**You need a proper title**

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**Abstract** abstract

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# Introduction

（Article citation: Ending obstetric fistula by 2030: A call for transformative action and strategic partnerships to address the protracted crisis in West and Central Africa） (Baba, 2005) (Weston et al., 2011)

(Miller et al., 2005)

(World Health Organization, 2024a)

# Literature Review

（Transition sentence, linking the introduction and the literature review）

(Capes et al., n.d.)

(Khisa et al., 2017)

## Definition of Key Terms

### Fistula

Fistula is an abnormal connection between two body parts. (MedlinePlus, 2024) When a woman has fistula, a tube forms between the vagina and the bladder or rectum that causes leakage of urine or stool.(Cook et al., 2004) Common types of fistulas in women are obstetric fistulas, vesicovaginal fistulas, and rectovaginal fistulas. Obstetrical fistula is the most common, accounting for 79% to 100%, followed by rectovaginal fistula (1% to 8%) and vesicovaginal with rectovaginal fistula (1% to 23%). (Tebeu et al., 2012) Due to the fact that it is impossible to identify the specific kind of fistula that the women had in the dataset, fistula was considered broadly in this research.

### West Africa

West Africa covers more than a quarter of the African continent and consists of 16 countries, including Benin, Burkina Faso, Cape Verde, Côte d’Ivoire, The Gambia, Ghana, Guinea, GuineaBissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo. (Bossard,

2009) This research finally chose 6 West African countries: Côte d’Ivoire, Guinea­Bissau, Mali, Nigeria, Sierra Leone, and Togo. These 6 countries include both coastal and inland areas, with diverse languages and customs. It is economically diverse, with Nigeria having the greatest economy and Guinea­Bissau the smallest. Therefore, these 6 countries are representative and can well reflect the characteristics of West Africa.

### Women of Reproductive Age

Women of reproductive age range from 15 to 49 years. (World Health Organization, 2024b) Following this standard, this research explored the factors related to fistula in West African women of childbearing age.

## Theoretical Framework

After clarifying the concepts of fistula, West Africa, and women of childbearing age, it is necessary to explore the factors influencing fistula in West African women of reproductive age. As a health problem, in order to better understand the relevant factors at various levels, social determinants of health are chosen as the starting point, and then a specific analysis will be conducted through a comprehensive framework of health factors.

Social determinants of health (SDH) are non­medical factors that have an impact on health outcomes. These aspects mostly involve economics, society, personal life, and access to medical care. (Marmot et al., 2012) In order to have a more comprehensive understanding of the factors affecting fistula, these levels will be divided into upstream and downstream factors. Health outcomes are jointly influenced by a series of upstream and downstream factors. The upstream social determinants of health are more fundamental causal parts that can deal with health inequity from its root. Economic and societal variables influence living conditions. The lower the socioeconomic class, the worse the health. Personal conduct, family planning, and access to medical care are downstream factors that have a direct impact on health outcomes under the influence of upstream factors. (Braveman et al., 2011; Marmot & Bell, 2010) According to the SDH theory and the upstream and downstream framework of health, the theoretical framework of this study is as follows:

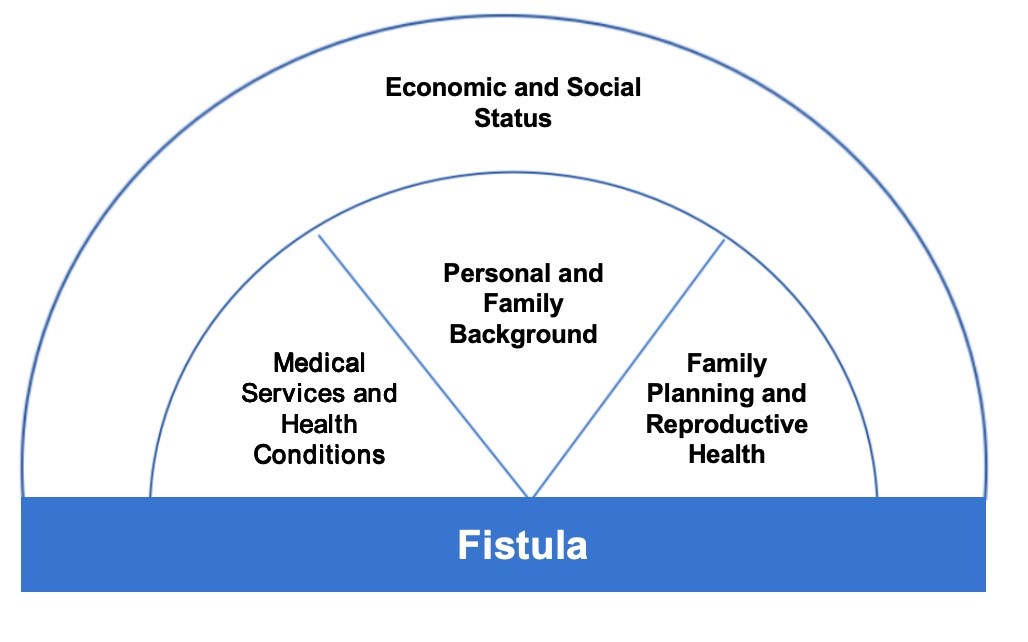


Figure 1: Theoretical Framework of Social Determinants of Fistula

## Related Factors

Based on the theoretical framework, the factors affecting fistula will be investigated from four aspects.

### Economic and Social Status

Wealth Index

Wealth index, as an economic indicator, influences fistula. A study on the determinants of obstetric fistula in Ethiopia discovered that wealth significantly affects the incidence of obstetric fistula. (Andargie & Debu, 2017) This is because poverty reduces access to health services and accessibility to health care, which in turn increases the risk of disease. (Deribe et al., 2020) As a result, economic disparity may lead to differences in the risk of disease and cause health imbalances.

Education

Education level is one of the factors. The uneducated women in Ethiopia have the highest incidence rate. (Andargie & Debu, 2017) An analysis of 14 African countries found that educated women have a significantly lower risk of fistula. (Alie, 2021) It is due to more educated women have better access to healthcare facilities, which contributes to minimize the possibility of fistula. (Rettig et al., 2020) More educated women are more likely to recognize fistula and seek treatment to avoid the disease.

Employment Status

Another factor influencing fistula is employment status. In Ethiopia, unemployed women have higher chance of suffering from fistula. (Andargie & Debu, 2017) Furthermore, a research in Kenya discovered that unemployed women with fistulas were more likely feel depression. This demonstrates how occupation influences the prevalence of fistula in women. (Weston, Mutiso, Mwangi, Qureshi, Beard, & Venkat, 2011) These findings illustrate that employment status has an important effect on women’s physical and psychological wellbeing. Employment can increase income, increasing the probability of receiving health care and lowering the risk of sickness.

### Personal and Family Background

Age

Age is also a factor. Obstetric fistula is primarily caused by difficult delivery. Due to inadequate pelvic development in teenagers, the size of the fetal head and the maternal pelvis may not match, leading to Obstructed labour. (Miller, Lester, Webster, & Cowan, 2005) According to research, adolescent pregnant women are more likely to suffer from fistula. (Tebeu, Fomulu, Khaddaj, Bernis, Delvaux, & Rochat, 2012) Early pregnancy may be linked to poor education levels and a lack of sex education.

