total effect of quality ANC on birth weight in Ghana.

3. methodology

**3.1 Data collection**

The study compiled the 2007 and 2017 datasets of the Ghana Maternal Health Survey (GMHS) conducted by the Ghana Statistical Service (GSS) in partnership with the Ghana Health Service (GHS) with technical assistance from Macro International (MI) for the various analyses as described elsewhere **[28].**

**3.2 Variables used in the study**

Two outcome variables assessed socioeconomic inequality in Ghana’s quality antenatal care utilization and childhood birth weight. In the first instance, the study assessed three dimensions of quality antenatal care service provided, namely, antenatal attendance, trimester of first antenatal visits, and content of the care provided during antenatal visits based on WHO quality recommendations as outcome variables **[23].**

In the second instance, childhood birth weight was used as the second primary outcome variable, and the weight of the child at birth, as self-reported by the mother or guardian, was measured irrespective of gestational age. Consistent with the literature, the constructions of individuals’ potential mediating socioeconomic factors that may influence childhood birth weight or that may hinder quality ANC utilization were generated and used in the analysis considering previous studies **[29].** See *appendix 2* for further construction.

**3.3 Model specification and estimation strategy**

**3.3.1 Concentration curve**

To analyze the trend of inequalities in antenatal care utilization, this study constructed a concentration curve (CC) for the 2007 and 2017 data sets of inequality in quality antenatal care utilization. The CC represents a graphical representation of the patterns of inequality in quality antenatal care utilization **[30]**. A proportional CC is attained when the curve lies within the 450 lines. A CC that lies below or above the equality line (450) represents a pro-rich or pro-poor concentration, respectively.

**3.3.2 Concentration index**

The concentration index (CI) provides a numerical measure of the magnitude of inequality in the utilization of quality ANC. The CI was defined as the area between the CC and the equality line (45° line) **[30]**. The CI was constructed as twice the weighted covariances of the quality of ANC with the pregnant woman’s socioeconomic status, all divided by the mean. Following the work of O’Donnell et al. **[30]** the CI is presented as follows:

The CI equals the weighted covariance of ***Zi*** & **H*i*** where **Hi** is the weighted data representing the quality ANC status of the ***i*th** pregnant woman aged 15-49 years and **Zi** represents the index of the household socioeconomic fractional rank of the pregnant women in the population. **µ** is the weighted unconditional mean value of the quality of antenatal care, and ***cov*** refers to the weighted covariance. The CI ranges between −1 and +1.

Because the outcome variable of the study is binary, the value of the CIis unlikely to liebetween the normal bounds of −1 and +1. For this reason, the value of the CI will depend on the mean [**31].** For this reason, equation (1) is reduced to the normalized level-independent version of the CI, referred to as the Erreygers’ Index (EI) **[32]**. The EI for quality antenatal care is:

where are the upper and lower bounds of the quality of antenatal care, respectively **[33].** A – or + EI signifies a pro-poor or pro-rich socioeconomic inequality in ANC utilization, respectively.

**3.3.3 Decomposition of the concentration index**

To estimate the contribution of various socioeconomic factors to inequality, the CI was decomposed **[30]**. This was achieved by expressing a linear function of the quality antenatal care variables in relation to the socioeconomic variables:

Following Wagstaff et al. **[21],** we can deduce the decomposition of the CI of ỿi and represent it as:

**CI (ỿi)=+ ≡+ (4)**

where CI (ỿi) is the decomposition of the concentration index, is the mean of, is the CI for , is the mean of ỿi, and is the generalized CI for the error term (ε).

Equation (4) above indicates two important dimensions of inequality in quality ANC utilization. The first term is “explained”) on the left-hand side, which indicates a weighted sum of the CI of k regressions, where the weight is the elasticity of ỿi with respect to **(ηk = ).** The second term on the right-hand side is “unexplained” **(),** which is the residual that represents inequality that cannot be explained by the selected socioeconomic variables **[34].**

**3.3.3.1 Total Differential Approach**

The approach used in *equation (4)* allows the study to decompose the marginal effect i.e. the sensitivity of each of the socioeconomic variables on quality ANC [**21].** To disentangle changes occurring within the elasticities of the decomposed CI, this research used a model called “**total differential approach**” the proposed solution by Wagstaff et al. **[21]** to address the limitations of *equation (4).* This approach allows for changes in the means, regression parameters, and concentration indices of the regressors. These changes are approximated as follows:

*Equation (5)* shows how unequally is distributed and thus how a change in the coefficient () or the mean () affects the CI. The more (i.e., Ck) is unequally distributed, the greater the CI will be. In contrast, an increase in has the opposite influence on the CI. The various components of *equation (5)* are presented in Table 3. This was obtained by estimating the regression for each year-specific (2007 & 2017) dataset and taking the differences between them appropriately weighted coefficients and variable means **[21].**

**3.3.4 Multilevel logistic regression models**

To ascertain whether the effect of ANC on birth weight is mediated by socioeconomic factors, a multilevel logistic regression model was used, as shown in equation (6).

