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**Demographic and provider-related determinants in circumcision mishaps: a retrospective study from a Teaching Hospital in Ghana**

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## Abstract

***Introduction:*** *provider skill and client demographics influence Circumcision outcomes. In Ghana, procedures are performed by both medical and traditional practitioners, resulting in variable complication rates. This study assessed the demographic and provider-related determinants of circumcision complications in the Volta Region.* ***Methods:*** *a five-year retrospective study was conducted at Ho Teaching Hospital involving 186 cases. Data on client age, parental education, occupation, residence, provider type, and outcomes were extracted using a structured tool. Chi-square and logistic regression analyses were performed at a 5% significance level.* ***Results:*** *among 186 cases, 33 (17.74%) had complications-12.40% anatomic and 5.34% non-anatomic. Common complications included incomplete circumcision (43.48%), bleeding (21.74%), urethrocutaneous fistula (13.04%), and infections. Complication rates varied significantly by provider: traditional circumcisers (60.0%), midwives (13.3%), and doctors (3.4%). Clients ranged from 1 week to 28 years (mean: 11 months); 41.4% were aged 1 month to 1 year. Complication rates were highest in children >5 years (100%) and lowest in neonates and adults ($p < 0.001$). Parental education significantly influenced outcomes: tertiary (11.76%), primary (43.75%), none (40%, $p = 0.012$). Rural residence (40%) was associated with higher risk than urban (9.2%, $p < 0.001$). Religion and ethnicity were not significant. Traditional circumcisers (OR = 43.5, $p = 0.002$) and non-facility (home) settings (OR = 2.30) posed higher risks. Post-neonatal circumcision increased risk up to 3.71 times ($p = 0.001$), while tertiary education reduced risk by 80% ($p = 0.011$). Peri-urban (OR = 9.84) and rural (OR = 6.56) residence also increased odds.* ***Conclusion:*** *age, parental education, occupation, residence, and provider type significantly affect circumcision outcomes. Safer practices require regulation, risk stratification, and public health education.*


## Introduction

The success of circumcision procedures is highly dependent on the skill, experience, or level of supervision of the healthcare provider performing the operation. In regions where circumcision is common, such as Ghana, the variability in provider expertise can lead to a range of outcomes, from successful procedures to severe complications [1]. Understanding the provider-related factors that contribute to circumcision mishaps is essential for improving patient safety and surgical outcomes. Both medical and traditional practitioners perform circumcision. Traditional circumcisers are prevalent in countries like Israel, Turkey, and Ghana, where they often operate under minimal supervision [2]. In Ghana, circumcisions are primarily conducted by midwives and nurses, accounting for 77.8% of cases, with traditional circumcisers (Wanzams) and doctors responsible for the remainder [3]. Poor training, lack of proper equipment, and unhygienic conditions contribute to higher complication rates, particularly when performed by inexperienced or untrained providers [4]. However, complications are not limited to traditional circumcisers; healthcare providers in Ghana have also been implicated in notable rates of complications, suggesting a need for improved training and resources [4,5]. We sought to explore the demographic and provider-related factors that could have a bearing on the likelihood or otherwise of circumcision complications amongst our circumcising population as a needs assessment for possible public health interventional activities. The general objective of this retrospective study aims to analyse the influence of socio-demographic and provider-related factors on circumcision outcomes in the Volta Region. By identifying these determinants, risk stratification of our clients can be done as part of preventive measures for circumcision mishaps. The specific objectives to study the distribution of circumcisions and complications amongst the various sociodemographic groupings and circumcision-providers. To analyse the impact of healthcare

provider factors, such as training and experience, on circumcision outcomes.

To identify common client-related socio-demographic factors that may increase the risk of circumcision mishaps at Ho Teaching Hospital. The conceptual framework for this study focuses on the provider-patient interaction during circumcision procedures. It suggests that the outcomes of circumcision are directly influenced by the provider's level of training, years of experience, and adherence to established surgical protocols [6]. The framework will examine how these factors relate to the incidence of complications. Additionally, it will consider the role of preselection in influencing clients´ risk of suffering circumcision mishaps/disasters, based on the data (Figure 1). Preselection in the context of certain diseases or circumcision mishaps refers to the process of identifying individuals who have specific characteristics, risk factors, or predispositions that make them more likely to develop a particular condition or experience complications. This can involve screening or assessment of medical history, genetics, or environmental exposures to determine which individuals are at a higher likelihood of encountering these outcomes [7]. For circumcision mishaps, preselection might involve identifying infants or individuals with anatomical abnormalities (such as penile torsion or hypospadias) that could complicate the circumcision process (Figure 1). Additionally, a family history of bleeding disorders, such as haemophilia, and some demographic characteristics like parents´ education level or religion, might preselect patients for a higher likelihood of bleeding or other complications during circumcision [8].

