# RESEARCH

# Trends and inequalities in adequate antenatal care coverage among women in Sierra Leone, 2008–2019

Augustus Osborne<sup>1\*</sup>, Florence Gyembuzie Wongnaah<sup>2</sup>, Medlin Soko Tucker<sup>3</sup>, Camilla Bangura<sup>1</sup>, Fatmata Gegbe<sup>4</sup> and Bright Opoku Ahinkorah<sup>5,6</sup>

# Abstract

**Background** Prenatal care is a critical component of maternal and child health, providing essential preventive, diagnostic, and therapeutic services to pregnant women. Adequate antenatal care has been linked to reduced maternal and infant mortality and improved birth outcomes. Despite its importance, disparities in antenatal care coverage persist globally, including Sierra Leone, with significant implications for maternal and child health. This study examined the trends and inequalities in antenatal care utilisation in Sierra Leone.

**Methods** We used data from the 2008, 2013, and 2019 Sierra Leone Demographic and Health Surveys. Simple inequality measures (Difference and Ratio) and complex measures (Population Attributable Risk and Population Attributable Fraction) were computed using the World Health Organization's Health Equity Assessment Toolkit software. Inequality in antenatal care was calculated on six stratefiers: age groups for women, birth order, educational levels, economic status, residential areas, and sub-national province.

**Results** There was a significant increase in adequate antenatal care coverage from 2008 (15.2%) to 2013 (36.5%) but a decrease in 2019 (22.1%). The inequality in age increased over time from a Difference of 2.7 percentage points in 2008 to a Difference of 5.3 percentage points in 2019, indicating age-related inequalities. The Population Attributable Fraction decreased from 2.7% in 2008 to zero in 2013, indicating no further improvement in the national average of adequate antenatal care coverage can be achieved in the absence of age-related inequalities. However, it increased to 7.7% in 2019, indicating that the national average of adequate antenatal care coverage would have increased by 7.7% in the absence of age-related inequalities. The birth order inequality increased from a Difference of -5.2 percentage points in 2008 to 2.6 percentage points in 2019. The Population Attributable Fraction was zero in 2008 and 3.4% if there was no parity-based inequality. Inequality in economic status decreased from 32.1 percentage points in 2008 (Difference = 32.1) to 2.8 percentage points in 2019 (Difference = 2.8). The Population Attributable Fraction revealed that the national average could have been 164.4% higher in 2008 and 20.8% higher in 2013; however, it was zero in 2019, indicating that no further improvement can be achieved in the national average if there was no inequality related to economic status. Inequality for education decreased from 49.9 percentage points in

\*Correspondence: Augustus Osborne augustusosborne2@gmail.com

Full list of author information is available at the end of the article



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc-nd/4.0/.



**Open Access** 

2008 (Difference = 49.9) to 11.0 percentage points in 2019 (Difference = 11.0). Inequality decreased from a Difference of 20.8 percentage points in 2008 to a Difference of 1.7 percentage points in 2019 for place of residence inequality, showing a reduction in inequality. Provincial inequality decreased from a Difference of 33.9 percentage points in 2008 to 8.5 percentage points in 2019.

**Conclusion** While there have been notable improvements in antenatal care coverage in Sierra Leone, adequate antenatal care coverage is still below the WHO target of 78% in 2016, and significant inequalities persist. Addressing these inequalities requires a multifaceted approach considering demographic, economic, educational, and geographic indicators considered in this study. Sustained efforts and targeted interventions are critical by the Sierra Leone government to ensure that all women, regardless of their background, have access to essential antenatal care services up to at least eight visits.

Keywords Antenatal care, Coverage, Inequality, Women, Sierra Leone

#### Text box 1. Contributions to the literature

• Provides a comprehensive overview of changes in adequate antenatal care (ANC) coverage in Sierra Leone between 2008 and 2019, contributing to understanding progress and challenges in maternal health. Identifies disparities in ANC coverage based on age, wealth, education, parity, and geographic location, highlighting the need for targeted interventions.

• Offers evidence-based recommendations to address the identified inequalities and improve ANC coverage among vulnerable populations in Sierra Leone.

• Establishes a benchmark for measuring future progress in ANC coverage and informing the design of maternal health interventions in Sierra Leone.

# Introduction

Increasing the frequency of high-quality antenatal care (ANC) coverage is a critical strategy for reducing maternal and newborn fatalities [1-4]. Numerous studies indicate that a higher number of quality ANC coverage correlates with a lower likelihood of pregnancy complications and adverse outcomes [5-9]. Timely access to ANC enables healthcare providers to counsel pregnant women effectively on selecting skilled birth attendants, which is essential for improving maternal health [10-12].

In 2020, approximately 800 women died daily from avoidable pregnancy-related factors, translating to a death every two minutes, primarily in low-income countries [13]. Sub-Saharan Africa accounts for 66% of these deaths, with Sierra Leone, South Sudan, and Chad having the highest maternal mortality ratios globally [13]. In Sierra Leone, the maternal mortality ratio in 2019 was 717 deaths per 100,000 live births, and the newborn mortality rate was 31 deaths per 1,000 live births [14]. The third Sustainable Development Goal (SDG) aims to reduce maternal fatalities to below 70 per 100,000 live births and neonatal mortality to 12 per 1,000 live births by 2030 [5], necessitating the expansion of interventions that effectively decrease maternal and newborn mortality in the country [10].

The World Health Organization (WHO) initially recommended a Focused Antenatal Care (FANC) model with a minimum of four ANC coverage [5]. However, in 2016, this was revised to a minimum of eight contacts, with the first visit occurring within the first trimester [15–17]. The updated guidelines emphasise comprehensive care, including medical treatment and health education, fostering a dynamic interaction between pregnant women and healthcare providers. This shift aims to enhance health education and prepare women for childbirth [18].