**Yij = β1 + β2X 2ij+ … + βpXpij +ℇij  (6)**

Considering the hierarchical and sampling design of the datasets, all regressions were weighted and the "meqrlogit” command in Stata was used to construct a multilevel binary logistic regression model with random intercepts **[35].**

***3.3.4.1 Mediation and moderation analysis***

The study further examined the intervening or conditional effects of socioeconomic variables mediating the effect of quality antenatal care on childhood birth weight. In doing so, the study used the ‘khb’ rescaling method. This applies to the residual of the known mediators from the reduced model to a full model to fix the scale of the reduced model **[36, 33, 15].** To decompose the total effects into direct and indirect effects in order to compare various factors across the nested model I relied on the linear regression model of Mood [**36]** as follows:

**Y=α\_ (F) +β\_f H+γ\_f Z+δ\_f R+ ε (7)**

where Y is the birth weight of the child and H is the key variable, quality antenatal care, whose effect is decomposed. Z represents the socioeconomic variables serving as mediators in the assumption that "*quality antenatal care is hypothesized to partly operate through the socioeconomic variables to affect childhood birth weight".* R is any other associated variable used as a control variable for the decomposition. β\_f is the regression coefficient called the direct effect in the hypothesized situation.

4. results and discussion

**4.1 Trends and pattern of socioeconomic inequality in quality antenatal care utilization**

Figures 1 and 2 below depict the socioeconomic inequality curves of quality ANC utilization for 2007 and 2017, respectively. *Figure 1* shows that there was greater utilization of high-quality ANC services by pregnant women from high socioeconomic households than among those from low socioeconomic households in 2007. This observation represents a pro-rich inequality in quality ANC utilization.

*Figure 1: Concentration curve for quality antenatal care utilization in Ghana for 2007*

![A graph with a line of equality

Description automatically generated]()

As shown in *Figure 2*, quality ANC utilization has favored vulnerable pregnant women in 2017. This observation represents pro-poor inequality in quality ANC utilization.

*Figure 2: Concentration curve for quality antenatal care utilization in Ghana for 2017*

*![A graph with a line of quality

Description automatically generated]()*

**4.2 Magnitudes of socioeconomic inequalities in quality antenatal care**

*Table 1* highlights the CI values for the quality ANC and its corresponding indicators. It is noteworthy that the magnitude of the CI in 2007 was greater, with a value of 0.052 compared to -0.046 in 2017. This indicates an absolute pro-rich inequality in 2007 and an absolute pro-poor inequality in the utilization of quality ANC in 2017. Both results were statistically significant at the 1% level.

*Table 1: Concentration indices for quality antenatal care utilization in Ghana, 2007-2017*

|  |  |  |
| --- | --- | --- |
| Variable | 2007 | 2017 |
| Quality ANC | 0.052\*\*\* | -0.046\*\*\* |
|  | (0.020) | (0.012) |
| Clinical intervention | -0.049\* | -0.019\* |
|  | (0.025) | (0.012) |
| Diagnostic screening | 0.032\* | -0.028\*\*\* |
|  | (0.017) | (0.006) |
| 4+ ANC visits | 0.033\* | -0.011 |
|  | (0.019) | (0.009) |
| Trimester visits | 0.027 | -0.019 |
|  | (0.020) | (0.014) |
| Blood test | 0.034\*\* | -0.006\* |
|  | (0.015) | (0.003) |
| Urine test | 0.049\*\*\* | -0.028\*\*\* |
|  | (0.015) | (0.005) |
| Blood pressure | -0.004 | -0.001 |
|  | (0.005) | (0.002) |
| Weight | -0.002 | 0.002 |
|  | (0.006) | (0.002) |
| Tetanus | -0.009 | -0.014\* |
|  | (0.011) | (0.008) |
| Iron | 0.006 | 0.002 |
|  | (0.007) | (0.007) |
| Complication | -0.057\* | -0.025\*\* |
|  | (0.031) | (0.012) |
| Intestinal drug | 0.040\* | 0.042\*\*\* |
|  | (0.023) | (0.015) |
|  |  |  |

\*\*\* p=.01, \*\* p=.05, and \* p=.1 indicate significance. The numbers in the brackets are the robust standard errors of the values.

According to *Table 1*, Diagnostic Screening yielded significant results at the 10% and 1% levels for the years 2007 and 2017, respectively, with recorded CIs of 0.032 and -0.028, respectively. Similarly, clinical intervention showed significant levels of -0.049 and -0.019 for both years, at a significant level of 10%. The negative CIs obtained from Clinical Intervention in both years suggest that the utilization of quality ANC favors vulnerable pregnant women.