## Methods

**Study design:** this study was a five-year retrospective and analytic study, utilizing data from August 1, 2019, to July 31, 2024. The study site was Ho Teaching Hospital, Ho, Volta region of Ghana. The major tool used for the study was a structured data extraction sheet which consisted of several questions on an MS Excel spreadsheet. Data collected included socio-demographic data, clinical data and data pertaining to complications resulting from the circumcisions. It was a census study.

**Inclusion criteria:** males (neonates, infants, children, and adolescents) who underwent circumcision within the study period. Circumcisions performed by trained or untrained practitioners in various settings (clinical or non-clinical). Availability of complete demographic, clinical, and circumcision-related data.

**Exclusion criteria:** cases with incomplete or missing key circumcision-related data. Circumcisions performed outside the study region and not adequately documented.

**Assessments and outcomes:** the study evaluated circumcision complications (CCD) as the primary outcome, categorized as present (CCD= 1) or absent (CCD= 0). The key exposures included circumcision operator type (trained vs. untrained), circumcision setting (hospital/clinic vs. home/traditional), circumcision age (neonatal, infant, childhood, adolescence), clinical variables (presence of bleeding, infection, or anatomical circumcision complications), and laboratory findings (haemoglobin level, white blood cell count, platelet counts at the time of reporting. Predictors assessed included demographic factors (circumcision age, ethnicity, religion, parental occupation, education, and residence), the circumciser´s skill level and the setting/facility at which circumcision was done.

**Data sources and measurement:** data was extracted from medical records and procedural documentation. Circumcision complications were identified based on clinical diagnoses recorded in medical charts, including excessive bleeding (requiring medical intervention), infection (localized or systemic), and anatomical complications (confirmed by urological

evaluation). Ethnicity, religion, parental occupation, education, and residence were all extracted from the records available. Operator type and circumcision setting were determined through documented procedure records.

**Study size:** as a retrospective study, a census approach was employed, including all participants satisfying the inclusion criteria within the study period. No formal sample size calculation was performed; rather, all available cases meeting the inclusion criteria were analysed.

**Statistical analysis:** chi-square tests, ANOVA (analysis of variance) tests and bivariate regression analysis were conducted on the data using circumcision outcome as a binary function (0 = no circumcision complication, and 1= circumcision mishap present); as the dependent variable, and various characteristics; the circumciser (skill level, provider facility, age at circumcision, parent´s education, occupation, residence, ethnicity and religion) as the independent variables. The bivariate logistic regression analysis was conducted, with each independent variable regressed separately against the dependent variable (circumcision complications). The independent variables analysed included: demographic factors: Circumcision age, occupation, education, residence religion and ethnicity of the parents of the clients. Clinical and procedural factors: Circumcision operator type/skill level, circumcision setting/facility. The outcome variable was the presence or absence of circumcision complications (CCD= 1 or 0). A chi-square test was used to assess categorical variable associations before regression. Relationships were expressed as odds ratios (ORs), with corresponding 95% confidence intervals (CIs). Statistical significance was set at $p < 0.05$. Descriptive statistics for the demographic features were also presented.

**Ethical considerations:** this study adhered to the ethical guidelines and policies for research involving human subjects, as outlined by the University of Health and Allied Sciences Ethical Review Committee. The following ethical considerations were considered: human subject ethics review approval: ethical clearance for this retrospective study was obtained from the University of Health and Allied Sciences Ethical Review Committee. The ethical review number is UHAS-REC A.10 [103] 23-24.

**Informed consent:** due to the retrospective nature of the study, the requirement for individual informed consent was waived. The data utilized was part of a larger database collected under prior consent for routine clinical care. Institutional Review Board (IRB) approval explicitly covered the use of such data for secondary analysis. Participants were not directly contacted, and their identities remained confidential.