With 1,360 mothers dying for every 100,000 live births, Sierra Leone has the highest ratio of maternal mortality in the world [13], as the health indices for mothers and children in Sierra Leone are poor [19, 20]. Maternal deaths account for 9% of all deaths among women of reproductive age, with a lifetime risk of maternal mortality at 3.4% [21]. Despite improvements in some maternal and child health services, such as skilled birth attendance [22], four or more ANC coverage has only slightly increased from 76% in 2013 to 79% in 2019 [14]. Additionally, the percentage of women starting ANC in the first trimester has decreased from 45% in 2013 to 44% in 2019 [14]. Research indicates that the quality of Maternal Child Health services is subpar, with only 27% of women receiving examinations and less than half obtaining recommended interventions [23]. In 2018, Sierra Leone joined the Global Quality of Care Network, aiming to ensure high-quality care for all pregnant women, newborns, and children [24]. The Ministry of Health adopted the WHO ANC model in 2017, targeting a reduction in the maternal mortality ratio to 650 per 100,000 live births and the neonatal mortality rate to 23 per 1,000 live births [25].

To reduce maternal and newborn deaths, effective implementation of the new WHO ANC model is imperative. However, there is a lack of studies assessing ANC coverage according to these updated guidelines, which hampers efficient implementation. Our research focuses on the trends and inequalities in the coverage of eight or more ANC among women in Sierra Leone from 2008 to 2019. Understanding these trends is crucial for designing effective interventions to improve access to quality ANC services, particularly as socio-economic status, education level, and place of residence significantly influence ANC utilisation [26, 27].

# Methods

# Study setting and data source

Data was obtained from the 2008, 2013, and 2019 Sierra Leone Demographic Health Survey (SLDHS). The SLDHS is a comprehensive survey conducted throughout the country to determine regular patterns and alterations in demographic indicators, health indicators, and social issues among individuals of all genders and age groups. The SLDHS utilised a cross-sectional design, where respondents were selected through a stratified multi-stage cluster sampling procedure. The comprehensive sampling approach has been discussed in the SLDHS report [2]. This study included women who had given birth within five years before the survey. For the analysis, a sample of 2,478, 4,821, and 3,950 women were selected from the 2008, 2013, and 2019 SLDHS datasets, respectively. The 2008, 2013, and 2019 SLDHS data were accessible for direct utilisation via the WHO HEAT online platform [28]. This study was written following the requirements outlined in the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [29].

#### Variables

The outcome variable was adequate ANC coverage. Within the SLDHS, women were asked about the frequency of their visits to the ANC clinic during their most recent pregnancy within the past two years. A binary variable was created by categorizing ANC coverage into two groups: "inadequate" for 0-7 visits and "adequate" for 8 or more visits. The study utilised six variables as inequality stratifiers identified in existing literature [26, 27, 30-32]. The WHO HEAT software included these stratifiers for evaluating inequalities in several health and social indicators [28]. The stratifiers were age groups of women (15-19 and 20-34, 35-49), birth order (1, 2-3, 4-5 and 6+), educational levels (no education, primary, secondary, and higher), economic status (poorest, poorer, middle, richer, and richest), place of residence (rural and urban), and sub-national province (East, North, Northwestern, South, and West).

#### Statistical analyses

All analyses were conducted using the online version of the WHO HEAT software. The WHO HEAT is an internet-based statistical tool used to examine health inequalities within and among nations, utilising a range of health and social indices [28]. We analysed the prevalence of adequate ANC across the six stratifiers: age groups, birth order, educational levels, economic status, place of residence, and sub-national area. We used four indices to measure the inequality. The four measures were Difference (D), Ratio (R), Population Attributable Fraction (PAF), and Population Attributable Risk (PAR). D and R measures are simple measures and PAF and PAR were complex measures. In addition, both D and PAR are absolute measures and R and PAF are relative measures. Both D and R provide a straightforward understanding of the magnitude of inequalities. D shows the difference between two population subgroups. It is calculated for all inequality dimensions, provided that subgroup estimates are available for the two subgroups used in the calculation of D. R shows the ratio of two population subgroups. It is calculated for all inequality dimensions, provided that subgroup estimates are available for the two subgroups used in the calculation of R. The PAF measures the percentage change in the national average of ANC if there was no inequality in any of the stratifiers. This metric helps quantify the potential impact of reducing inequalities by focusing interventions on the disadvantaged population. In other words, it illustrates how much of the existing coverage could be improved if efforts were made to elevate the least advantaged group to the level of the more advantaged groups. On the other hand, the PAR estimates the number of additional women who would receive eight or more adequate antenatal care coverage if the entire population achieved the same level of coverage as the most advantaged group. This measure highlights the potential benefits of increasing access to antenatal care for all women, particularly by learning from the practices and conditions of the most advantaged groups. It provides a measure of the potential impact of reducing inequalities on the overall level of antenatal care coverage. Using these complementary measures, we aimed to provide a comprehensive and nuanced understanding of the trends and inequalities in antenatal care coverage in Sierra Leone, enabling policymakers to identify target populations for interventions and prioritise strategies to reduce inequalities. The WHO HEAT software employs standard epidemiological methods to calculate the difference, ratio, populationattributable fraction, and population-attributable risk. In our study, we compared two distinct population groups regarding antenatal care coverage: the most advantaged group and the least advantaged group. The terms "most advantaged" and "most disadvantaged" refer to population groups defined by selected socioeconomic and demographic variables, such as wealth quintile and education level. For instance, the most advantaged group may represent individuals in the highest wealth quintile, while the most disadvantaged group represents those in the lowest quintile. In our analysis, adequate ANC coverage was categorized based on these variables. Specifically, individuals were classified into wealth quintiles,

with the highest quintile considered the most advantaged and the lowest as the most disadvantaged. For education, we categorized individuals based on their highest level of education attained, with those having secondary or higher education classified as most advantaged and those with no formal education classified as most disadvantaged. The difference in ANC coverage is calculated as the absolute difference in prevalence between the most advantaged and most disadvantaged groups. The ratio is computed as the prevalence of ANC coverage in one group relative to that in another group. Additionally, the PAF and PAR estimate the proportion of ANC coverage attributable to the socioeconomic exposures (e.g., wealth and education). This is done by comparing the observed distribution of ANC coverage among the population to a hypothetical distribution where these exposures do not influence the outcome. This approach allows us to assess the impact of socioeconomic factors on ANC coverage more comprehensively.