Religion

Religion emerged as a confounding variable in a study conducted in Sub­Saharan Africa. (Maheu­Giroux et al., 2016) Because in rural communities, religious beliefs play an important role in women’s experience with fistula. (Gatwiri & McLaren, 2017) Different religions have different attitudes on illnesses such as fistula, which can prevent women from seeking medical care in a timely manner. For example, in Nigeria, religious people are more likely to prefer spiritual treatments than medical care. (Oluwabamide & Umoh, 2011) This may lead to delays in care before and after childbirth, increasing the risk of fistula.

Residence

Residence is a significant factor influencing fistula incidence. In Ethiopia, a 2005 study found that rural women had a higher prevalence of fistula than urban women. (Andargie & Debu, 2017) Similarly, statistical analysis from 2016 showed that rural women were more likely to have fistula than urban residents. (Gedefaw et al., 2021) A multi­level investigation of 14 African countries also found that urban women had a lower risk of fistula than rural women. (Alie, 2021) However, in another African study, urban women had a higher prevalence. This could be owing to easier access to care in cities, which may encourage more patients to relocate. (MaheuGiroux et al., 2015) These findings indicate that the impact of residence on fistula may differ by geography. When there are less medical services in rural regions, the risk of fistula increases, and cities may acquire more fistula cases from surrounding areas due to the accessibility of medical facilities. It is necessary to consider the residence factor in a local context.

Height and Weight

Height and weight are additional variables that could influence a fistula. The body mass index (BMI) can be computed using weight and height. Obese Ethiopian women with a BMI above 30 are at a higher risk of developing obstetric fistulas. (Andargie & Debu, 2017) Being overweight can increase the risk of obstetric fistula, which is the main cause of obstetric fistula.

### Medical Services and Health

Postpartum Care

One of the factors is postpartum care. Women’s education level has an impact on their usage of health care, according to a study conducted across 14 African nations. More attention is paid to health services by those with higher education degrees. (Alie, 2021) In addition, a further study revealed that women who are economically independent are more likely to have access to healthcare services. Postpartum care is a health service, which can effectively reduce the incidence of vaginal fistula. (Deribe, Fronterre, Dejene, Biadgilign, Deribew, Abdullah, & Cano, 2020) Postpartum care is an important part of protecting maternal health. Women can prevent and detect gynecological problems in time through professional care. This can reduce the risk of fistula.

Place of Delivery

The place of delivery is also essential. In Ethiopia, women who give birth at home have a much higher incidence of fistula than those who give birth in health facilities or other places. (Andargie & Debu, 2017) Giving birth in a hospital enables for early diagnosis and treatment. Due to a lack of awareness about fistula, giving birth at home or in other places without trained professionals may be unable to identify the disease. This will lead to a delay in therapy.

Distance to Medical Facilities

Distance to health facilities is a key factor affecting the risk of fistula. A study using data from the 2016 Ethiopian Demographic and Health Survey indicated that women who live distant from health facilities face a higher risk of fistula due to lack of timely access to necessary medical interventions. (Gedefaw, Wondmieneh, Getie, Bimerew, & Demis, 2021) A study on maternal mortality in 8 West African countries showed that maternal referral service utilization in remote areas was low, which exacerbated the risk of childbirth. (Ronsmans et al., 2003) These findings demonstrate that long distances and inconvenient transportation may cause pregnant women to have prolonged labor and increase the risk of fistula. (Tebeu, Fomulu, Khaddaj, Bernis, Delvaux, & Rochat, 2012) Being closer to health facilities makes it easier to receive professional delivery and postpartum care, which effectively prevents the occurrence of fistula.

Professional Delivery

It is also important to consider whether the delivery was performed professionally. Lack of access to safe cesarean sections during hard labor and exposure to dangerous birthing methods can make fistulas more prevalent, since they have a greater tendency to be at risk of iatrogenic injury. (Mama & Chandra Regmi, 2022) Areas with a lack of trained hospital staff and suitable surgical options during labor might result in major complications, such as fistula.

### Family Planning and Sexual Health

Contraception Use

Not using contraception is a risk factor for fistula. Contraception can reduce pregnancy­related health risks for women, particularly adolescent girls. (World Health Organization, 2024b) According to a 2016 study in Ethiopia, women who did not use contraception had a 3.43 times higher risk of getting a fistula than those who did. (Gedefaw, Wondmieneh, Getie, Bimerew, & Demis, 2021) Reducing the possibility of pregnancy decreases the probability of fistula.

Age of First Sexual Intercourse

The age of first sexual intercourse is also associated with the occurrence of fistulas. Having first sexual intercourse at a younger age is easier to result in a fistula. (Maheu­Giroux, Filippi, Maulet, Samadoulougou, Castro, Meda, Pouliot, & Kirakoya­Samadoulougou, 2016) Being younger means that the pelvis may not be fully developed, increasing the chance of a fistula when one is become pregnant. Delaying the age of first sexual intercourse and using proper contraception are excellent approaches to lower the risk.

Total Births

The number of births should also be considered. In a Nigerian investigation, primiparas proved to be more fragile and thus more prone to disease. (Ijaiya et al., 2010) Furthermore, limiting the total number of births through family planning can effectively lower the chance of pregnancy causing fistula. (Gedefaw, Wondmieneh, Getie, Bimerew, & Demis, 2021) It means that limiting the number of pregnancies, particularly in high­risk women, can reduce the chance of getting fistula.

Sexual Violence

The final factor is sexual violence. Sexual violence is not a common cause of fistula. However, more than one in five women in conflict zones report having fistula caused by sexual violence. (Maheu­Giroux, Filippi, Samadoulougou, Castro, Maulet, Meda, & Kirakoya­Samadoulougou, 2015) A research in sub­Saharan Africa have also shown that sexual violence significantly affects vaginal fistula. (Maheu­Giroux, Filippi, Maulet, Samadoulougou, Castro, Meda, Pouliot, & Kirakoya­Samadoulougou, 2016) Moreover, sexual violence was a major indicator of traumatic fistula in Rwanda and Malawi. (Peterman & Johnson, 2009) While sexual violence is not common, it can be a substantial risk factor for fistula in certain areas.

## Fistula in West Africa

Obstetric fistula is a public health issue in West Africa. The incidence of fistula is high in West Africa, especially in poor areas. (Nathan et al., 2009) Women without proper medical resources are more prone to get fistulas. Although the incidence varies by region in West Africa, the prevalence of obstetric fistula in most West African countries is significantly higher than the global average. For example, Nigeria, a country with a good economic level in West Africa, has a significantly higher incidence of vesicovaginal fistula, especially in the northern part of the country, where women become more easy to experience a fistula due to prolonged labor. (Ijaiya, Rahman, Aboyeji, Olatinwo, Esuga, Ogah, Raji, Adebara, Akintobi, Adeniran, & Adewole, 2010)

The main causes of fistula in West Africa are prolonged labor, unskilled delivery, caesarean sections, and birth customs related to early marriage and early childbearing. These factors are further exacerbated by poverty, ignorance and culturally embedded traditional attitudes. (Ijaiya, Rahman, Aboyeji, Olatinwo, Esuga, Ogah, Raji, Adebara, Akintobi, Adeniran, & Adewole, 2010) For example, many women are unable to access quality care due to financial limitations and cultural restrictions, resulting in serious complications during childbirth and ultimately fistula formation. (Ronsmans, Etard, Walraven, Høj, Dumont, Bernis, & Kodio, 2003)

Fistulas have an impact on not just physical health, but also psychological and social well­being.