**Privacy and confidentiality**: all data used in this study were anonymized or de-identified to protect the privacy of the participants. Identifiable information was not included in the dataset. Measures to ensure confidentiality were maintained throughout the study, including secure storage of data and restricted access to authorized personnel only.

**Compensation details:** as this was a retrospective study utilizing pre-existing data, no compensation was provided to participants. Participants did not incur any direct benefits or risks associated with this research.

## Results

**Demographic characteristics:** infants aged 1 month to 1 year constituted the most circumcision clients (41.4%). Nearly half of the parents (47.3%) were engaged in service or manual labour occupations. Most had attained secondary education (52.2%), identified as christians (68.8%), and were predominantly of Ewe ethnicity (82.8%). The vast majority were Ghanaian (95.7%) and resided in Ho or its environs (69.9%) (Table 1).

**Types and frequencies of circumcision complications:** of the 186 circumcision cases

reviewed, 12.34% (n= 23) experienced complications. The most frequent complication was incomplete circumcision (43.48%), followed by post-circumcision bleeding (21.74%), urethrocutaneous fistula (13.04%), and low haemoglobin levels (12.9%). Several cases also showed infected ulcers and related sequelae.

**Association between provider-related factors and complication risk**

**Practitioner type and complication risk:** doctors had the lowest complication rate (3.4%), followed by nurses (7.0%), midwives (13.3%), and wanzams/herbalists (60%). A Chi-square test confirmed a statistically significant difference in complication rates across practitioner types ($\chi^2(3) = 26.04$, $p < 0.001$), (Table 2). Logistic regression, using doctors as the reference group, showed that: nurses had a 120% increased odds of complications (OR= 2.20, p= 0.48), Midwives had a 346% higher odds (OR= 4.46, p = 0.16), and Wanzams had a 4250% higher odds (OR= 43.5, p= 0.002), the only statistically significant result. These findings indicate that wanzam-performed circumcisions are significantly more likely to result in complications, while differences for nurses and midwives were not statistically significant.

**Practitioner type and laboratory parameters:** mean haemoglobin was highest among cases handled by doctors (13.43 g/dL) and lowest among wanzam cases (10.18 g/dL), although the difference was not statistically significant (p = 0.081). Platelet counts were significantly higher among wanzam-performed cases (431.14 x $10^3$/µL) compared to other groups (p = 0.046), reflecting reactive thrombocytosis from bleeding. White blood cell counts were highest among nurse-handled cases (33.02 x $10^3$/µL) but did not differ significantly across groups (p = 0.217) (Table 3, Figure 2).

**Provider facility type and complication risk:** circumcision complication rates also varied by the type of provider facility (Table 2). Teaching hospitals had the lowest complication rate (9.1%), while home-based procedures recorded the highest (18.7%), accounting for 60.6% of all complications. District hospitals, CHPS compounds, and health centres each had complication rates around 20%. No complications were recorded in quasi-governmental institutions, polyclinics, or private hospitals. Chi-square analysis revealed a significant association between provider facility and complication risk ($\chi^2 = 18.51$, $p = 0.047$). Using the teaching hospital as the reference, odds ratios indicated: quasi-governmental, polyclinic, and private hospitals had OR = 0.00 (no complications), district hospitals, CHPS compounds, and health centres had OR = 2.50 (p = 0.449), and home-based procedures had OR = 2.30 (p = 0.116). Although these odds suggest higher complication likelihood in non-tertiary and informal settings, only the overall association across groups was statistically significant.

**Association between client demographics and complication risk**

**Demographic correlates of complications:** client's age at circumcision was strongly associated with complication incidence (p < 0.001). Similarly, lower parental education levels, non-urban residence, and occupational categories also correlated significantly with increased complication risk. Ethnicity and religion, however, showed no statistically significant associations (Table 4).

**Predictive odds for complication risk:** children under 5 and adolescents had significantly increased odds of complications compared to neonates (OR= 5.2 and 8.7, respectively; both p= 0.001). Tertiary-educated parents were significantly less likely to have children with complications (OR= 0.209, p= 0.011). Additionally, peri-urban and rural residence were strong predictors of elevated risk, with odds ratios of 9.84 and 6.56, respectively (both p < 0.0001). While some ethnic groups exhibited higher odds, these were not statistically significant (Table 5).