We refer the reader to the detailed methodology in the WHO HEAT user manual for a comprehensive explanation of the calculation algorithms [33, 34]. For the interpretation, D indicates the absolute gap in antenatal care coverage between two population groups. A larger difference suggests a greater inequality. R shows the relative magnitude of antenatal care coverage between the two groups. A Ratio greater than 1 indicates that one group has higher coverage. PAF represents the proportion of antenatal care coverage in the overall population that could be eliminated by reducing inequalities. A higher PAF indicates a greater potential for improving coverage by addressing disparities. PAR estimates the number of additional women who would receive adequate antenatal care coverage if the entire population had the same coverage as the most advantaged group. A higher PAR indicates a larger potential impact of reducing inequalities on overall coverage. Also, in interpreting our results, "indicating age-related disparities" refers to the differences in antenatal care coverage across various age groups. The phrase "no further improvement can be achieved" signifies that our findings suggest certain groups have reached a coverage plateau, indicating that additional interventions may not significantly increase their antenatal care access. Lastly, "without inequality" describes the ideal scenario where all population groups have equal access to antenatal care.

## Formulas for inequality indices:

$$\mathbf{D} = ANC_8$$
 in most advantaged  
- ANC<sub>8</sub> in most disadvantaged

$$\mathbf{R} = \frac{\text{ANC}_8 \text{ in most advantaged}}{\text{ANC}_8 \text{ in most disadvantaged}}$$

$$\mathbf{PAR} = ANC_8$$
 in most advantaged  $-\mu$ 

$$\mathbf{PAF} = (\mathrm{PAR}/\mu) *100$$

Where:

- **ANC**<sub>8</sub>: Proportion of a population with adequate (at least 8) antenatal care visits
- µ: National average estimate for adequate ANC coverage in Sierra Leone
- **D**: Difference
- **R**: Ratio
- PAR: Population Attributable Risk
- PAF: Population Attributable Fraction

The inequalities between the extremes were given priority for stratifiers with more than two categories. For example, there are differences in educational attainment between those with no education and those with secondary or higher education. Similarly, economic inequalities exist between individuals in the poorest and richest quintiles. Additionally, there are variations in several factors between provinces, such as the South and East. The calculations above indicate that the age group 20–49, individuals living in metropolitan areas, those with secondary or higher education, individuals with higher wealth, and individuals residing in the South region are the most privileged.

# **Ethical consideration**

Since the SLDHS dataset is publicly accessible, ethical clearance was not sought. The authorisation to utilise the dataset for publication was acquired from the Monitoring and Evaluation to Assess and Use Results Demographic and Health Surveys (MEASURE DHS).

#### Results

# Trends in adequate antenatal care coverage among women in Sierra Leone

Table 1 shows trends in adequate antenatal care coverage among women in Sierra Leone between 2008 and 2019. There was a significant increase in coverage from 2008 (15.2%) to 2013 (36.5%) but a decrease in 2019 (22.1%). The percentage of women who had adequate ANC coverage was lower in those who are <20 but was the same for those aged 20-34 and those who are 35-49 in 2008 (12.8% and 15.6% vs. 15.6%), and in 2019 (18.3% and 22.6% vs. 23.7%). Women with one birth tended to have higher coverage in 2008 and 2013 but had the least coverage in 2019. Wealthiest women, classified as those in the richest (quintile 5), consistently had the highest ANC coverage in both 2008 and 2013. However, in 2019, it was observed that women in the richer (quintile 4), exhibited the highest coverage. Women in the poorest (quintile 1) had the lowest ANC coverage in all survey years. In all

| Dimension            | 2008 (15.2%) |                | 2013 (36.59 | %)             | 2019 (22.1%) |                |  |
|----------------------|--------------|----------------|-------------|----------------|--------------|----------------|--|
|                      | Sample       | Percentage (%) | Sample      | Percentage (%) | Sample       | Percentage (%) |  |
| Age groups           |              |                |             |                |              |                |  |
| < 20 years           | 389          | 12.8           | 967         | 37.4           | 663          | 18.3           |  |
| 20–34 years          | 1711         | 15.6           | 3144        | 37.2           | 2648         | 22.6           |  |
| 35–49 years          | 378          | 15.6           | 710         | 31.7           | 639          | 23.7           |  |
| Birth order          |              |                |             |                |              |                |  |
| 1                    | 492          | 18.6           | 1059        | 1059 38.9      |              | 20.2           |  |
| 2–3                  | 891          | 16.2           | 1689        | 1689 35.9      |              | 21.5           |  |
| 4–5                  | 619          | 12.1           | 1191        | 1191 37.7      |              | 24.6           |  |
| б+                   | 477          | 13.3           | 881         | 32.9           | 580          | 22.8           |  |
| Economic status      |              |                |             |                |              |                |  |
| Quintile 1 (poorest) | 570          | 7.9            | 1110        | 30.7           | 917          | 18.3           |  |
| Quintile 2           | 535          | 12.3           | 1012        | 33.5           | 867          | 22.3           |  |
| Quintile 3           | 517          | 7.9            | 1056        | 36.4           | 792          | 23.2           |  |
| Quintile 4           | 476          | 15.0           | 923         | 40.7           | 752          | 25.8           |  |
| Quintile 5 (richest) | 379          | 40.0           | 719         | 719 44.0       |              | 21.2           |  |
| Educational level    |              |                |             |                |              |                |  |
| No education         | 1819         | 11.8           | 3118        | 34.5           | 2037         | 21.7           |  |
| Primary education    | 339          | 12.5           | 735         | 36.7           | 36.7 610     |                |  |
| Secondary education  | 295          | 35.2           | 920         | 41.5 1199      |              | 21.2           |  |
| Higher education     | 24           | 61.7           | 47          | 47 63.0        |              | 32.7           |  |
| Place of residence   |              |                |             |                |              |                |  |
| Rural                | 1797         | 9.3            | 3580        | 33.9 2558 21   |              | 21.5           |  |
| Urban                | 681          | 30.2           | 1240 43.9   |                | 1392 23.2    |                |  |
| Province             |              |                |             |                |              |                |  |
| East                 | 500          | 11.5           | 1113 41.5   |                | 847          | 24.3           |  |
| North                | 1114         | 8.1            | 2830 30.8   |                | 796          | 17.1           |  |
| Northwestern         | N/A          | N/A            | N/A         | N/A            | 758          | 22.8           |  |
| South                | 507          | 15.3           | 877         | 48.0           | 816          | 25.6           |  |
| West                 | 357          | 42.0           | N/A         | N/A            | 733 20.1     |                |  |

| Table 1 | Trends in adequate antenatal | care coverage among women | in Sierra Leone by dif | fferent inequality | dimensions, 2008–2019 |
|---------|------------------------------|---------------------------|------------------------|--------------------|-----------------------|
|         |                              | 5                         |                        | 1 /                |                       |

N/A = Not Applicable

the survey years, adequate ANC coverage was higher in women with higher education. Urban women consistently had higher coverage than rural women. Coverage varies across provinces. Women in the West (42.0%) had the highest coverage in 2008, and women in the South had the highest coverage in 2013 (48.0%) and 2019 (25.6%), while women in the North have the lowest in all survey years.