The investigation also revealed that in 2007, blood test use was concentrated among pregnant women from high socioeconomic households, with a CI of 0.03400 at a significance level of 5%. However, in 2017, the scenario changed as usage shifted toward low socioeconomic households among expectant mothers, with a negative CI of -0.00274 at a significant level of 10%. The study further revealed that in 2007, most pregnant women who underwent urine sample laboratory analysis were from high socioeconomic households. The CI is 0.04909, which is significant at the 1% level. Conversely, in 2017, the collection of urine samples for laboratory analysis was primarily conducted on pregnant women with low socioeconomic status, with a CI of -0.02763 at a significant level of 1%. Pregnant women with low socioeconomic status were found to benefit from receiving comprehensive information on pregnancy complications, as indicated by their negative CIs (-0.057, -0.02533) at a significance level of 10% and 5%, respectively, in 2007 and 2017.

Finally, privileged pregnant women were administered medication for intestinal parasites with positive CI values of 0.04253 and 0.04346 in 2007 and 2017, respectively. This result indicated that women from high socioeconomic households were the primary beneficiaries of this ANC treatment intervention, which was statistically significant at the 10% and 1% levels, respective.

**4.3 Decomposing inequality in quality antenatal care utilization**

The explained parts of the decomposition of the concentration index in equation (3), as presented in *Table 2* shows that the ten selected socioeconomic variables of interest collectively contributed approximately 85% and 84.8%, with the unexplained residual component contributing 15% and 15.2% to the observed pro-rich and pro-poor inequalities in the quality ANC utilization among pregnant women in 2007 and 2017, respectively.

*Table 2: Concentration indices for quality antenatal care utilization in Ghana, 2007-2017*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2007 | | | | 2017 | | | |
| Variable | elasticities | centration  indices | Contri-  butions | % contri-  butions | elasticities | centration  indices | Contri-  butions | % contri-  butions |
| Literate women | 0.054\*\*\* | 0.162\*\*\* | 0.009\*\*\* | 20.68 | 0.042\*\*\* | -0.156\*\*\* | -0.007\*\*\* | 18.7 |
| Not risky age | 0.175\*\*\* | 0.006\*\*\* | 0.001\*\*\* | 2.33 | 0.081\*\*\* | -0.004\*\*\* | 0.000\*\*\* | 1.0 |
| Not poor | 0.013 | 0.890 | 0.012 | 27.50 | -0.010 | 0.872 | -0.008 | 24.1 |
| Urban residence | 0.086\*\*\* | 0.155 | 0.013\*\*\* | 31.60 | 0.003 | -0.139 | 0.000 | 1.0 |
| Religion | 0.007 | -0.168 | -0.001 | -2.69 | 0.021 | -0.249 | -0.005 | 15.0 |
| Ethnic group | 0.006 | -0.684 | -0.004 | -9.73 | -0.006 | 0.500 | -0.003 | 8.3 |
| In a union | 0.011 | -0.050 | -0.001 | -1.37 | 0.012 | 0.034 | 0.000 | -1.1 |
| ANC Provider | 0.072 | 0.028\*\*\* | 0.002 | 4.86 | 0.456\*\*\* | 0.001\*\*\* | 0.000\*\*\* | -0.8 |
| Place of ANC | 0.004 | -0.019 | 0.000 | -0.19 | -0.116\*\*\* | 0.004\*\*\* | 0.000\*\*\* | 1.2 |
| Media exposure | 0.037\* | 0.142\*\*\* | 0.005\* | 12.41 | 0.078 | -0.078 | -0.006 | 17.5 |
| “Residual” |  |  |  | 14.60 |  |  | 0.152 | 15.2 |
| Total |  | 0.433 | 0.036 | 100 |  | 0.782 | -0.030 | 100 |
| Source: Author’s computation. \*\*\* p=.01, \*\* p=.05, \* p=.1 are the significant levels | | | | | | | | |

From *Table 2*, the results of the decomposition of inequality in quality antenatal care utilization in 2007 reveal that urban place of residence, at a 1% significance level, was the largest driver, contributing approximately 32% to the observed pro-rich inequality with a positive elasticity significant at the 1% level. The other significant positive contributors to the pro-rich inequality in the utilization of quality antenatal care in 2007 were the pregnant woman’s literacy status (21%) and her mass media exposure (12%).

The results from *Table 2* also show that, with a positive elasticity significant at the 1% level, the highest positive contributor to the observed pro-poor inequality in 2017 was the pregnant woman’s literacy status. With a significant level of 1%, it contributed approximately 19%. Other notable variables, such as the pregnant woman’s place of residence, age at childbearing, and ANC provider, had minimal contributions to the pro-poor inequality in the utilization of quality antenatal care in 2017.