**Summary of key statistical findings:** a total of 186 male clients aged 1 week to 28 years (mean age:

11 months, SD: 10 months) were studied. The overall complication rate was 17.74%, with anatomical complications accounting for 12.40% and non-anatomical complications such as bleeding and infections comprising 5.34%. Among the 33 clients who experienced complications, the most frequent were incomplete circumcision (43.48%), post-circumcision bleeding (21.74%), urethrocutaneous fistula (13.04%), and infections. Midwives and traditional circumcisers (Wanzams) recorded higher complication rates (13.3% and 60.0%, respectively), while doctors had the lowest (3.4%). Notably, traditional circumcisions were associated with significantly higher platelet levels compared to medical circumcisions (p= 0.046, ANOVA).

**Odds ratio (OR) analysis revealed:** traditional circumcisions had 43.5 times higher odds of complications compared to those performed by doctors (OR= 43.50, p= 0.002). Home-based procedures were 2.3 times more likely to result in complications than hospital-based ones, though not statistically significant (OR= 2.30, p= 0.116). Non-neonatal circumcisions carried up to 3.7 times increased odds of complications (OR= 3.71, p= 0.001). Tertiary parental education was protective, associated with an 80% reduction in complication odds compared to secondary education (OR= 0.209, p= 0.011). Rural and peri-urban residence were linked to significantly higher odds of complications compared to urban settings (OR = 9.84 and 6.56, respectively; both p= 0.0001).

## Discussion

The results of this study point to two sets of factors as important determinants of circumcision mishaps. These include demographic factors (child´s age, parents´ occupation, education, and residence) and provider-related factors (circumcision provider´s skill level, and the kind of facility at which the circumcision was done).

**Relationship between provider and outcome of the circumcision:** the significant association between practitioner type and circumcision outcomes, highlighted by the Pearson Chi-square test ($\chi^2(3)= 26.04$, $p < 0.001$), underscores the critical influence of training, supervision, and expertise on procedural outcomes. Doctors, with a complication rate of 3.4%, had the lowest risk, consistent with existing literature that emphasizes the benefits of formal medical training in reducing surgical risks [8]. Nurses and midwives, though medically trained, exhibited higher complication rates of 7.04% and 13.33%, respectively. These findings could reflect variations in experience, supervision, equipment availability, and adherence to surgical guidelines, as noted in studies that document variability in outcomes based on healthcare provider type [5]. The most concerning results were from traditional circumcisers (wanzams/herbalists), who had a 60% complication rate and a significantly higher odds of complications (OR = 43.50, p= 0.002). This supports existing evidence that traditional circumcisers, often lacking formal medical training, supervision and operating in non-sterile environments, contribute disproportionately to circumcision-related complications, including severe infections and excessive bleeding [1]. These findings align with studies from sub-Saharan Africa, where traditional circumcisers are frequently implicated in higher rates of adverse outcomes compared to healthcare professionals [9].

Further analysis of haemoglobin levels revealed no significant differences between practitioner types (p= 0.081), though doctors had the highest mean levels (13.43 g/dL and wanzams the lowest, 10.18 g/dl). This could be indicative of better preoperative patient evaluation and perioperative management by doctors, which is often not prioritized by non-medical practitioners, or a higher haemorrhage rates amongst wanzams. The need for further research on this cannot be gainsaid. The significant difference in platelet counts (p = 0.046), with wanzams showing the highest mean (431.14 x $10^3$/µL), might reflect increased bleeding in their patients; probably due

to poor procedural technique and lack of haemostasis management on their part [10]. In comparison, doctors and midwives had lower platelet counts, indicative of better control of bleeding during and after the procedure. White blood cell (WBC) counts, though not significantly different across groups (p= 0.217), were highest in nurses (33.02 x $10^3$/µL). The elevated WBC counts in some patients could suggest higher infection rates post-circumcision, potentially linked to procedural aseptic techniques. Prior studies have shown that circumcisions performed under suboptimal hygienic conditions tend to have increased post-surgical infections [1], a factor that might explain the observed WBC variability.