# Provincial distribution of prevalence of adequate antenatal care coverage among women in Sierra Leone in 2019

Figure 1 shows the provincial distribution of prevalence of adequate antenatal care coverage among women in Sierra Leone in 2019. The Southern region had the highest prevalence of 25.6%, while the Northern region had the lowest prevalence of 17.1%.

# Inequality indices of indicators of adequate antenatal care coverage among women in Sierra Leone

Table 2 presents inequality indicators of adequate antenatal care coverage among women in Sierra Leone from 2008 to 2019. The indices include rate D, PAF, PAR, and R. However, for ease of interpretation of the results, we focus on one absolute measure (D) and one relative measure (PAF). The inequality in age-related adequate ANC coverage increased from a 2.7 percentage points difference in 2008 to 5.3 percentage points in 2019, reflecting a growing age-related disparity. The PAF dropped to zero in 2013 but rose to 7.7 in 2019, suggesting that the national average of adequate ANC coverage could have been 7.7% higher without age-related inequality. Birth order inequality increased from a -5.2 percentage points difference in 2008 to 2.6 percentage points in 2019. The PAF was zero in 2008 but reached 3.4% in 2019, implying a potential increase of 3.4% in ANC coverage in the absence of parity-based inequality. Economic status inequality fell significantly, from 32.1 percentage points in 2008 to 2.8 percentage points in 2019. PAF results revealed that national ANC coverage could have been 164.4% higher in 2008 and 20.8% in 2013, with no remaining impact in 2019 if economic disparities were absent. Educational inequality in ANC coverage decreased from



Fig. 1 Provincial distribution of the prevalence (%) of adequate antenatal care coverage among women in Sierra Leone in 2019

a difference of 49.9 percentage points in 2008 to 11.0 percentage points in 2019, with a corresponding decline in PAF from 307.1 to 48.4%. Place of residence inequality dropped from 20.8 percentage points in 2008 to 1.7 percentage points in 2019, and provincial inequality reduced from 33.9 percentage points to 8.5 percentage points over the same period. Without provincial disparities, the national ANC average could have increased by 177.3% in 2008 and 15.8% in 2019.

# Discussion

Notably, the proportion of women receiving adequate ANC coverage rose markedly from 15.2% in 2008 to 36.5% in 2013 before declining to 22.1% in 2019. This trend could be due to government policies providing free maternal care to women and the Free Health Care Initiative in 2010 [35, 36]. However, these fluctuations suggest that while initial efforts to improve ANC were successful, sustaining these gains proved challenging. The existence of peripheral health units such as Community Health Centres, Community Health Posts, and Maternal and Child Health Units in villages may explain the observed trends [37]. These facilities provide accessible healthcare services at the community level, potentially increasing ANC coverage by making services more available and convenient for pregnant women. Despite these gains, the prevalence of women receiving adequate ANC during the three-year study periods was significantly below the 78% target recommended by the 2016 Lancet Global Burden of Disease study, which is necessary to achieve Sustainable Development Goal 3.1 [38]. The considerable lag may be due to the varying effectiveness and reach of the peripheral health units across different regions and demographics. The study shows a higher prevalence of adequate ANC coverage among older women, those with one birth, economically advantaged women, those with higher education, urban residents, and those living in the Southern region.

Our study found that older women (35–49) consistently had higher coverage than younger women (under 35). This finding aligns with prior research conducted in Sierra Leone and other sub-Saharan countries [39] and findings from a systematic review conducted in conflictaffected areas [40]. This indicates that older women may increase their ANC coverage due to their accumulated experience in childbirth and awareness of the heightened risks of pregnancy complications associated with ageing. However, no inequalities were observed in the study conducted in Ghana [41].

Women with fewer prior births demonstrated higher adequate ANC contacts across the years except for 2019, as reported consistently by a study in Ethiopia [42] and