Fistula patients in West Africa may face shame, divorce, and social exclusion. For example, in Mali and Niger, women with fistula frequently face divorce, polygamous husbands remarrying and husbands disappearing. (Ouedraogo et al., 2018)

Fistula repair surgery has a high success rate in some regions of West Africa, but overall treatment remains challenging. In Niger, where early marriage and pregnancy are widespread, obstetric fistula is extremely common. Repair success rates are high for first­time patients, but much lower for complex situations where many procedures have failed. (Ouedraogo, Payne, Nardos, Adelman, & Wall, 2018) This indicates that treating complex cases remains difficult.

Additionally, access to treatment is restricted, with many patients unable to receive prompt treatment due to financial barriers.

In summary, the problem of obstetric fistula in West Africa must be treated seriously. In addition to improving the quality of healthcare, the impact of socioeconomic, cultural and personal concepts on women’s health should also be positively guided in order to reduce the prevalence of fistula.

## Research Gaps and Future Research Directions

### Gaps Found in Current Research

Obstetric fistula is still not a priority in many resource­poor countries, especially West Africa.

This is reflected in the lack of data on fistula prevalence in some areas. (Cowgill et al., 2015) In addition, the reliability of some existing data must be enhanced. (Pope, 2018) This has inhibited some research on local factors influencing fistula, and thus prevented targeted policy recommendations from being made.

While current research has investigated various features of fistula, there is missing of data on specific fistula forms. (Tweneboah et al., 2023) There is also a lack of scientific study on fistula, including a lack of prevalence studies and a lack of research on barriers to fistula treatment. (Baker et al., n.d.; Creanga et al., 2007) This research also lacks data to identify specific categories. This issue restricts study into the factors that influence each fistula type and does not provide specific recommendations for different fistula types.

In addition, while there have been studies on factors influencing fistula, such as the economy and education, there has been inadequate study on how these factors combine. Furthermore, there is a dearth of research on the impact of cultural practices and psychological aspects. (Elkins, 1997) This research will involve religious factors as a supplement to the study on cultural customs.

### Research Gaps in the West African Context

From the 19 studies chosen for risk factors for fistula, 15 were from Sub­Saharan Africa and four from the Middle East. (Tebeu, Fomulu, Khaddaj, Bernis, Delvaux, & Rochat, 2012) This reflects a lack of studies focused on West Africa. Furthermore, West African countries such as Côte d’Ivoire face issues with poor data quality and potential underestimate. (UNFPA The Gambia, 2022)

### Future Research Directions

Future studies should focus on how stigma affects fistula patients. (Changole et al., 2017) It is vital to treat not only the medical disease, but also any psychological issues that occur. For example, research can focus on eliminating misconceptions that contribute to stigma. (Bashah et al., 2018; Roush, 2009) Research might also be undertaken on how to successfully reintegrate into society. (Khisa, Wakasiaka, McGowan, Campbell, & Lavender, 2017) Furthermore, prevention measures for fistulas should better identify specific risk factors in different countries. (Tebeu, Fomulu, Khaddaj, Bernis, Delvaux, & Rochat, 2012) West African countries urgently require efficient national fistula treatment and prevention initiatives. (UNFPA The Gambia, 2022) When developing strategies, consider close integration with the Sustainable Development Goals. (Slinger & Trautvetter, 2020)

## Summary

Although current research proves that fistula is a severe problem in Africa, and some studies have explored the fistula problem in some West African countries, there is a lack of data on the prevalence and influencing factors of fistula in West Africa as a whole. By summarizing the relevant elements impacting fistula in various regions, the common connected factors are identified in Table 1.

|  |  |
| --- | --- |
| **Factors** | **Definition of variables** |
| Wealth |  |
| Education |  |
| Occupation |  |
| Age |  |
| Religion |  |
| Residence |  |
| Height and Weight |  |
| Postpartum Care |  |
| Place of Delivery |  |
| Distance |  |
| Professional Delivery |  |
| Contraception Use |  |
| Age of First Sexual Intercourse |  |
| Total Births |  |
| Sexual Violence |  |
| **Factors** | **References** |
|  | & Kirakoya­Samadoulougou, 2016; Peterman & Johnson,  2009) |

Table 1: Summary of Relevant Literature on Determining Influencing Factors

This study will analyze the prevalence and regional differences of fistula in six West African countries. At the same time, different influencing factors in West Africa and specific countries will be explored. Finally, a data dashboard will be built to visually represent the research findings. This work contributes to the current literature on regional variations in fistula in West Africa and provides a dashboard for presenting and analyzing these data. This will allow for a more comprehensive understanding of the prevalence and determinants of fistula in West Africa.

# Methodology

## Research Objectives

The literature review part includes a brief description of the research questions. The specific research objectives are as follows:

1. Identify regional gaps in the determinants of fistula in West Africa. Understand the special circumstances of fistula in various areas through analyzing the prevalence in West Africa and each country, as well as the prevalence under different factors. Analyze the similarities and differences in influencing factors among countries.
2. Investigate the economic and social, personal background, health care utilization, family planning, and sexual health aspects related to fistula in women of reproductive age in West Africa. Using quantitative analysis methods, determine how related factors affect the prevalence of fistula in different West African countries. And explore how economic status, education, and occupation interact with other factors to influence fistula prevalence.
3. Create a data dashboard to visualize the prevalence of fistula in West Africa, as well as the social determinants of women of childbearing age. The design of the dashboard can help users to have a better knowledge of the social determinants of fistula in women of reproductive age in West Africa, supporting the implementation of appropriate policies for different areas.

## Data Source

The data used in this study are from the Demographic and Health Survey (DHS) dataset. The DHS program has conducted more than 400 surveys in more than 90 countries to collect and analyze accurate and representative demographic and health data. (The DHS Program, 2024a) At first, data from 9 West African countries were considered. After data preparation, the decision was made to concentrate the analysis on 6 countries. The detailed information for each country dataset is shown in Table 2:

|  |  |  |  |
| --- | --- | --- | --- |
| **Country** | **Year** | **Sample Range** | **Sample size** |
| Cote d’Ivoire | 2021 | All women 15­49 years | 14877 |
| Guinea Bissau | 2018 | All women 15­49 years | 10874 |
| **Country** | **Year** | **Sample Range** | **Sample size** |
| Mali | 2018 | All women 15­49 years | 10519 |
| Nigeria | 2018 | All women 15­49 years | 41821 |
| Sierra Leone | 2019 | All women 15­49 years | 15574 |
| Togo | 2013 | All women 15­49 years | 9480 |

Table 2: Dataset Information

This study uses data from the Demographic and Health Survey (DHS), which used a complicated multi­stage sampling design. The survey includes both stratified and cluster sampling. To ensure sample representativeness, stratified sampling takes place at the national, residential, and regional levels. A two stage cluster sampling design is developed using stratified sampling.

Data collecting involves selecting households at random from each urban block or village. (The DHS Program, 2024b)

To verify that the results are nationally representative, this research used the DHS dataset’s weight column. After the weight adjustment, the results can better reflect the characteristics of the disease.