**4.4 Decomposing changes in the concentration indices**

*Table 3* illustrates the estimated impacts of inequality in quality ANC utilization for 2007 and 2017 caused by (i) changes in the regression coefficients of the socioeconomic variables, (ii) changes in the means of the socioeconomic variables, and (iii) changes in the degree of inequalities in the socioeconomic variables as stated in *equation 5*.

*Table 3: Changes in the CIs following the total differential approach.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables | **β’s** | Means of x’s | CIs | Total | Percent |
| Literate women | 0.013\*\*\* | 0.001\*\*\* | -0.078 | -0.008 | 20 |
| Not risky age | -0.037\*\*\* | 0.030\*\*\* | -0.001 | -0.001 | 2 |
| Not poor | 0.001 | 0.008 | -0.009 | -0.009 | 24 |
| Urban residence | -0.080\*\*\* | 0.020\*\*\* | -0.008 | -0.006 | 15 |
| Religion | 0.001 | -0.006 | -0.041 | -0.002 | 6 |
| Ethnic group | 0.000 | 0.005 | 0.092 | 0.000 | 0 |
| In a union | 0.004 | -0.002 | 0.008 | 0.000 | -1 |
| Skill provider of ANC | 0.205\*\*\* | -0.158\*\*\* | -0.014 | -0.001 | 2 |
| Improved place of ANC | -0.037\* | 0.047\* | 0.008 | 0.000 | 0 |
| Mass media exposure | 0.022\*\*\* | -0.018\*\*\* | -0.032 | -0.006 | 17 |
| “Residual” | |  |  | -0.025 | 15 |
| Total | 0.091 | -0.074 | -0.073 | -0.058 | 100 |

Source: Author’s computation. \*\*\* p=.01, \*\* p=.05, \* p=.1

In *Table 3* the overall results showed that there is a significant pro-poor inequality contribution in the use of quality ANC over time in Ghana, with a CI = -0.058. It was also observed that changes within the regression coefficients (βs) i.e. the protective effects of the socioeconomic variables contributed to inequalities favoring privileged pregnant women in 2007 and 2017. Changes within the means (of x’s) i.e. adverse effects of the socioeconomic variables accounted for the pro-poor inequality in quality ANC utilization in 2007 and 2017.

In *Table 3*, the study also revealed that the protective effect of literacy in pregnant women out ways its adverse effects which led to the utilization of quality ANC being favored by illiterate pregnant women. Thus, a strong protective effect of 0.013 points contributed 20% to the decrease in pro-rich socioeconomic inequality from 2007 to 2017 that was observed in *Table 2*. A substantial portion of the observed residency effect in *Table 3* is due to a change in its adverse effect (-0.080 points), which contributed approximately 15% to the increase in pro-poor inequality in quality ANC utilization over time. This means that utilizing quality ANC favored pregnant women from low socioeconomic households in 2017 than in 2007. The results in *Table 3* further indicate that changes occurring within the means and coefficients of pregnant women’s exposure to mass media in accessing information on quality ANC, on average, contributed approximately 17% of the total pro-poor socioeconomic inequality observed over time. Thus, it tended to increased the pro-rich and improved pro-poor socioeconomic inequalities in quality ANC utilization in 2007 and 2017 respectively.

The take-home message from the total differential decomposition presented in Table 3 is that inequality in quality ANC utilization was caused by the protective and adverse effects within the socioeconomic variables as enumerated by the total differential approach in *Table 3*, rather than by just their elasticities, as suggested by the decomposition approach in *Table 2*.

**4.4 The role of socioeconomic factors in mediating the total effect of quality antenatal care on childhood birthweight**

*Table 4* shows the results of multilevel linear regression of childhood birth weight status for women who had at least one ANC visit in 2017 from three adjusted models. The first model represents the effect of high-quality ANC on birth weight. The second model represents the effect of high-quality ANC on birth weight mediated by healthcare systems. Finally, the third model presents the influence of high-quality ANC on birth weight mediated by both healthcare system and socioeconomic variables.