| Dimension          | 2008  |       |       | 2013 |      |      | 2019 |      |      |
|--------------------|-------|-------|-------|------|------|------|------|------|------|
|                    | Est.  | LB    | UB    | Est. | LB   | UB   | Est. | LB   | UB   |
| Age groups         |       |       |       |      |      |      |      |      |      |
| D                  | 2.7   | NA    | NA    | -5.7 | NA   | NA   | 5.3  | NA   | NA   |
| PAF                | 2.7   | 2.7   | 2.8   | 0    | -0.0 | 0.0  | 7.7  | 7.6  | 7.8  |
| PAR                | 0.4   | -2.9  | 3.0   | 0    | -3.1 | 3.1  | 1.7  | -1.2 | 4.7  |
| R                  | 1.2   | NA    | 1.3   | 0.8  | NA   | NA   | 1.2  | NA   | NA   |
| Birth order        |       |       |       |      |      |      |      |      |      |
| D                  | -5.2  | NA    | NA    | -6   | NA   | NA   | 2.6  | NA   | NA   |
| PAF                | 0     | -0.1  | 0.1   | 0    | -0.0 | 0.0  | 3.4  | 3.3  | 3.6  |
| PAR                | 0     | -2.7  | 2.7   | 0    | -2.8 | 2.8  | 0.7  | -2.3 | 3.9  |
| R                  | 0.7   | NA    | NA    | 0.8  | NA   | NA   | 1.1  | NA   | NA   |
| Economic status    |       |       |       |      |      |      |      |      |      |
| D                  | 32.1  | NA    | NA    | 13.3 | NA   | NA   | 2.8  | NA   | NA   |
| PAF                | 164.4 | 164.1 | 164.7 | 20.8 | 20.7 | 20.9 | 0    | -0.1 | 0.1  |
| PAR                | 24.9  | 20.6  | 29.2  | 7.6  | 4.2  | 10.9 | 0    | -2.9 | 2.9  |
| R                  | 5.0   | NA    | NA    | 1.4  | NA   | NA   | 1.1  | NA   | NA   |
| Educational level  |       |       |       |      |      |      |      |      |      |
| D                  | 49.9  | NA    | NA    | 28.5 | NA   | NA   | 11   | NA   | NA   |
| PAF                | 307.1 | 305.8 | 308.4 | 72.9 | 72.5 | 73.3 | 48.4 | 48.0 | 48.8 |
| PAR                | 46.6  | 27.0  | 66.1  | 26.6 | 12.8 | 40.3 | 10.7 | 1.8  | 19.5 |
| R                  | 5.2   | NA    | NA    | 1.8  | NA   | NA   | 1.5  | NA   | NA   |
| Place of residence |       |       |       |      |      |      |      |      |      |
| D                  | 20.8  | NA    | NA    | 10   | NA   | NA   | 1.7  | NA   | NA   |
| PAF                | 100.0 | 99.9  | 100.2 | 20.3 | 20.2 | 20.4 | 4.9  | 4.9  | 5.0  |
| PAR                | 15.1  | 12.5  | 17.7  | 7.4  | 5.0  | 9.7  | 1.1  | -0.6 | 2.8  |
| R                  | 3.2   | NA    | NA    | 1.2  | NA   | NA   | 1.0  | NA   | NA   |
| Province           |       |       |       |      |      |      |      |      |      |
| D                  | 33.9  | NA    | NA    | 17.1 | NA   | NA   | 8.5  | NA   | NA   |
| PAF                | 177.3 | 177.0 | 177.6 | 31.8 | 31.7 | 31.9 | 15.8 | 15.7 | 16.0 |
| PAR                | 26.9  | 22.3  | 31.4  | 11.6 | 8.6  | 14.6 | 3.5  | 0.8  | 6.1  |
| R                  | 5.1   | NA    | NA    | 1.5  | NA   | NA   | 1.4  | NA   | NA   |

Table 2 Inequality measures of indicators of adequate antenatal care coverage among women in Sierra Leone, 2008–2019

Est: Estimate, LB: Lower Bound, UB: Upper Bound, NA: Not Applicable

Haiti [43]. This pattern could also reflect that first-time mothers are more cautious and, therefore, more likely to attend ANC, while women with more children might face greater time constraints [44]. Also, older women may perceive that they do not require services because they have sufficient experience with pregnancy and childbirth [45].

In line with previous research conducted in Ghana [41], Malawi [46], Benin [47], and a multi-country study in upper and low-middle-income countries [39], our findings showed that the prevalence of adequate ANC contacts was higher among wealthier women. This economic inequality indicates that financial barriers impede access to antenatal care for poorer women. Research indicates that women from affluent households are more inclined to access and utilise maternal healthcare services than those from less privileged households [47]. Women from wealthier households often have the advantage of residing in regions with sufficient health infrastructure, enabling more accessible access to maternal services.

Additionally, they possess the financial resources to afford healthcare expenses and insurance coverage. According to the WHO, despite establishing the Sierra Leone Social Health Insurance (SLeSHI) in 2018, this initiative has faced challenges in effective implementation [48, 49]. These obstacles include underfunding, recurrent disease outbreaks, and inequalities in the distribution of skilled healthcare personnel [48]. These challenges may hinder the effective implementation of free maternal healthcare initiatives, thereby limiting women's ability to access ANC services as intended. Financial difficulties have been shown to hinder women's ability to receive early ANC and the recommended number of visits, according to a previous study [40]. Therefore, it is essential that the government increases funding for maternal healthcare programs, strengthen the implementation of the SLeSHI, and ensure equitable distribution of skilled healthcare personnel.

The study results showed education-related inequalities in adequate ANC coverage. Women with higher education levels had much higher coverage than those without education, although the inequality gap narrowed over time. Several previous studies have documented similar findings [39–41, 46, 47]. Education likely influences women's health-seeking behaviours and ability to navigate the healthcare system [50]. Women with limited access to higher education are less likely to be aware of the benefits of ANC or the recommended timing and frequency of its utilisation [40].

Another consistent finding was the higher ANC coverage among urban women than their rural counterparts, despite a reduction in the pattern of inequality between 2008 and 2019. These findings highlight the inequality in healthcare service provision between rural and urban areas related to barriers, such as costs and distance, infrastructure, availability of skilled health professionals, and service delivery that disproportionately affect women in rural areas [49, 51-53]. A recent study in Nigeria has indicated that residing in rural areas is associated with lower utilisation of ANC [54]. For instance, another study in Nigeria shows that living in rural areas reduces the likelihood of utilising ANC services by 76% [55]. Similarly, other studies in Ghana [41], Malawi [46], Bennin [47], Namibia [56], and Bangladesh [57] argued that women in urban locations have a greater probability of accessing maternal health services compared to those in rural locations. Additionally, despite the Free Health Care Initiative in Sierra Leone [35], the 2020 Ministry of Health & Sanitation Reproductive and Child Health Report shows that 59% of the population resides in rural areas [37]. This implies lower utilisation of ANC in these settings, which can lead to poorer maternal and child health outcomes.

The study identified provincial-based inequalities in adequate ANC coverage, with the South having the highest coverage and the North having the lowest. These regional differences could be attributed to variations in healthcare infrastructure, economic development, cultural practices, and possibly differing levels of governmental and non-governmental health interventions. The Southern Province, mainly urban centres, may have more healthcare facilities equipped to provide ANC services than Northern Province. Nevertheless, the Northern Province is primarily rural; hence, access to health services and infrastructure and poor health service quality may be more limited [36]. A study conducted in Northern Sierra Leone found that ANC interventions were inadequate due to poor infrastructure, a shortage of skilled staff, frequent stock-outs of essential supplies, inadequate obstetric care facilities, and geographical inequalities in access to services [23]. This implies the need to enhance maternal health services and adequate ANC coverage in the Northern Province and rural communities in the other provinces [58].