The provider facility for the circumcision also played a role in outcomes. Home-based procedures had the highest complication rates (OR= 2.30, p= 0.116), consistent with literature showing that circumcisions performed outside clinical settings are more prone to adverse outcomes due to lack of sterile environments and appropriate equipment [1]. This aligns with findings that emphasize the importance of conducting surgical procedures in regulated healthcare facilities, where infection control measures and trained personnel are available [11]. On the other hand, quasi-governmental and private hospitals, which reported no complications, may reflect the benefits of institutionalized circumcision practices, adhering to standardized surgical protocols [12]. In a nutshell, the data suggest that while medical professionals, particularly doctors, maintain the lowest complication rates, traditional circumcisers (wanzams/herbalists) pose a significantly higher risk to patients. These findings are consistent with previous studies that advocate for stricter regulations and training programs for non-medical circumcisers to mitigate risks [1]. Furthermore, the importance of circumcision in a healthcare setting is reinforced by the strong association between home-based procedures and elevated complication rates, underscoring the need for circumcisions to be performed in clinical settings to ensure better outcomes.

**Demographic preselection: demographic determinants of circumcision mishaps:** preselection for circumcision mishaps refers to identifying individuals or groups at higher likelihood of experiencing complications based on pre-existing risk factors. Certain anatomical anomalies, such as buried penis, penile adhesions, or hypospadias, increase the likelihood of mishaps during circumcision [4,13]. These conditions can make the surgical procedure more technically challenging, leading to risks like excess skin removal, accidental injury to the glans, or improper wound healing. Additionally, infants with bleeding disorders such as haemophilia are more susceptible to severe bleeding during or after the procedure, making preselection for these risks essential for planning safer interventions [14]. Circumcision mishaps can also arise from improper techniques, particularly when performed by untrained or inadequately supervised practitioners, which increases the chances of infection or more severe injuries such as glans amputation. Identifying this group of risk factors beforehand, also allows healthcare providers to either avoid circumcision or ensure it is performed under controlled conditions, such as in a hospital setting with appropriate precautions [8].

The distribution of circumcision complications by age groups presents critical insights into the risks associated with performing circumcisions at different developmental stages. Neonates (0 to 1 month) demonstrated a 100% complication-free rate, consistent with literature suggesting that circumcisions performed in the neonatal period, typically within sterile medical environments, are associated with fewer complications [8]. In contrast, infants (1 month to 1-year-old) had a 19% complication rate. However, this accounted for most (53.76%) of the total number of circumcision complications. This mirrors findings from studies that identify infancy as a vulnerable period due to the rapid development and potential for improper wound healing [15]. To put

things more into context, we also state here that this group also accounted for 57.58% of the total number of circumcisions in the study.

In terms of rates alone, children under-five years old [2] had the second-highest complication rate (56.25%), with 27.27% of the total complications. This age group, according to literature, often undergoes circumcisions by non-medical practitioners or in non-clinical settings, which increases the likelihood of adverse outcomes due to poor technique and aseptic practices [8,16]. Adolescents [4] had a 66.67% complication rate, the highest of any age group. Adolescents are often circumcised in traditional settings, particularly during rites of passage, where complications such as infection and excessive bleeding are common due to lack of sterile equipment and proper medical care [16]. The Pearson's chi-square test ($p<0.001$) confirms a statistically significant association between age and complication rates, highlighting the importance of timing circumcisions during safer developmental windows.

The odds ratio analysis further supports this, with children under five having a significantly higher odds' ratio (OR= 5.229, p= 0.001) compared to infants, and adolescents having even higher odds (OR= 8.736, p= 0.001). Neonates, on the other hand, had zero odds of complications, consistent with recommendations from the American Academy of Paediatrics, which advocates for neonatal circumcision due to its safety profile and lower complication rates [17]. Parental educational level also significantly impacts complication rates. Individuals with no education (0) and those with only primary education (1) had the highest complication rates (40% and 43.75%, respectively). Lower educational attainment is often associated with less access to healthcare information and services, which may lead to increased reliance on traditional circumcisers, who often lack formal training [3]. In contrast, individuals with secondary and tertiary education had significantly lower complication rates (16.49% and 11.76%, respectively). This suggests that higher education levels may lead to better health-seeking behaviour, such as opting for circumcisions performed by trained medical professionals (8). The chi-square analysis (p=0.012) and the odds' ratio for tertiary education (OR= 0.209, p= 0.011) further confirm the protective effect of higher education against circumcision complications.