## Research Flow Chart

The flow chart of this research is shown in Figure 2:

(In Modification)

## Data Preprocessing

Before data analysis, preprocessing was performed to ensure data integrity. The specific steps are as follows:

1. Dataset merging: The initial data consisted of 9 independent DHS datasets. First, variables were screened for each dataset. All variables relevant to the research objectives were selected. Subsequently, these variables were recoded to ensure consistency in variable classification. Finally, the 9 processed datasets were combined into one complete dataset.
2. Missing value processing: First, all missing value samples in the target variable experienced\_fistula were deleted in the integrated complete data set. Secondly, the missing values of three variables (sexual violence, weight, and height) were removed by a cross­tabulation analysis. Although the factors of postpartum care and professional delivery have more missing values than others, they are maintained due to their significant impact on the study. Furthermore, the cross­analysis revealed that because the number of women who reported having a fistula in Gambia and Niger was less than 50, the proportion in each sample was less than 0.04%. This proportion is extremely low, making it difficult to conduct effective analysis. As for Burkina Faso, although the number of women who reported having fistula is relatively large, there are a large number of missing answers to related factors. After removing missing values from the relevant variables, the remaining data accounted for less than 0.02%. To verify the reliability and representativeness of the data analysis, data from Burkina Faso, Gambia, and Niger were removed.
3. Processing weights: The DHS dataset contains a weight variable, V005, which is used to adjust the sample to ensure that the analysis results are nationally representative. In the process of processing weights, V005 is first divided by 1,000,000, and then the processed weights are applied to the data in the analysis design. This process ensures that the data analysis results can be utilized across the country.
4. Variable Definition and Classification: The variable definitions and classifications maintained in this research are as follows:

experienced\_fistula: The survey question “Have you ever experienced a problem of urine or stool leakage from the vagina?” is the source of this variable. The responses are coded as 0 for “No” and 1 for “Yes,” indicating whether the respondent has ever had a fistula.

V005: This variable represents the sample weight provided in the dataset, which is used to ensure that the survey results are representative of the national population. country: This variable specifies the name of the country where the data was collected.

wealth: Wealth is categorized into five levels, with 1 being the poorest and 5 being the wealthiest: 1: Poorest; 2: Poorer; 3: Middle; 4: Richer; 5: Richest.

education: Education level is categorized as follows: 0: No education; 1: Primary education; 2: Secondary education; 3: Higher education.

occupation: Employment status is categorized into three groups: 0: Not working; 1: Working; 2: Don’t know.

religion: Religion is categorized into five groups: 1: Muslim; 2: Christian; 3: Animist; 4: No religion; 5: Other religions.

residence: This variable indicates the respondent’s place of residence, coded as: 1: Urban; 2: Rural.

age: Age is categorized into seven groups, each representing a five­year interval: 1: 15­19 years; 2: 20­24 years; 3: 25­29 years; 4: 30­34 years; 5: 35­39 years; 6: 40­44 years; 7: 45­49 years.

distance: This variable represents whether the respondent perceives the distance to a health facility as a significant problem in obtaining medical help. The responses are coded as: 0: Not a big problem; 1: A big problem.

delivery\_place: This variable represents the place of delivery. Considering that the respondents may have given birth more than once, the answers are divided into: 1: Never delivered in a health facility; 2: Occasionally delivered in a health facility; 3: Always delivered in a health facility.

postpartum\_care: This variable indicates whether the respondent received postpartum care, considering all births, and is categorized as: 1: Always received postpartum care; 2: Occasionally received postpartum care; 3: Never received postpartum care.

delivery\_professional: This variable indicates whether the delivery was assisted by a professional, considering all births, and is categorized as: 1: Always had professional assistance; 2: Occasionally had professional assistance; 3: Never had professional assistance.

contraception\_use: This variable indicates the current contraceptive method used, categorized as: 1: Modern medical methods; 2: No contraceptive use; 3: Other contraceptive methods. And modern medical contraceptive methods include contraceptive pills, condoms, IUDs, sterilization, etc.

age\_sex: This variable indicates the age at which the respondent first had sexual intercourse. It is categorized into four groups: 0: Never had sexual intercourse; 1: First sexual intercourse between 8­19 years; 2: First sexual intercourse between 20­49 years; 3: First sexual intercourse at the time of first cohabitation. The age group of 8­19 is significant because the pelvis may be underdeveloped during these years compared to adult.

number\_birth: This variable represents the total number of births. It is categorized as: 0: Three or fewer children; 1: Four or more children. This classification allows for the distinction between lower and higher birth rates and their potential impact on fistula incidence.

## Analytical Methods

### Descriptive Statistics

Descriptive statistics can grasp the fundamental properties and distribution of data, establishing the groundwork for future study. First, calculate descriptive statistics for each variable in this research, including the mean, quartile, standard error, maximum, and minimum values. After that, category the variables by country and analyze differences in distribution between them. This provides an adequate understanding of each variable’s central tendency and dispersion. Second, calculate the prevalence of each variable in West Africa. And creat a horizontal categorized bar chart to display the fistula prevalence of each factor in different categories. It assists in better understanding the impact of each factor on fistula. Next, compute the prevalence of each variable in West Africa by country. This time, use facet maps and heat maps to compare the relationship between various factors and fistula prevalence in different countries. Then perform feature analysis and visualization.Explore West Africa and each country from the following four perspectives: individual and family background, economic and social status, access to health care, and family planning and sexual health. Use charts to illustrate the correlation between the relevant factors and prevalence. Feature analysis provides key insights into the causes and influencing factors of fistula in West Africa. Finally, do multiple correspondence analysis (MCA) to investigate the relationships between the key variables in West Africa and each country. This reveals the variable combination patterns that are unique to each country and compare the differences between different countries.

### Bivariate Analysis

Bivariate analysis explored the association between two variables. Considering the existence of weights, chose the weighted generalized linear model analysis. In the GLM analysis, use the quasibinomial family since the target variable is a dichotomous variable. The analysis of West Africa and each country separately assists in determining whether factors are significantly connected with the development of fistula. The weighted chi­square test follows to confirm the relationship between each variable and the occurrence of fistula. The outcomes of the GLM analysis may also be supported by the chi­square test. It also helpful in identifying significant correlations that may exist in different areas.

### Survey­weighted Generalised Linear Models

Survey­weighted Generalized Linear Models (svyglm) are used to identify the important determinants influencing fistula in West African women of reproductive age. The analysis steps are as follows: multicollinearity check, basic model fitting, interaction term analysis, and final model selection.

1. Multicollinearity Check

The variance inflation factor (VIF) is calculated before constructing the weighted regression model to determine whether there is an issue with multicollinearity among the independent variables. First, the selected variables are subjected to regression analysis using the ordinary generalized linear model (GLM). Then the VIF is computed. If the VIF is larger than 5, it indicates a multicollinearity concern. The VIF test results for West Africa and other countries show that all variables’ VIF values below 5. As a result, it is assumed that there is no significant multicollinearity problem. The multicollinearity problem will have no effect on the succeeding svyglm model’s variable estimate.

1. Basic Model Fitting

Use the weighted generalized linear model (svyglm) for analysis after checking that there is no multicollinearity issue. This is because the data set has a complex sampling design and the target variable is a binary variable (experienced\_fistula). Svyglm is an extension of the generalized linear model (GLM) that considers complicated sampling designs. It can adjust the model estimation by considering sample weights, stratification, and clustering to make the results more accurate. The basic model formula is as follows:

logit(P (Y = 1)) = 𝛽0 + 𝛽1𝑋1 + 𝛽2𝑋2 + … + 𝛽𝑘𝑋𝑘

Y is the target variable experienced\_fistula, which indicates whether a fistula has been experienced. X1, X2,…, and Xk are independent variables. The logit function turns the dependent variable into log odds, making it suitable for binary data.