#### Policy and practice implications

The findings highlight several areas for policy and practice improvement. Efforts to sustain and build on the initial gains of adequate ANC coverage are crucial. Targeted interventions to address economic, educational, and geographic inequalities are essential. Policies should focus on reducing financial barriers for poorer women and enhancing education and awareness programs, especially in rural and less developed regions. Strengthening healthcare infrastructure and service delivery, particularly in the North and other underserved areas is essential, as the majority of the residents in Sierra Leone live in rural dwellings [37]. Expanding and improving the functionality of peripheral health units to ensure consistent and quality care across all regions could be useful. Future research should explore the underlying causes of the decline in adequate ANC post-2013 and investigate effective strategies to reverse this trend. Additionally, qualitative studies could provide a deeper understanding of the barriers faced by different demographic groups, informing more detailed and effective policy interventions. It would also be beneficial to assess the specific impact of peripheral health units on ANC coverage to understand their role in improving maternal health services.

### Strengths and limitations

The study has the following strengths. Firstly, it used a nationally representative SDHS, allowing generalisation to all women in Sierra Leone. Using absolute and relative measures of inequality offers a comprehensive perspective on the magnitude and trends of inequality in ANC coverage. The government and policymakers can easily identify critical areas for intervention to increase adequate ANC, as the results are categorised by inequality dimensions. Nevertheless, this study has some limitations. When describing inequality by comparing the most advantaged and most disadvantaged groups, we acknowledge that this approach may result in a loss of information regarding the distribution of inequality within the broader population. While focusing on the extremes provides valuable insights into disparities, it does not capture the nuances of inequality that may exist among other groups. This limitation is important to consider when interpreting our findings. Additionally, our analysis was conducted using the online version of the WHO HEAT software, which is designed to assess health inequalities. However, the binary classification of some of the inequality stratefiers may not fully reflect the complexity of the demographic and socioeconomic factors affecting ANC coverage across the entire population. Future analyses could benefit from employing more granular methods to better understand the distribution of inequality. Given that the data utilised is cross-sectional, causality cannot be established. Also, as the dataset is secondary, certain

confounding factors may not have been accounted for, including cultural beliefs, proximity to health facilities, healthcare service quality, prior pregnancy experiences, and availability of information. Additionally, it is essential to acknowledge that the change in WHO recommendations from four to eight ANC coverage, implemented in 2016, may affect the comparability of data across different periods. While the trend analysis provides valuable insights, the data from 2008 may not be directly comparable to data from later years due to this shift. It is recommended that future studies take into account this change in guidelines when analysing trends over time. They should strive to align their methodologies with current standards to achieve accurate comparisons. While this study focuses on facility-based ANC coverage, it is acknowledged that women may receive essential care from other sources, such as community health workers or traditional birth attendants. This limitation highlights the need for further research to comprehensively assess the number and quality of contacts with healthcare providers during pregnancy. Such studies could employ mixed methods approaches, including qualitative research, to explore women's experiences and identify opportunities to improve the delivery of antenatal care services.

### Conclusion

In conclusion, while there have been notable improvements in ANC coverage in Sierra Leone, the adequate coverage is still below the WHO target of 78%, and significant inequalities persist. Addressing these inequalities requires a multifaceted approach considering demographic, economic, educational, and geographic factors. Sustained efforts and targeted interventions by the Sierra Leone government and other non-governmental organisations can ensure that all women, regardless of their background, have access to essential ANC services up to at least eight visits.

#### Abbreviations

| D      | Difference  |
|--------|---|
| HEAT   | Health Equity Assessment Toolkit                        |
| PAF    | Population Attributable Fraction                        |
| PAR    | Population Attributable Risk                            |
| R      | Ratio   |
| SDG    | Sustainable Development Goal                            |
| SLDHS  | Sierra Leone Demographic and Health Survey              |
| STROBE | Strengthening the Reporting of Observational Studies in |
|        | Epidemiology  |
| WHO    | World Health Organization                               |

#### Acknowledgements

We are grateful to MEASURE DHS and the World Health Organization for making the dataset and the HEAT software accessible.

#### Author contributions

AO and BOA contributed to the study design and conceptualisation. AO and BOA performed the analysis. AO, FGW, MST, CB, FG, and BOA developed the initial draft. All the authors critically reviewed the manuscript for its intellectual

content. All authors read and amended drafts of the paper and approved the final version. AO had the final responsibility of submitting it for publication.

#### Funding

This study received no funding.

#### Data availability

The dataset used can be accessed at https://whoequity.shinyapps.io/heat/.

#### Declarations

#### Ethics approval and consent to participate

This study did not seek ethical clearance since the WHO HEAT software and the dataset are freely available in the public domain.

#### **Consent for publication**

Not applicable.

#### **Competing interests**

The authors declare no competing interests.

#### Author details

<sup>1</sup>Department of Biological Sciences, School of Basic Sciences, Njala University, PMB, Freetown, Sierra Leone

<sup>2</sup>Department of Global Public Health, Karolinska Institutet, Stockholm, Sweden

<sup>3</sup>World Health Organization Country Office, Freetown, Sierra Leone<sup>4</sup>Department of Nursing, School of Medical Sciences, Njala University, PMB, Freetown, Sierra Leone

<sup>5</sup>REMS Consultancy Services, Takoradi, Sekondi-Takoradi, Ghana
<sup>6</sup>Faculty of Health and Medical Sciences, The University of Adelaide, Adelaide, Australia