Parental occupational differences also played a role in circumcision outcomes. Farmers and tradespeople exhibited the highest complication rates (54.55%), likely due to lower health literacy and poorer access to healthcare facilities; leading them to seek circumcisions from traditional practitioners [3]. Health professionals, on the other hand, had the lowest complication rates (5.56%), likely because they deliberately choose medical professionals to circumcise their children. The significant association between parental occupation and complication risk (p=0.013) suggests that socio-economic factors significantly influence circumcision outcomes [1].

The residence of our circumcision clients also was a determinant of circumcision mishaps. Urban residents had the lowest complication rates (9.22%), likely because they had better access to healthcare services and professionals, allowing for safer circumcisions [18]. Periurban and rural residents, who may have less access to trained medical practitioners, had significantly higher complication rates (50% and 40%, respectively). The chi-square analysis (p= 0.013) confirms the significant association between residence and circumcision complications, which is consistent with studies showing that rural and periurban populations often rely on traditional circumcisers, leading to higher complication rates [3]

Religious affiliation, however, did not significantly affect complication rates ($\chi^2(2) = 1.6037$, $p = 0.448$). Christians and Muslims had similar complication rates (17.22% and 25%, respectively), while traditionalists showed no clear pattern. This lack of association could reflect the fact that both Christians and Muslims often seek circumcisions

from similar sources, such as healthcare professionals or traditional circumcisers, rather than differences in religious practices directly influencing outcomes [1]. Finally, ethnicity did not show a significant association with complication rates, with similar distributions of complications across ethnic groups ($\chi^2(4) = 5.348$, Pr= 0.253). The Ewe group had the largest sample size and a complication rate of 16.88%, comparable to the overall rate of 17.74%. The Akan (Ashanti + Fante) group had a higher complication rate of 35.71%, however all these were chance events. The chi-square test confirms that ethnicity, unlike age or education level, does not significantly influence complication rates.

**Limitations:** this study has several limitations. First, as a retrospective study, it relies on existing data, which may be subject to inaccuracies or incomplete information, for example, data on parents age was not collected. Additionally, the use of de-identified data limits the ability to explore certain individual-level variables in depth. The study's findings may also be influenced by the specific population sample available, which may not be generalizable to broader or different populations. Finally, the absence of direct participant interaction restricts the ability to collect real-time feedback or account for potential biases that could arise from participant self-reporting or other direct methods of data collection.

**Recommendations:** it is recommended that the national health authorities take steps towards enhancing healthcare provider training and regulation. They must also increase public awareness and education. At both the population and clinical levels, it would be expedient for attending health professionals to proactively take steps to identify clients who have an elevated risk for circumcision mishaps and mitigate the risk to prevent circumcision mishaps. Education, behaviour change communication, and follow-up would aid these. Advocacy for neonatal circumcision due to its safety profile and lower complication rates is in the right direction. It would be expedient for the demographic and practitioner-related determinants of circumcision mishaps identified in this study to be combined into public health and clinical risk stratification tools, including nomograms and digital risk calculators. These would serve as tools to help in identifying high-risk groups, for risk mitigation. Finally, the national health authorities need to foster collaborations between traditional and modern practices and strengthen referral systems for timely and appropriate care.

## Conclusion

The study provides valuable insights into circumcision practices and outcomes in the Volta Region. The consumption of circumcision services transcends age: age range was 1 week to 28 years, with a mean age of 11 months, and a standard deviation of 10 months. The overall circumcision complications rate was 17.74% (12.40% anatomical, 5.34% non-anatomical). Traditional circumcisions were associated with higher anatomical complications and platelet levels at presentation, than medical ones, reflecting procedural disparities. Based on Chi-square analysis, the demographic determinants of risk of circumcision mishaps in this study includes age of child: $\chi^2= 48.9990$, $p < 0.001$; highest educational level of parent: $\chi^2= 10.8811$, $p = 0.012$; occupation of parent: $\chi^2= 44.7225$, $p = 0.013$ and Residence: $\chi^2= 33.7421$, $p < 0.001$. Religion: $\chi^2= 5.2154$, $p= 0.448$ and ethnicity: $\chi^2= 8.3792$, $p = 0.253$ (were not statistically significant). The provider-related determinants include circumciser/practitioner´s skill or supervision level; $\chi^2=18.5119$ p-value = 0.047 and provider facility; $\chi^2= 26.04$, p= 0.001. The odds of having a circumcision complication were 42.5 times higher for traditional circumcisions compared to circumcisions by doctors (OR= 43.50, p= 0.002); and home-based circumcisions were 2.4 likely to end up in complications compared to hospital circumcisions (OR= 2.30, p= 0.116). It was safest to be circumcised as a neonate: circumcisions outside