In order to ensure the validity of the model, it is necessary to test the five key assumptions of the model. The model assumptions are as follows:

* 1. Assume that there is no significant multicollinearity between the independent variables: each variable in the model is independent of the others, and there is no high correlation to assure the model’s estimation reliability.
  2. Assume that the samples are independent of one another: Each sample in the data is independent of the others. This means that the results of one sample will have no effect on the results of the others.
  3. Assume that the model has no overdispersion: the model residuals follow the theoretical binomial distribution.
  4. Assume the model uses a suitable link function: the chosen link function can represent the relationship between the independent variable and the binary dependent variable.
  5. Assume that the model has a reasonable fit: the model fits the data well and can explain the variability of the data.

This research uses the following strategies to verify the hypothesis:

* 1. Multicollinearity: The generalized linear model (GLM) is used to conduct regression analysis on the independent variables and calculate the variance inflation factor (VIF). The results demonstrate that the values for the VIF are less than 5, implying that there is no significant multicollinearity.
  2. Sample Independence: To create the svyglm model, set id = 1. In this way, each observation can be considered independent.
  3. Overdispersion: When creating the svyglm model, the quasibinomial family is used to adjust the potential overdispersion problem.
  4. Link Function: Logit is the standard function for dealing with binary dependent variables. The quasibinomial family chosen for the model uses the logit function by default, thus it fits the hypothesis.
  5. Model Fit: The Akaike Information Criterion (AIC) is used to evaluate and compare the fit between the original and final models. The lower the AIC value, the better the model fits. The final model’s fit, which confirms the rationality of the validated significant variables, is indicated by a reduced AIC value. The results are shown in Table 3.

|  |  |  |
| --- | --- | --- |
| **Region** | **AIC(original)** | **AIC(current)** |
| West Afirca | 5016.987889 | 5015.870137 |
| Cote d’Ivoire | 749.249354 | 734.006360 |
| GuineaBissau | 1989.726257 | 1983.523536 |
| Mali | 373.6488525 | 363.1508204 |
| Nigeria | 375.884898 | 370.2257534 |
| Sierra Leone | 914.305117 | 913.238844 |
| Togo | 184.1343179 | 184.1343179 |

Table 3: Model Performance Comparison

1. Stepwise Validation of Interaction Terms

Due to the large number of variables, this research uses the gradual addition method to simplify the model and investigate the interaction between upstream economic and social characteristics (wealth, education, occupation) and other downstream aspects.

The specific steps involve adding only one interaction term at a time to the base model. The interaction term has two sides: the upstream and downstream factors. For example, add wealth\*postpartum\_care to the base model, then run the svyglm model to check the importance of the interaction term. Then, in the next analysis, replace postpartum\_care with age, rerun the model, and check the significance of the new interaction term.

If an interaction term is significant, it shows a meaningful interaction between the upstream and downstream factors. As a result, the independent factors (such as wealth and postpartum\_care) are included as important variables in the final model.

Furthermore, relevant interaction terms are investigated. Cross­tabulations are used to calculate fistula prevalence under various categorization combinations, and heat maps are used to highlight the true impact of these interaction effects.

4. Model Determination and Evaluation

The final factors influencing fistula are the combination of the important factors in the basic model and the significant factors in the interaction analysis. The final models of West Africa and each country are fitted again using svyglm, and the AIC is calculated to assess the quality of fit. Then the AIC is compared to that of the base model. The findings reveal that the final model’s AIC value is lower than that of the basic model, indicating that it is better.

## Summary

In this research, the weighted generalized linear model (svyglm) is used primarily to identify major factors influencing fistula in West Africa and other countries. The svyglm model can effectively identify factors that are significantly correlated with the target variable, as well as investigate the interaction between upstream factors (such as wealth, education, and occupation) and downstream factors by gradually adding interaction terms.

Although the svyglm model cannot automatically capture variable interactions, this research makes up for this limitation by gradually adding interaction terms, enabling a more comprehensive analysis of the complicated relationship between variables.

This research method can not only identify the impact of individual variables, but also deeply explore the joint effects of upstream and downstream factors through the analysis of interactions. Finally, through using this methodology comprehensively, the study effectively reveals the major factors that have a substantial impact on the occurrence of fistula in West Africa and other countries.

# Data Visualization

(Dashboard)

# Results Analysis

## Upstream Factors

### Wealth

In the West African region, the average value of wealth is 2.827, showing that most women are between “poor” and “middle”. However, the distribution of wealth is uneven, implying the presence of wealth inequality. Although the distribution of wealth is roughly similar between countries, Togo has a lower average wealth value (2.16), which may reflect the country’s relatively poor economic situation.

In terms of fistula prevalence, those in the economically better group has the highest prevalence, approximately 1.69%, while the poorest women have the lowest prevalence, 0.99%. In Cote d’Ivoire and Guinea­Bissau, the prevalence is higher among wealthy women, especially in Guinea­Bissau, where the prevalence of the richest female group reaches 7.4%. In contrast, Sierra Leone shows a negative correlation with wealth. Togo has a higher prevalence among the poorer and richer groups. Mali and Nigeria have a low prevalence of fistula regardless of wealth.

Overall, the impact of wealth on fistulas varies significantly among countries. Togo, Cote d’Ivoire, and Guinea Bissau show high relationships. This shows that economic position may be the main factor influencing the prevalence of fistula in these countries. Both MCA and bivariate analyses indicate that wealth has a significant impact on the prevalence distribution in West Africa and selected countries. These results are further confirmed in the svyglm analysis, showing that wealth is one of the key factors affecting fistula in West Africa, Cote d’Ivoire, Guinea­Bissau, Sierra Leone and Togo.

In conclusion, the impact of wealth on fistula is complex and diverse in West Africa and its various countries. In some countries, the prevalence of wealthy women is higher, which shows that wealth is not the only determinant and the prevalence may also be affected by other factors. Through subsequent cross­analysis, investigate the connection between wealth and other factors in more depth, revealing how wealth, as an upstream factor, affects fistula.

### Education

In West Africa, the average value of education is 0.72, indicating that most women are between “no education” and “primary education”. Nigeria (0.97) and Sierra Leone (0.84) have relatively high education levels, but they are also mainly concentrated in primary education. In other countries, women have a lower average education level, and the majority are uneducated, showing a serious lack of educational possibilities.

In West Africa, the prevalence of fistula is negatively correlated with education level. The prevalence decreases with increasing education level. Sierra Leone, Nigeria, Mali, and Togo generally follow this trend. Cote d’Ivoire has a high general prevalence, particularly among the higher education population. Guinea­Bissau has the highest prevalence of all countries, and the prevalence generally decreases with increasing education level, with one exception: the lowest prevalence occurs at the higher education level.

Overall, the impact of education on fistula varies significantly among countries. Guinea Bissau and Cote d’Ivoire have a significant association. This shows that education level could be one of the factors influencing the prevalence of fistula in these countries. MCA analysis demonstrates that education has a considerable impact on the distribution of prevalence in West Africa and in all countries. Bivariate analysis reveals that education has a considerable impact in West Africa and Sierra Leone. Svyglm study reveals that education is a crucial factor influencing fistula prevalence in West Africa and other countries (except GuineaBissau).