*Table 4: Multivariate analysis of the role of socioeconomic factors in mediating the effect of quality ANC on childhood birthweight in Ghana, 2017*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | |
|  | Model 1 | | Model 2 | | Model 3 | |
| variables | OR | CI (95%) | OR | CI (95%) | OR | CI (95%) |
| **Quality ANC** (ref: low) | | |  |  |  |  |
| High-quality | 1.567\* | [1.050 2.339] | 1.786\*\*\* | [1.176 2.712] | 1.745\*\*\* | [1.149 2.651] |
| **Clinical** (ref: low) | | |  |  |  |  |
| High-quality | 0.686\* | [0.469 1.004] | 0.521\*\*\* | [0.334 0.814] | 0.533\*\*\* | [0.341 0.833] |
| **Screening** (ref: low) | | |  |  |  |  |
| High-quality | 1.045 | [0.759 1.438] | 0.608\* | [0.335 1.102] | 0.604\* | [0.333 1.096] |
|  |  |  |  |  |  |  |
|  | |  |  |  |  |  |
| Source: Author's computation. Confidence Interval in parentheses, \*\*\* p=.01, \*\* p=.05, \* p=.1 | | | | | | |

The study revealed that higher-quality ANC utilization was significantly associated with better childhood birth weight outcomes in all three models and was highly mediated by socioeconomic variables. This showed that the probability of giving birth to infants with high birth weight was 1.567, 1.786, and 1.745 times greater for pregnant women with high-quality ANC than that of their peers who received low-quality ANC, and these values were 10%, 1%, and 1%, respectively, significant. (*Table 4*).

**4.4 Mediation and moderation analysis**

The significant changes in the odds ratios from 1.567 to 1.745) for quality ANC utilization accounting for healthcare systems, and socioeconomic variables in the multivariate logit models (1, 2 & 3) of *Table 4* cannot be solely attributable to the effects of quality antenatal care since adding more independent variables to a logistic model affects its scale **[15].**  To ascertain the true picture of the actual effect of quality antenatal care mediated by socioeconomic variables on birth weight, mediation analysis using the ‘khb’ rescaling method was applied. The variables that were significant in mediating the effect of quality antenatal care on birth-weight which warrant the formal mediation analysis (*see appendix 1*) is presented in *Table 5* below:

Table 5: Mediation effect of quality ANC using the ‘khb’ rescaling method on birthweight

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | | | |
| Independent | Rescaled reduced model | | | Full model | | | Difference (Full reduced) | | | Mediated effect |
| variables | coef. | SE | *P* value | coef. | SE | *P* value | coef. | SE | P value |  |
| quality ANC | -.158 | .052 | .002 | -.115 | .052 | 0.027 | -.043 | .009 | .000 | .272 |
| Source: Author's computation. | | | | | | | | | | |

The result as indicated in table 5 shows that the mediating effect of socioeconomic variables accounted for 27.2% of the total effect of quality ANC on birth weight. For pregnant women who give birth to normal birth weight babies, the total effect of inequality in quality ANC utilization is -0.158. However, when the pregnant woman’s socioeconomic factors are considered, the direct effect of quality ANC decreases to -0.115, leaving its confounding (indirect) effect at -0.043.

5. Discussion

The primary purpose of this study is to examine the nature of socioeconomic inequalities in quality antenatal care utilization in Ghana. The study found significant pro-poor socioeconomic inequality in the utilization of quality ANC in Ghana over time. This suggest that pregnant women from low socioeconomic households were favored in the utilization of quality ANC compared to their compatriots from high socioeconomic households.

These results contradict previous studies who reported a pro-rich inequality in ANC utilization in Ghana **[10, 9, 8].** It is worth noting that the focus of these studies was limited to reducing inequities in the frequency of ANC visits. This study differs from the studies discussed above in these distinct ways. While they used the frequency of ANC visits as a measure of quality ANC utilization, we used (i) the frequency of ANC visits, (ii) the trimester of the first ANC visits and (iii) the content of care received at ANC visits as a measure of quality ANC utilization.

The decomposition results using the total differential approach showed how protective effect of literacy status is a potential tool in addressing the presence of socioeconomic inequalities in pregnant women utilizing quality ANC in Ghana. This indicate that, pregnant women exhibited high health literacy by interpreting and correctly operationalizing ANC messages leading to good maternal health outcomes. This result is consistent with those of Boadi et al. **[37]** and Raru et al. **[38]** in indicating pregnant women with high health literacy are more likely to report high-quality ANC utilization.

To improve upon the pro-poor inequality in the utilization of quality ANC therefore mean ensuring more equitable policies and programs targeted at promoting health literacy in pregnant women. This intervention can prevent vulnerable pregnant women from persistently falling through the ANC inequality crack and help minimize the incidence of low birth weight in Ghana.

Other notable significant contributor to inequities in quality antenatal care utilization in Ghana are pregnant women’s exposure to mass media in accessing information on quality ANC and her residential status. This aligned with other studies which identified place of residence as a major determinant of health seeking behaviors among pregnant women in Ghana. Their significant contribution to the observed pro-poor socioeconomic inequality in the utilization of quality ANC over time shows that resourcing lower-level antenatal care clinics, enhancing healthcare financing, promoting good maternal health awareness, and increasing the activities and presence of healthcare workers at less developed health facilities Amporfu & Grépin **[39]**, will further improve on the pro-poor socioeconomic inequalities and its effect on childhood birth weight in Ghana.