# Received: 20 June 2024 / Accepted: 22 October 2024

Published online: 13 November 2024

#### References

- Phommachanh S, Essink DR, Jansen M, Broerse JEW, Wright P, Mayxay M. Improvement of quality of Antenatal Care (ANC) Service Provision at the Public Health Facilities in Lao PDR: perspective and experiences of supply and demand sides. BMC Pregnancy Childbirth. 2019;19(1):255.
- Benova L, Tunçalp Ö, Moran AC, Campbell OMR. Not just a number: examining coverage and content of antenatal care in low-income and middleincome countries. BMJ Glob Health. 2018;3(2):e000779.
- Kuhnt J, Vollmer S. Antenatal care services and its implications for vital and health outcomes of children: evidence from 193 surveys in 69 low-income and middle-income countries. BMJ Open. 2017;7(11):e017122.
- Sserwanja Q, Mutisya LM, Musaba MW. Exposure to different types of mass media and timing of antenatal care initiation: insights from the 2016 Uganda Demographic and Health Survey. BMC Womens Health. 2022;22(1):10.
- Sarker BK, Rahman M, Rahman T, Rahman T, Khalil JJ, Hasan M, Rahman F, Ahmed A, Mitra DK, Mridha MK, et al. Status of the WHO recommended timing and frequency of antenatal care visits in Northern Bangladesh. PLoS ONE. 2020;15(11):e0241185.
- Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L. Evidencebased, cost-effective interventions: how many newborn babies can we save? Lancet (London England). 2005;365(9463):977–88.
- Hollowell J, Oakley L, Kurinczuk JJ, Brocklehurst P, Gray R. The effectiveness of antenatal care programmes to reduce infant mortality and preterm birth in socially disadvantaged and vulnerable women in high-income countries: a systematic review. BMC Pregnancy Childbirth. 2011;11:13.
- Beeckman K, Louckx F, Downe S, Putman K. The relationship between antenatal care and preterm birth: the importance of content of care. Eur J Pub Health. 2013;23(3):366–71.
- Sserwanja Q, Nuwabaine L, Gatasi G, Wandabwa JN, Musaba MW. Factors associated with utilisation of quality antenatal care: a secondary data analysis of Rwandan demographic Health Survey 2020. BMC Health Serv Res. 2022;22(1):812.

- Emiru AA, Alene GD, Debelew GT. Individual, Household, and contextual factors influencing the timing of the First Antenatal Care Attendance in Northwest Ethiopia: a two-level binary logistic regression analysis. Int J Women's Health. 2020;12:463–71.
- Sserwanja Q, Nabbuye R, Kawuki J. Dimensions of women empowerment on access to antenatal care in Uganda: a further analysis of the Uganda demographic health survey 2016. Int J Health Plann Manage. 2022;37(3):1736–53.
- 13. Maternal N. Child and Adolescent Health [Internet]. Unicef.org. 2016 [cited 2024 Jul 31]. https://www.unicef.org/sierraleone/maternal-neonatal-child-an d-adolescent-health
- 14. Statistics Sierra Leone StatsSL, ICF. Sierra Leone Demographic and Health Survey 2019. In. Freetown/Sierra Leone: StatsSL/ICF; 2020.
- Tunçalp Ö, Pena-Rosas JP, Lawrie T, Bucagu M, Oladapo OT, Portela A. Metin Gülmezoglu A. WHO recommendations on antenatal care for a positive pregnancy experience-going beyond survival. BJOG. 2017;124(6):860–2.
- De Masi S, Bucagu M, Tunçalp Ö, Peña-Rosas JP, Lawrie T, Oladapo OT, Gülmezoglu M. Integrated Person-Centered Health Care for all women during pregnancy: Implementing World Health Organization recommendations on Antenatal Care for a positive pregnancy experience. Glob Health Sci Pract. 2017;5(2):197–201.
- 17. World Health Organization. WHO recommendation on Antenatal Care for positive pregnancy experience. Geneva: WHO. 2016.
- Lattof SR, Moran AC, Kidula N, Moller A-B, Jayathilaka CA, Diaz T, Tunçalp Ö. Implementation of the new WHO antenatal care model for a positive pregnancy experience: a monitoring framework. BMJ Glob Health. 2020;5(6):e002605.
- Higgins-Steele A, Waller K, Fotso JC, Vesel L. Peer-driven quality improvement among health workers and traditional birth attendants in Sierra Leone: linkages between providers' organisational skills and relationships. BMC Health Serv Res. 2015;15(Suppl 1):S4–4.
- Sserwanja Q, Mutisya LM, Nuwabaine L, Kamara K, Mutebi RK, Musaba MW. Continuum of maternal and newborn health in Sierra Leone: a 2019 national survey. Arch Public Health. 2022;80(1):186.
- 21. Carshon-Marsh R, Aimone A, Ansumana R, Swaray IB, Assalif A, Musa A, Meh C, Smart F, Hang FS, Newcombe L, et al. Child, maternal, and adult mortality in Sierra Leone: nationally representative mortality survey 2018–20. Lancet Glob Health. 2022;10(1):e114–23.
- Sserwanja Q, Mufumba I, Kamara K, Musaba MW. Rural-urban correlates of skilled birth attendance utilisation in Sierra Leone: evidence from the 2019 Sierra Leone Demographic Health Survey. BMJ Open. 2022;12(3):e056825.
- Koroma MM, Kamara SS, Bangura EA, Kamara MA, Lokossou V, Keita N. The quality of free antenatal and delivery services in Northern Sierra Leone. Health Res Policy Syst. 2017;15(Suppl 1):49–49.
- 24. World Health Organization. Sierra Leone becomes 10th country to join global Quality of Care Network. https://www.afro.who.int/news/sierra-leone-becom es-10th-country-join-global-quality-care-network
- Sierra Leone Ministry of Health and Sanitation. Sierra Leone National Reproductive, Maternal, Newborn, Child and Adolescent Health Strategy 2017–2021. https://www.afro.who.int/publications/sierra-leone-national-repr oductive-maternal-newborn-child-and-adolescent-health
- Bognini JD, Samadoulougou S, Ouedraogo M, Kangoye TD, Van Malderen C, Tinto H, et al. Socio-economic inequalities in curative healthcare-seeking for children under five before and after the free healthcare initiative in Sierra Leone: analysis of population-based survey data. Int J Equity Health. 2021;20(1):124. https://equityhealthj.biomedcentral.com/articles/10.1186/s12 939-021-01474-7.
- Jalloh MB, Bah AJ, James PB, Sevalie S, Hann K, Shmueli A. Impact of the free healthcare initiative on wealth-related inequity in the utilisation of maternal & child health services in Sierra Leone. BMC Health Serv Res. 2019;19:1–5.
- World Health Organization. Health Equity Assessment Toolkit Plus (HEAT plus): Software for exploring and comparing health inequalities in countries. Upload database edition. Geneva: World Health Organization. 2024.
- Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The strengthening the reporting of Observational studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. Int J Surg. 2014;12(12):1495–9.
- Sserwanja Q, Musaba MW, Kamara K, Mutisya LM, Mukunya D. Status of the latest 2016 World Health Organization recommended frequency of antenatal

care contacts in Sierra Leone: a nationally representative survey. BMC Health Serv Res. 2022;22(1):1208.