In summary, the impact of education on fistula shows a diverse relationship in West Africa and its individual countries. Although in most countries, the prevalence of fistula is higher in groups with lower education levels, this trend is not absolute, especially in some countries, the relationship between education and prevalence is more complex.This shows that education is not the only determinant. Further interactive analysis will help to gain a deeper understanding of the interaction between education and other factors, thereby revealing the specific impact of education as an upstream factor on fistula prevalence.

### Occupation

In West Africa, the average value of occupation is 0.901, indicating that most women are working. Data from various countries also show that most women are employed.

In West Africa as a whole, as well as in Mali, Guinea­Bissau, and Cote d’Ivoire, working women have a lower prevalence, showing a negative correlation trend. In Nigeria, although there are fewer samples without work, the prevalence of working women is very low. In contrast, working women in Togo and Sierra Leone have a higher prevalence. It is worth noting that, regardless of whether they work or not, Guinea­Bissau has the highest prevalence among all countries. In the questionnaire, a few women chose the “don’t know” option, probably because they were unwilling to provide specific information. In general, the prevalence of women in this group is lower, except in Guinea­Bissau. However, due to the small number of samples, this part of the data cannot be directly compared with the group with clear working status.

In summary, occupation and fistula prevalence show a significant relationship in West Africa.

MCA analysis shows that occupation has a significant impact on fistula prevalence in West

Africa, Cote d’Ivoire, Nigeria, Mali and Sierra Leone, while the impact is weaker in GuineaBissau and Togo. Bivariate analysis further confirms the significant association between employment status and fistula prevalence in West Africa overall, Nigeria, and Sierra Leone. The svyglm analysis reveals that occupation is a significant influencing factor in all countries except Mali, which may be related to the role of the interaction term in some countries.

In conclusion, occupation is an important factor affecting fistula prevalence in most West African countries, although its impact varies between countries.

## Downstream Factors

### Age

In West Africa, the average age is 3.46, indicating that women aged 20­39 account for a large proportion. In each country, the age group with the largest number of women is also concentrated in this range.

Across West Africa as a whole, prevalence is highest among women aged 45­49 and 15­19 years. The prevalence rates in other age groups also exceeded 1.1%. Guinea­Bissau and Sierra Leone have higher prevalence that worsens with age, while Nigeria and Mali show lower prevalence, which is milder especially in older age groups. Cote d’Ivoire had a higher prevalence rate among young women, while Togo had a significant increase in prevalence among middle­aged women.

Overall, there are certain differences in the performance of the age variable in different analyses. Data from Guinea Bissau and Sierra Leone show that there is a strong correlation between age and fistula prevalence, indicating that age may be one of the factors influencing the prevalence. In the MCA analysis, although age has a limited impact on the first dimension, in the second dimension age makes a larger contribution in West Africa and in each country. Bivariate analysis shows that age is a significant influencing factor in Nigeria and Togo. Svyglm analysis further confirms the importance of age in Nigeria, Sierra Leone, and Togo, emphasizing its important impact on fistula.

In conclusion, age is a significant factor influencing the prevalence of fistula in West Africa, with young and elderly populations requiring special attention.

### Religion

In West Africa, the average religion is 1.338, indicating that most respondents believe in “Muslim”. In most countries, Muslims dominate, except in Togo, where most women believe in Christians and Animists.

In general, in West Africa, Muslims have the highest prevalence, while other religious groups have relatively low prevalence. Sierra Leone has the highest prevalence among Christians. Togo has the highest prevalence among women of no faith. In other countries, Muslims have the highest prevalence. Among them, Guinea Bissau has an abnormally higher prevalence among both Muslim and Christian women than in other countries.

MCA analysis shows that religion makes a certain contribution to fistula in Nigeira and Togo. Bivariate analysis shows that religion is a significant factor in West Africa, Guinea­Bissau, Mali and Nigeria. Further svyglm analysis shows that religion has a significant impact on prevalence in all countries except Cote d’Ivoire, highlighting its influence on fistula.

In West Africa, religion has a significant impact on health status, especially in Muslim­dominated countries, where the prevalence of disease is generally higher among Muslim groups. Religion plays an important role in influencing women’s health, especially fistula incidence.

### Residence

In West Africa, the average value of residence is 1.65, indicating that more women live in rural areas. Women in Cote d’lvoire are more likely to live in cities. Women in other countries mainly live in rural areas.

Overall, the prevalence of disease in urban women in West Africa is slightly higher than that in rural women. However, in Mali, Nigeria and Sierra Leone, the prevalence of disease in rural women is higher than that in urban women. In other countries, the prevalence of disease in urban women is higher. Among them, the prevalence of disease in Guinea Bissau women is significantly higher than that in other countries, whether living in urban or rural areas.

MCA analysis shows that residence has an important contribution to fistula in West Africa and various countries. Bivariate analysis indicate that religion is a significant factor in Cote d’Ivoire, Guinea­Bissau, and Nigeria. Further svyglm analysis find that domicile had a substantial impact on prevalence in Cote d’Ivoire, Nigeria, and Togo.

In conclusion, residence influences the prevalence of fistula in West Africa, but there are geographical variations. In Cote d’Ivoire, Nigeria, and Togo, residence has an important impact on prevalence.

### Postpartum\_care

In West Africa, the mean value of residence is 2.48, indicating that most women occasionally receive postpartum care. Specifically, women in Mali and Nigeria are more likely to never receive postpartum care. Women in other countries mainly receive care occasionally.

Overall, women who have been receiving postpartum care in West Africa have much higher rates of the disease than other groups. In Nigeria and Togo, the prevalence of postpartum care among women who never received care is higher than among those who always received care, while the opposite is true in other countries. In particular, Guinea Bissau’s prevalence of receiving postpartum care is unusually high.

In the MCA analysis, postpartum care does not show a significant contribution in West Africa and in each country. However, bivariate analysis show that postpartum care is a significant influencing variable in West Africa, Guinea­Bissau, and Sierra Leone. Further svyglm analysis reveal that postpartum care is a significant influencing factor in West Africa, Guinea­Bissau, Nigeria, Sierra Leone, and Togo.

In summary, the effect of postpartum care on fistula prevalence in West Africa is complex. Although not showing a significant contribution in the MCA analysis, in deeper bivariate and svyglm analyses, postpartum care emerged as a significant factor in West Africa and across multiple countries, possibly reflecting the interaction of upstream factors. It is worth noting that the higher proportion of women receiving postpartum care could be linked to more frequent care visits due to illness.

### Place of Delivery

In the West African region, the mean value of place of delivery is approximately 2.2, indicating that most women occasionally give birth in health facilities. Women in Cote d’Ivoire and Sierra Leone are more likely to give birth in a health facility, while women in Togo gave birth more often in non­health facilities. Women in Nigeria, Mali, and Guinea­Bissau give birth in between the two frequencies.

Overall, West Africa has a higher prevalence of births in health facilities than other locations. Fistula prevalence across countries shows different trends by production site. Guinea­Bissau has unusually high prevalence in all conditions, while Mali and Nigeria have progressively decreased prevalence with increasing frequency of use of health facilities. The situation in Sierra Leone and Togo is more complex, with prevalence rates fluctuating between production sites.

In the MCA analysis, the contribution of place of delivery is not significant in Sierra Leone, but shows a larger contribution in West Africa and other countries. Bivariate analysis shows that the location of production is a significant influencing variable in West Africa, Guinea­Bissau and Mali. Further svyglm analysis reveal that the place of delivery in West Africa and all countries was a significant influencing factor.