The secondary objective of this study is to examine the impact of quality antenatal care mediated by socioeconomic variables on childhood birth weight in Ghana. The finding showed that higher-quality ANC utilization was significantly associated with better birth outcomes; this is consistent with the finding that receipt of quality ANC is crucial when determining childhood birth weight **[14].**

Secondly, the study found that, in Ghana, the effect of utilization of quality ANC on childhood birth weight is gravely mediated by her socioeconomic status. This corroborates with other findings from previous studies that, pregnant woman’s level of education **[11],** age at childbearing **[14]**, marital status **[12],** and ethnicity **[40]** are essential in ensuring the delivery of normal birth-weight babies. Therefore, the study concludes that the slow pace decreases seen in the incidence of LBW among vulnerable pregnant women over the years in society is likely due to the inequality in the utilization of quality ANC in Ghana.

5. Conclusion Policy implications and recommendations

This study examined the nature of socioeconomic inequality in quality antenatal care utilization in Ghana. In addition, I sought to identify key factors accounting for the observed inequality. Lastly, the study examined the effect of antenatal care on childhood birth-weight net of socioeconomic factors. The study found a minimal pro-poor socioeconomic inequality, a sign of deepening equality in the utilization of quality antenatal care in Ghana. The total differential approach showed that drivers of inequality in ANC utilization extended beyond approximate healthcare sector reforms, variables such literacy, residency, and mass media were the significant contributors to the inequality. The study further found that the presence of socioeconomic variables strongly mediated the total effect of quality antenatal care utilization on childhood birth weight in Ghana.

Notwithstanding, the study identified pro-rich socioeconomic inequalities in the utilization of some content of quality ANC in Ghana. Any laxity will present a situation whereby pregnant women from low socioeconomic households, believed to have been highly prone to the risk of delivering low-birth-weight babies, would underutilize quality antenatal care. This will likely not reduce the incidence of low-birth-weight to the desired rate of World Health Assembly’s (WHA) and Sustainable Development Goals (SDGs) 3.2 targets in Ghana. Government should ensure more equitable policies and programs targeted at promoting health literacy in pregnant women.

DEFINITIONS, ACRONYMS, ABBREVIATIONS

ANC: Antenatal Care; CC: Concentration Curve; CI: Concentration Index; DHS: Demographic and Health Survey; EI: Erreygers’ Index; GMHS: Ghana Maternal Health Survey; LBW: Low Birth Weight; NHIS: National Health Insurance Schemes;

SDGs: Sustainable Development Goals; GDHS: Ghana Demographic and Health Surveys;

WHO: World Health Organization.

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APPENDIX 1

Multivariate analysis of the role of socioeconomic factors mediating the effect of Quality ANC on Childhood Birth Weight in Ghana, 2017