- Tsawe M, Susuman AS. Inequalities in maternal Healthcare use in Sierra Leone: evidence from the 2008–2019 demographic and health surveys. PLoS ONE. 2022;17(10):e0276102.
- Dickson KS, Kwabena Ameyaw E, Akpeke M, Mottey BE, Adde KS, Esia-Donkoh K. Socio-economic disadvantage and quality Antenatal Care (ANC) in Sierra Leone: evidence from demographic and Health Survey. PLoS ONE. 2023;18(1):e0280061.
- 33. World Health Organization. Handbook on health inequality monitoring: with a special focus on low-and-middle-income countries. Geneva: World Health Organization. 2013.
- Hosseinpoor AR, Nambiar D, Schlotheuber A, Reidpath D, Ross Z. Health Equity Assessment Toolkit (HEAT): software for exploring and comparing health inequalities in countries. BMC Med Res Methodol. 2016;16:1–0.
- 35. Finley LL. Amnesty International. Encycl Sch Crime Violence. 2011;1:15-6.
- Bertone MP, Samai M, Edem-Hotah J, Witter S. A window of opportunity for reform in post-conflict settings? The case of Human Resources for Health policies in Sierra Leone, 2002–2012. Confl Health. 2014;8(1):1–12.
- 37. Maternal Death Surveillance and Response. Government of Sierra Leone Ministry of Health & Sanitation. Causes of Maternal Deaths. In: Maternal Death Surveillance & Response, Annual Report 2016. 2017. https://www.afro.who.int /sites/default/files/2017-06/mdsrreport.pdf
- Kassebaum NJ, Barber RM, Dandona L, Hay SI, Larson HJ, Lim SS, et al. Global, regional, and national levels of maternal mortality, 1990–2015: a systematic analysis for the global burden of Disease Study 2015. Lancet. 2016;388(10053):1775–812.
- Ekholuenetale M. Prevalence of adequate Antenatal Care contacts: findings from Multi-country nationally Representative Data. Glob Pediatr Heal. 2021;8.
- Alibhai KM, Ziegler BR, Meddings L, Batung E, Luginaah I. Factors impacting antenatal care utilisation: a systematic review of 37 fragile and conflictaffected situations. Confl Health. 2022;16(1):1–16. https://doi.org/10.1186/s13 031-022-00459-9
- Seidu AA, Okyere J, Budu E, Duah HO, Ahinkorah BO. Inequalities in antenatal care in Ghana, 1998–2014. BMC Pregnancy Childbirth. 2022;22(1):1–7. https:// doi.org/10.1186/s12884-022-04803-y
- 42. Muchie KF. Quality of antenatal care services and completion of four or more antenatal care visits in Ethiopia: a finding based on a demographic and health survey. BMC Pregnancy Childbirth. 2017;17(1):1–7.
- 43. Babalola SO. Factors associated with use of maternal health services in Haiti: a multilevel analysis. Rev Panam Salud Publica. 2014;36(1):1–9.
- 44. Loudon K, Buchanan S, Ruthven I. The everyday life information seeking behaviours of first-time mothers. J Doc. 2016;72(1):24–46.
- 45. Gabrysch S, Campbell OM. Still too far to walk: literature review of the determinants of delivery service use. BMC Pregnancy Childbirth. 2009;9:1–8.
- Yaya S, Bishwajit G, Shah V. Wealth, education and urban-rural inequality and maternal healthcare service usage in Malawi. BMJ Glob Heal. 2016;1(2):1–12.
- Yaya S, Uthman OA, Amouzou A, Ekholuenetale M, Bishwajit G. Inequalities in maternal health care utilisation in Benin: a population-based cross-sectional study. BMC Pregnancy Childbirth. 2018;18(1):1–9.
- World Health Organization. Country Cooperation Strategy: Sierra Leone 2008–2013. World Heal Organ Reg Off Africa [Internet]. 2018;1–2. https://app s.who.int/iris/bitstream/handle/10665/137364/ccs\_sle.pdf?sequence=1&isAll owed=y
- Heath Mof. National Health Sector Strategic Plan 2017–2021. Mitchell, [Internet]. 2017; (September):1–87. http://www.nationalplanningcycles.org/sites/default/files/planning\_cycle\_repository/sierra\_leone/sierra\_leone\_nhssp\_2017-21\_final\_sept2017.pdf
- The Lancet Public Health. Education: a neglected social determinant of health. Lancet Public Health. 2020;5(7):e361.
- Silal SP, Penn-Kekana L, Harris B, Birch S, McIntyre D. Exploring inequalities in access to and use of maternal health services in South Africa. BMC Health Serv Res. 2012;12(1).
- 52. Samuel O, Zewotir T, North D. Decomposing the urban-rural inequalities in the utilisation of maternal health care services: evidence from 27 selected countries in Sub-Saharan Africa. Reprod Health [Internet]. 2021;18(1):1–12. https://doi.org/10.1186/s12978-021-01268-8
- Habib SS, Jamal WZ, Zaidi SMA, Siddiqui JUR, Khan HM, Creswell J, et al. Barriers to access of healthcare services for rural women— applying gender lens on TB in a rural district of Sindh, Pakistan. Int J Environ Res Public Health. 2021;18:19.

- Ekholuenetale M, Benebo FO, Idebolo AF. Individual-, household-, and community-level factors associated with adequate antenatal care contacts in Nigeria: Evidence from Demographic and Health Survey. PLoS One. 2020;15(9 September):1–19. https://doi.org/10.1371/journal.pone.0239855
- 55. Dahiru T, Oche OM. Determinants of antenatal care, institutional delivery and postnatal care services utilisation in Nigeria. Pan Afr Med J. 2015;21:1–17.
- Zere E, Tumusiime P, Walker O, Kirigia J, Mwikisa C, Mbeeli T. Inequities in the utilisation of maternal health interventions in Namibia: implications for progress towards MDG 5 targets. Int J Equity Health. 2010;9(i):1–11.
- Collin SM, Anwar I, Ronsmans C. A decade of inequality in maternity care: antenatal care, professional attendance at delivery, and caesarean section in Bangladesh (1991–2004). Int J Equity Health. 2007;6:1–9.
- Ministry of Health and Sanitation. Maternal Death Surveillance & Response -Annual Report 2016. MDSR Annu Rep. 2016;36. https://reliefweb.int/report/si erra-leone/maternal-death-and-surveillance-response-annual-report-2016

# Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.