In conclusion, birth location has a significant impact on fistula prevalence, but it is not the only determining factor. Although birth in a health facility is generally considered to reduce complications, the prevalence of fistula in health facility deliveries in West Africa is higher than in other locations. This may be related to factors such as uneven distribution of medical resources, overcrowding of facilities, or inadequate postpartum care.

### Distance

In West Africa, the average distance is about 0.38, indicating that the distance to medical facilities is not a major problem for most women. In each country, women generally do not think that distance is a prominent problem.

In West Africa, women who think distance to health facilities is a problem have higher rates of illness overall. In Mali and Nigeria, women who think distance is a problem have higher rates of illness. In Cote d’Ivoire, Sierra Leone, and Togo, women who think distance is not a problem have higher rates of illness. GuineaBissau has very high rates regardless of perception.

In the MCA analysis, distance contribute to GuineaBissau and Mali. Bivariate analysis indicate that distance is significant in West Africa and Togo. Svyglm analysis further show that distance is one of the important factors affecting West Africa and Togo fistula.

In short, distance is an important factor in West Africa overall and Togo. In West Africa, the prevalence of people who believe that distance from medical facilities is not a problem is lower, while in Togo the opposite is true. This suggests that the effect of distance to medical facilities on fistula varies significantly in different regions. This phenomenon may reflect the distribution and accessibility of medical resources in different countries.

### Professional Delivery

In West Africa, the average value of delivery\_professional is about 1.31, indicating that most women always give birth in a professional environment. Specifically, most women in Nigeria fall between always giving birth in a professional environment and occasionally giving birth in a professional environment. Women in other countries are more likely to always give birth in a professional environment.

In West Africa, women who always delivered in a professional setting have higher overall rates of fistula. Professional births are related to greater incidence of fistula in Cote d’Ivoire, Guinea Bissau, and Sierra Leone, whereas women who lacked a professional birth had higher rates of fistula in Mali, Nigeria, and Togo.

In the MCA analysis, specialized production contributes to all regions except Sierra Leone and Togo. Bivariate analysis shows that specialized production is a significant factor in West Africa, Cote d’Ivoire, and Guinea Bissau. In svyglm, specialized production is significant in Cote d’Ivoire, Guinea Bissau, Sierra Leone, and Togo.

The impact of skilled birth attendance on fistula prevalence in West Africa varies across countries. As most women receive skilled birth attendance, this means that high­risk groups may be more likely to be concentrated in healthcare settings, and therefore fistula prevalence may be higher in these settings. Some countries, such as Togo, have higher prevalence among women who do not receive skilled birth, suggesting that lack of skilled birth may be a key risk factor for fistula prevalence.

### Contraception Use

In West Africa, the average contraceptive use is about 1.88, indicating that most women do not use contraceptive measures. In each country, women generally do not use contraceptive measures.

Overall, the highest prevalence appears among women using other types of contraception, followed by those who never used contraception. In Sierra Leone and Togo, the highest frequency occurs in women who did not use contraception. In Cote d’Ivoire, Guinea Bissau, and Mali, women who used other kinds of contraception have the greatest prevalence rate. In Nigeria, the prevalence is low regardless of the type of contraception used.

Contraception lack a substantial impact on the MCA analysis results. In West Africa, Guinea Bissau, and Sierra Leone, bivariate analysis show that contraception use is a significant determinant. Further svyglm research indicate contraceptive use has a considerable impact on prevalence in West Africa and other countries than Mali.

Overall, women using scientific contraception have the lowest prevalence. In several countries, women who used other contraceptive methods have the highest prevalence, most likely because these techniques are less effective and have similar protective effects to not using contraception. As a result, the choice of contraceptive method has a significant impact on the prevalence of fistula, stressing the necessity of carefully selecting contraceptive methods.

### Age of First Sexual Intercourse

In West Africa, the average age of first sexual intercourse is around 1.136, implying that the majority of women have their first sexual experience between the ages of 8 and 19. Except for Togo, women in other nations often have sexual experience between the ages of 8 and 19, whereas women in Togo have their first sexual encounter later, often in adulthood.

In West Africa, first sexual experience is more common among women during their first cohabitation, followed by sexual experience between the ages of 8 and 19. The highest frequency appears in Cote d’Ivoire, Guinea Bissau, Nigeria, and Sierra Leone among those aged 8 to 19, however Nigeria has a lower overall prevalence. In Mali, the prevalence is the same regardless of age. In Togo, the frequency is highest when the first cohabitation occurred, with the lowest prevalence seen between the ages of 8 and 19.

In the MCA analysis, the age of first sexual intercourse in Guinea Bissau and Togo is included. In the bivariate study, only Sierra Leone is recognized as a relevant variable. The svyglm analysis show that the age of first sexual intercourse in Cote d’Ivoire, Sierra Leone, and Togo has a substantial impact on the prevalence of fistulas.

In conclusion, the age of first sexual intercourse has a certain influence on fistula. In Togo, since most women have their first sexual intercourse at a later age, the incidence of sexual experience during the first cohabitation period is higher, so the prevalence of fistula is higher in this period. At the same time, the lower prevalence of fistula in the 8­19 years period may be related to the reduction of the chance of early pregnancy, thus avoiding the situation of increasing the risk of fistula due to pelvic immaturity. These results emphasize the importance of delaying the first sexual experience and the potential role of preventing early pregnancy in reducing the prevalence of fistula.

### Total Births

In West Africa, the average number of births is about 0.46, indicating that the number of births is evenly distributed between low fertility (three or less) and high fertility (four or more). Specifically, Cote d’Ivoire, Guinea Bissau and Sierra Leone generally have 3 or fewer births. Mali, Nigeria and Togo have a relatively balanced number of births, slightly more than the first three countries.

Overall, in West Africa, women with three or fewer children have a slightly higher prevalence. Data from Cote d’Ivoire, Nigeria, and Sierra Leone show higher prevalence among women with fewer children (three or fewer), although Nigeria’s overall prevalence is still low. In contrast, in Togo, women who had four or more children had much higher rates than women who had fewer children. There is little difference in the prevalence of Guinea Bissau and Mali with different birth numbers. However, the prevalence rate in Guinea Bissau is very high, while that in Mali is lower.

In the MCA analysis, the total number of births contributes significantly to the analysis for West Africa and individual countries. Bivariate analysis shows that the number of births is a significant influencing factor in West Africa and Togo. The svyglm analysis further shows that fertility number has a significant effect in West Africa, Sierra Leone and Togo.

In conclusion, the number of births is one of the factors affecting fistula in West Africa and some countries. In West Africa and Sierra Leone, the prevalence is higher among women with fewer children, which may be related to the larger sample size of most women having three or fewer children. In Togo, the number of births is more evenly distributed, and women with four or more children have a significantly higher prevalence, indicating that the risk of disease may increase with more births.

## Interaction Effects

This research aims to explore the key factors affecting fistula in women of childbearing age in West Africa. In the previous section, the influencing factors have been analyzed separately, and this section will focus on the analysis of the interactive effects within the West African region.

The combined influence of the three upstream factors—wealth, education, and occupation— and other downstream variables on the health condition of West African women can be revealed by delving deeper into their interaction. Although the previous research included data from different countries, this interaction impact analysis will concentrate on West Africa to provide more particular insights and policy recommendations.