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | |
|  | Model 1 | | Model 2 | | Model 3 | |
| variables | OR | CI (95%) | OR | CI (95%) | OR | CI (95%) |
| **Quality ANC (ref: low-quality)** | | |  |  |  |  |
| high-quality | 1.567\* | [1.050 2.339] | 1.786\*\*\* | [1.176 2.712] | 1.745\*\*\* | [1.149 2.651] |
| **Clinical (ref: low-quality)** | | |  |  |  |  |
| high-quality | 0.686\* | [0.469 1.004] | 0.521\*\*\* | [0.334 0.814] | 0.533\*\*\* | [0.341 0.833] |
| **Screening (ref: low-quality)** | | |  |  |  |  |
| high-quality | 1.045 | [0.759 1.438] | 0.608\* | [0.335 1.102] | 0.604\* | [0.333 1.096] |
|  |  |  |  |  |  |  |
| **Components of ANC** | |  |  |  |  |  |
| Urine (Ref: no) | |  |  |  |  |  |
| yes | 1.247\* | [0.969 1.604] | 1.306 | [0.815 2.092] | 1.322 | [0.823 2.122] |
| Tetanus (Ref: no) | |  |  |  |  |  |
| yes | 1.084 | [0.935 1.257] | 1.151 | [0.956 1.386] | 1.138 | [0.945 1.372] |
| Iron (Ref: no) | |  |  |  |  |  |
| yes | 1.083 | [0.866 1.354] | 1.163 | [0.905 1.493] | 1.169 | [0.909 1.503] |
| Complication (Ref: no) | |  |  |  |  |  |
| yes | 0.955 | [0.835 1.093] | 1.019 | [0.852 1.218] | 0.997 | [0.834 1.193] |
| Blood sample (ref: no) | |  |  |  |  |  |
| yes | 1.037 | [0.738 1.458] | 1.171 | [0.772 1.776] | 1.167 | [0.769 1.772] |
| Blood pressure (ref: no) | | |  |  |  |  |
| yes | 0.903 | [0.494 1.651] | 1.009 | [0.532 1.912] | 0.990 | [0.521 1.880] |
| Weight (ref: no) | |  |  |  |  |  |
| yes | 2.005\*\* | [1.133 3.548] | 2.294\*\*\* | [1.242 4.238] | 2.342\*\*\* | [1.265 4.337] |
| Drugs (ref: no) | |  |  |  |  |  |
| yes | 0.935 | [0.848 1.030] | 0.965 | [0.866 1.075] | 0.980 | [0.879 1.093] |
| **Trimester visit (ref: 3 trimester)** | | |  |  |  |  |
| first trimester | 0.705 | [0.367 1.353] | 0.688 | [0.357 1.324] | 0.665 | [0.345 1.283] |
| second trimester | 0.734 | [0.383 1.406] | 0.715 | [0.372 1.374] | 0.702 | [0.365 1.351] |
| **ANC visits (ref: less than 4)** | | |  |  |  |  |
| more than 4 | 1.432\*\*\* | [1.207 1.698] | 1.430\*\*\* | 1.205 1.696] | 1.418\*\*\* | [1.193 1.683] |
| more than 8 | 1.802\*\*\* | [1.494 2.173] | 1.768\*\*\* | [1.464 2.135] | 1.700\*\*\* | [1.403 2.058] |
|  |  |  |  |  |  |  |
| HEALTHCARE SYSTEM | |  |  |  |  |  |
| **ANC provider (ref: TBA)** | | |  |  |  |  |
| Doctors |  |  | 0.683 | [0.209 2.230] | 0.656 | [0.202 2.132] |
| Nurse/midwife | |  | 0.639 | [0.196 2.081] | 0.636 | [0.196 2.058] |
| Comm. health | |  | 0.578 | [0.176 1.897] | 0.577 | [0.176 1.884] |
| **ANC place (ref: Home)** | |  |  |  |  |  |
| Govt. hospital | |  | 1.376 | [0.725 2.611] | 1.306 | [0.688 2.481] |
| Govt. CHPS | |  | 1.200 | [0.633 2.273] | 1.179 | [0.621 2.237] |
| Private facility | |  | 1.221 | [0.633 2.353] | 1.142 | [0.592 2.204] |
|  |  |  |  |  |  |  |
| SOCIOECONOMIC VARIABLES | | |  |  |  |  |
| **Age at childbearing (Ref: <19)** | | |  |  |  |  |
| 20-24 |  |  |  |  | 1.170 | [0.922 1.484] |
| 25-34 |  |  |  |  | 1.232\* | [0.978 1.548] |
| 35+ |  |  |  |  | 1.214\* | [0.956 1.540] |
| **Economic status (Ref: lowest)** | | |  |  |  |  |
| second |  |  |  |  | 0.925 | [0.738 1.159] |
| middle |  |  |  |  | 0.925 | [0.740 1.156] |
| fourth |  |  |  |  | 0.966 | [0.773 1.203] |
| highest |  |  |  |  | 0.986 | [0.791 1.225] |
| **Educational level (Ref: no)** | | |  |  |  |  |
| primary |  |  |  |  | 0.889 | [0.766 1.031] |
| middle/jss/jhs | |  |  |  | 0.914 | [0.791 1.055] |
| sss/shs/tech/voc/comm | | |  |  | 0.960 | [0.795 1.160] |
| higher |  |  |  |  | 1.265\* | [0.975 1.633] |
| **Place of residence (Ref: rural)** | | |  |  |  |  |
| urban |  |  |  |  | 0.997 | [0.883 1.125] |
| **Ethnic group (Ref: akan)** | | |  |  |  |  |
| Ga/Dangme |  |  |  |  | 1.216 | [0.923 1.603] |
| Ewe |  |  |  |  | 1.349\*\*\* | [1.105 1.648] |
| Northern tribe | |  |  |  | 0.913 | [0.786 1.061] |
| Other |  |  |  |  | 1.367\* | [1.064 1.759] |
| **Mass media exposure (Ref: no)** | | |  |  |  |  |
| less than once a week | |  |  |  | 0.969 | [0.841 1.117] |
| at least once a week | |  |  |  | 1.001 | [0.859 1.167] |
| **Religion (ref: no religion)** | | |  |  |  |  |
| Christian |  |  |  |  | 1.328\* | [1.020 1.727] |
| Muslims |  |  |  |  | 1.243 | [0.941 1.642] |
| Traditionalist | |  |  |  | 1.326 | [0.914 1.923] |
| In a union (ref: single) | |  |  |  |  |  |
| currently married | |  |  |  | 1.205\*\* | [1.033 1.407] |
| living with a man | |  |  |  | 1.095 | [0.932 1.287] |
| Source: Author’s computation. Standard errors in parentheses \*\*\* p=.01, \*\* p=.05, \* p=.1 | | | | | | |