the neonatal age were associated with up to a 2.7 times increased odds of having complications, compared to neonatal circumcisions (OR= 3.71, p =0.001). Children of parents with tertiary education had an 80 percent reduced odds of coming down with complications compared to those with parents with secondary level education (OR =0.209, p = 0.011). Rural dwelling and peri-urban were associated with a 6 to 9 times increased odds of coming down with circumcision complications compared with urban residence; (OR= 9.84, p =0.0001) and (OR= 6.56, p= 0.0001) respectively.

***What is known about this topic***

- *Circumcision is commonly practiced across Ghana by both medical professionals and traditional practitioners, with variable safety outcomes;*
- *Complications from circumcision are often linked to provider skill, patient age, and procedural setting, but data on these associations in Ghana remain limited and localized.*

***What this study adds***

- *This study identifies specific demographic and provider-related factors-such as rural residence, parental education, and non-hospital settings-that significantly increase the risk of circumcision complications;*
- *It provides robust statistical evidence supporting the potential use of these factors to develop risk-stratification tools or digital risk calculators for improving circumcision safety in resource-limited settings.*

## Competing interests

The authors declare no competing interests.

## Authors' contributions

Sylvester Appiah: study design, methodology, data collection, visualization, writing, and editing. Frank Obeng: conceptualization, study design, supervision, data curation, visualization, initial draft, writing, and editing. All authors have reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work.

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## Tables and figures

**Table 1**: frequency table for socio-demographic variables of clients and parents (n = 186)

**Table 2**: association of (provider factors) practitioner type and facility type with circumcision mishaps (CCD = 1)

**Table 3**: report on laboratory parameters (haemoglobin, platelet, and white blood cell count) versus circumciser

**Table 4**: summary of chi-square associations between circumcision complications and the studied demographic characteristics

**Table 5**: summary of odds ratios for demographic characteristics versus circumcision complication risk

**Figure 1**: conceptual framework diagram (source author´s construct, based on reviewed literature

**Figure 2**: a comparison of clinical parameters by a circumcision practitioner

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**Table 1**: frequency table for socio-demographic variables of clients and parents (n=186)

| Variable | Category | Frequency | Percent (%) |
|---|---|---|---|
| **Age in months of clients** | Up to 1 month | 53 | 28.5% |
| | 1 month to 1 year | 77 | 41.4% |
| | 2 to 4 years | 26 | 14.0% |
| | 5 to 11 years | 17 | 9.1% |
| | 12 years and above | 13 | 7.0% |
| ***Descriptive stats:* AGE** | Min: 1 week; max: 28 years; mean: 11 months, SD: 10 months | | |
| **Occupation of parents** | Healthcare and medical professionals | 28 | 15.1% |
| | Educational professionals | 34 | 18.3% |
| | Administrative and office roles | 15 | 8.1% |
| | Creative and design roles | 21 | 11.3% |
| | Service and manual labour | 88 | 47.3% |
| **Education of parents** | No formal education | 5 | 2.69% |
| | Primary education | 16 | 8.6% |
| | Secondary education | 97 | 52.15% |
| | Tertiary education | 68 | 36.56% |
| **Religion of parents** | Christians | 128 | 68.8% |
| | Muslims | 49 | 26.3% |
| | Traditionalist | 9 | 4.8% |
| **Ethnicity of parents** | Ewe | 154 | 82.8% |
| | Ga, Adangme, Krobo | 7 | 3.76% |
| | Akan | 14 | 7.53% |
| | Northern tribes (Ghana) | 5 | 2.69% |
| | Ibo (Nigerians) | 8 | 4.3% |
| **Nationality** | Ghanaian | 178 | 95.7% |
| | Nigerian | 8 | 4.3% |
| **Place of residence** | Ho and surroundings | 130 | 69.9% |
| | Adaklu and nearby | 16 | 8.6% |
| | Other towns in the Region | 40 | 21.5% |