As an upstream factor, wealth level significantly affects the choice of postpartum care among West African women. Among women with higher wealth levels, those who always receive postpartum care show a higher prevalence of fistula. This may be because these women themselves face higher risks of pregnancy and childbirth, prompting them to choose continuous postpartum care. However, it is precisely this high­risk pregnancy and childbirth situation that may lead to an increase in the prevalence of fistula. It is worth noting that the higher the wealth level, the higher the prevalence of fistula, which may be because they have more resources to identify and choose care, but may also be because they face more complex health conditions. Wealth level not only affects the accessibility and choice of postpartum care, but is also closely related to fistula.

Education, as an upstream factor, works together with distance to influence fistula prevalence. Among women who think distance is not a problem, the higher the education level, the lower the prevalence. However, among women who believe distance is a problem, the prevalence is highest among women with no education, followed by those with higher education. Overall, women with no education have the highest prevalence. This suggests that the interactive effect of education and distance has a significant impact on fistula prevalence, with the risk of women with no education being particularly prominent.

The prevalence of fistulas is highest among the Muslim group, and educational attainment has little impact on prevalence among this group. However, in other religions, education has a significant impact on fistula prevalence, with the highest prevalence among the uneducated group. Education plays an important protective role among non­Muslim groups, with prevalence rates decreasing as education levels increase. This suggests that the interaction effect of religious background and education has a significant impact on fistula prevalence, especially in the nonMuslim group, where the protective effect of education is particularly prominent.

Fistula is more common among women who never gave birth in a professional setting, and education level has a substantial effect on prevalence, with lower education levels being related with higher incidence. Fistulas are less common among women who gave delivery in a professional setting. Lower education levels are linked with increased occurrence. However, it is worth noting that women with higher education have a higher prevalence in this category, which contrasted with the overall trend. It demonstrates that birth location and education level interact to influence fistula prevalence in a complex way.

The prevalence of fistulas is higher among unemployed women than among employed women, and the prevalence among urban women is higher than among rural women. This suggests that occupation and place of residence have a significant impact on the prevalence of fistula, especially in unemployed urban women. This may reflect that the urban environment and lack of occupation jointly increase health risks.

Postpartum care and occupational status jointly affect fistula prevalence. Although the prevalence of women who receive postpartum care is higher, occupational status further complicates this effect. The prevalence of working women in continuous care is particularly prominent, which may be because the demands of the workplace cause them to face more health challenges during the postpartum recovery period, thereby increasing the risk of fistula.

Overall, the interaction between upstream and downstream factors has a complex impact on fistula prevalence. The interaction between different factors highlights the need for more targeted public health interventions to reduce the risk of fistula among women in West Africa. Policymakers should consider the complexity of these interactions and develop more nuanced health strategies for women from different socioeconomic backgrounds and geographic regions.

## Comparative Analysis Across Countries

By comparing the determinants of fistula among women of childbearing age in West Africa and across countries, some conclusions can be drawn. Upstream factors (wealth, education, and occupation) play a key role in most West African countries. However, the specific impacts vary significantly between countries. Education and occupation are important determinants in almost all countries, showing the extensive impact of upstream factors on fistula. However, countries have different emphases on the factors of Personal and Family Background, Medical Services and Health, and Family Planning and Sexual Health.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Factors** | **West**  **Africa** | | **Cote Guine­ Mali Nigeria d’lvoire aBissau** | | | **Sierra­**  **Leone** | **Togo** |
| wealth | √ | | √ √ | | | √ | √ |
| education | √ | | √ √ √ | | | √ | √ |
| occupation | √ | | √ √ √ | | | √ | √ |
|  | Table 4: Economic and Social Status Factors | | | | |  |  |
| **Factors** | **West Cote Guine­ Mali Nigeria**  **Africa d’lvoire aBissau** | | | | | **Sierra­**  **Leone** | **Togo** |
| age | √ | | | | | √ | √ |
| religion | √ √ √ √ | | | | | √ | √ |
| residence | √ √ | | | | |  | √ |
|  | Table 5: Personal and Family Background Factors | | | | |  |  |
| **Factors** | **West**  **Africa** | | **Cote Guine­ Mali Nigeria d’lvoire aBissau** | | | **Sierra­**  **Leone** | **Togo** |
| delivery\_professional | |  | | √ √ | | √ | √ |
| distance | | √ | |  | |  | √ |
| postpartum\_care | | √ | | √ √ | | √ | √ |
| delivery\_place | | √ | | √ √ √ √ | | √ | √ |
|  | | Table 6: Medical Services and Health Factors | | | |  |  |
| **Factors** | | **West**  **Africa** | **Cote Guine­ Mali Nigeria d’lvoire aBissau** | | | **Sierra­**  **Leone** | **Togo** |
| number\_birth | | √ |  | |  | √ | √ |
| contraception\_use | | √ | √ √ | | √ | √ | √ |
| age\_sex | |  | √ | |  | √ | √ |

Table 7: Family Planning and Sexual Health Factors

Analysis in West Africa (prevalence 1.25%) shows the importance of these upstream factors, as well as medical factors (postpartum care, location of delivery and distance from health facilities) and family planning factors (number of births and contraceptive use). There is a significant impact. In contrast, personal background factors have a lower impact, with only religious background showing a certain effect.

The situation in Cote d’Ivoire (prevalence 1.18%) is similar to that in West Africa as a whole, showing that upstream factors, medical factors, and family planning factors are equally important, while personal background factors have a relatively small impact. This may reflect that the country’s socioeconomic development is similar to that of West Africa, and the combined effects of various factors on health outcomes are relatively balanced.

The analysis of Guinea­Bissau (prevalence 4.5%) shows a different pattern. In the country, occupation is the only significant upstream factor, showing its special socioeconomic background. At the same time, personal background factors and health service factors also play an important role in the prevalence of fistulas in the country, while family planning aspects only need to focus on contraceptive use. This suggests that the prevalence of fistula in Guinea­Bissau may be more affected by occupation, personal background and health care factors.

The situation in Mali (prevalence 0.46%) is more special, with very limited influencing factors, only education level is the only important upstream factor, while in personal background, religious background has a significant impact, and medical factors are limited to the place of birth. This shows that in Mali, the influencing factors of fistula prevalence are relatively single, which may be related to the lower overall prevalence.

In Nigeria (prevalence 0.2%), upstream factors such as wealth, education, and occupational are also very important. At the same time, personal background factors also have a significant impact on fistula prevalence. In contrast, the impact of medical care and family planning is relatively limited. As a relatively wealthy country in West Africa, Nigeria may have better medical facilities than other regions, so the impact of these factors is smaller.

The analysis of Sierra Leone (prevalence 1.4%) and Togo (prevalence 1.02%) show that fistula prevalence in these two countries is affected by a combination of factors. Upstream factors, personal background factors, medical service factors, and family planning factors all show importance in both countries, indicating that health risks in these two countries are multidimensional and require comprehensive consideration of various factors to develop intervention measures.

Overall, these findings highlight the importance of taking into account country­specific contexts and differences when developing public health policies in West Africa. While some upstream factors appear to be of general importance in most countries, the role of medical care, personal background and family planning varies significantly across countries. Therefore, policymakers need to design more targeted health interventions based on the specific socioeconomic context of each country to effectively reduce fistula prevalence and improve the overall health of women in West Africa.

# Conclusion

## Summary of Findings

## Limitations

## Conclusions

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