APPENDIX 2

Variables description and measurements

|  |  |
| --- | --- |
| Variables |  |
| quality antenatal care | Quality antenatal care was measured by the extent of the utilization of four categorized antenatal care services (antenatal attendance, trimester of first antenatal visits, clinical intervention, and diagnostic procedures). If a pregnant woman received a total score of 4 the study classified, her as “high-quality antenatal care used” with a binary value of 1 and 0 if not as “low-quality antenatal care used |
| Birth weight | Birth weight was dichotomized as a dummy variable that takes a value of one if the weight of the child at birth is ≥ 2,500 grams to be a normal birth weight, and 0 if the weight of the child at birth irrespective of its' gestational age was ˂ 2,500 grams considered as low birth weight |
| Clinical intervention | Clinical intervention includes iron, tetanus injection, drugs, and information on pregnancy complications. Outcome was measured as dummy variables that take a value of one should the pregnant woman receive at least three of these clinical interventions and 0 otherwise |
| Diagnostic procedures –screening | Diagnostic screening includes weight and blood pressure measurements, and urine and blood samples for laboratory. The outcome was measured as a dummy variable that takes a value of one if a woman received all four diagnostic procedures and 0 otherwise |
| 4+ ANC visits | Pregnant women’s recent birth responses were coded into a binary, giving a value of one if antenatal visits were ≥ 4 and 0 otherwise |
| Trimester visits | A pregnant woman's response was classified as one if she had her first antenatal visit to the antenatal clinic within the first or second trimester of her pregnancy and 0 otherwise. |
| blood test, urine sample, pregnancy complications, intestinal drugs, blood pressure, weight, tetanus, and iron | Mothers were asked whether each of these procedures was conducted at least once during antenatal care. The adequacy of these variables was measured by assigning a binary to each of the above-listed procedures, resulting from 1 if yes and 0 otherwise |
|  |  |
| literacy status | This was measured using the number of years of completed school categorized orderly as (no school, primary, secondary, and higher) for the Multivariate analysis, but for the decomposition analysis, the study dichotomized it as 0 indicating ‘illiterate’ and 1 indicating ‘literate’ status |
| mass media exposure | The study coded mass media exposure as “yes” = 1 and “no” = 0 |
| Ethnic | Pregnant women's ethnicity was grouped into three (akan, ga/dangme, ewe, northern tribe, and no tribes) for the multivariate regression analysis. But for the decomposition analysis, the study dichotomized it as "belonging to an ethnic group" coded as 1, and "not belonging to any ethnic groups" coded as 0 |
| Religion | Religion was categorized into four groups (no religion/other, Christians, Muslims, and Traditionalists) for the multivariate regression analysis, for the decomposition analysis, Religion was dichotomized as "no religion" coded as 0, and "all other religions" coded as 1. |
| marital status | The study categorized the pregnant woman’s marital status into three (single, currently married, and living with someone) for the multivariate regression analysis, but for the decomposition analysis, the study dichotomized the variable marital status into a binary “in union” coded as 1 and “not inion” coded as 0. |
| wealth status | Wealth status was ranked into five quintiles i.e., (lowest, second, middle, fourth, and highest) depending on the pregnant woman’s level of household wealth for the multivariate analysis. But was later re-categorized into 0 indicating ‘poor’ and 1 indicating ‘not-poor’ for the decomposition analysis. |
| type of ANC provider | The study categorized the type of ANC provider into four (doctors, nurses & midwives, community health attendants, and Traditional Birth Attendants (TBA)) for the multivariate regression analysis, but for the decomposition analysis, the study dichotomized the variable type of ANC provider as “skilled providers” coded as 1 and “unskilled providers” coded as 0. |
| antenatal facility | The type of antenatal care facility was categorized into government hospitals and polyclinics, government health centers (CHPS compounds, etc.), private facilities (maternity homes), and the home of the woman or the provider for the multivariate regression analysis. For the decomposition analysis, the study dichotomized it as “improved facilities” coded as 1 and “unimproved facilities” coded as 0 |
| Age | For the multivariate regression analysis, the study categorized age into four groups (≤ 19, 20-24, 25-34, and 35+), but for the decomposition analysis, the study dichotomized it as “risky” age of childbearing ranges from 15 to 24 years coded as 0 and “non-risky” age at childbearing to include 25+ years coded as 1 |
| Type of residence | Type of residence of the pregnant woman was coded as either urban or rural |