| **Table 2:** association of provider factors practitioner type and facility type with circumcision mishaps (CCD=1) | | | | | | |
|---|---|---|---|---|---|---|
| **Provider type** | **CCD=0 (count, %)** | **CCD=1 (count, %)** | **Total (count, %)** | **Chi-square (p-value)** | **Odds ratio** | **Odds ratio p-value** |
| Doctor | 29 (96.67%) | 1 (3.33%) | 30 (16.13%) | $\chi^2$=26.04 (p=0.000) | 1.00 (Ref) | - |
| Nurse | 66 (92.96%) | 5 (7.04%) | 71 (38.17%) | | 2.20 | 0.48 |
| Midwife | 65 (86.67%) | 10 (13.33%) | 75 (40.32%) | | 4.46 | 0.16 |
| Wanzam | 4 (40.00%) | 6 (60.00%) | 10 (5.38%) | | 43.50 | 0.002 |
| Teaching hospital | 50 (90.91%) | 5 (9.09%) | 55 (29.73%) | $\chi^2$=18.51 (p=0.047) | 1.00 (Ref) | - |
| Quasi-Government Hospital | 9 (100.00%) | 0 (0.00%) | 9 (4.84%) | | 0.00 | - |
| Polyclinic | 1 (100.00%) | 0 (0.00%) | 1 (0.54%) | | 0.00 | - |
| Other polyclinics | 4 (80.00%) | 1 (20.00%) | 5 (2.69%) | | 2.50 | 0.449 |
| Private hospital | 7 (100.00%) | 0 (0.00%) | 7 (3.77%) | | 0.00 | - |
| Home circumcision | 87 (81.31%) | 20 (18.69%) | 107 (57.53%) | | 2.30 | 0.116 |

| **Table 3:** report on laboratory parameters (haemoglobin, platelet, and white blood cell count) versus circumciser | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | **N (40)** | **Mean** | **Std. deviation** | **ANOVA Sig** | **Mini-mum** | **Maximum** |
| Haemoglobin level | Doctor | 21 | 13.43 | 2.66 | 0.081 | 6.30 | 17.60 |
| | Midwife | 5 | 12.56 | 2.51 | | 9.50 | 15.50 |
| | Nurse | 7 | 12.17 | 2.12 | | 9.60 | 15.60 |
| | Wanzam | 7 | 10.18 | 3.80 | | 3.40 | 14.70 |
| Platelet count | Doctor | 21 | 265.04 | 149.74 | 0.046 | 12.80 | 694.00 |
| | Midwife | 5 | 293.20 | 44.11 | | 234.00 | 347.00 |
| | Nurse | 7 | 259.10 | 108.81 | | 20.69 | 345.00 |
| | Wanzam | 7 | 431.14 | 139.52 | | 260.00 | 607.00 |
| White blood cell | Doctor | 21 | 8.41 | 2.70 | 0.217 | 4.13 | 15.49 |
| | Midwife | 5 | 10.99 | 2.63 | | 7.69 | 14.70 |
| | Nurse | 7 | 33.02 | 63.13 | | 4.85 | 176.00 |
| | Wanzam | 7 | 14.93 | 11.98 | | 8.00 | 40.62 |
| Source: field data, 2024 | | | | | | | |

**Table 4:** summary of Chi-square associations between circumcision complications and the studied demographic characteristics

| **Factor/characteristic** | **$\chi^2$ (Chi-square statistic)** | **P-value** | **Interpretation** |
|---|---|---|---|
| Age of circumcision clients | 48.999 | 0.000 | Strong and significant association with age |
| Parental education level | 10.88 | 0.012 | Significant association between education and complication risk |
| Parental occupation | 44.72 | 0.013 | Significant association between occupation and complication risk |
| Residence (urban vs. peri-urban vs. rural) | 29.76 | < 0.0001 | Significant association between residence and complication risk |
| Ethnicity | 5.35 | 0.253 | No significant association |
| Religion | 1.60 | 0.448 | No significant association |

| **Table 5:** summary of odds ratios for demographic characteristics versus circumcision complication risk | | | | | |
|---|---|---|---|---|---|
| **Factor** | **Comparison** | **Odds ratio (OR)** | **Z-statistic** | **P-value** | **Interpretation** |
| **Age category** | **Neonates (Ref)** | — | — | — | **Reference group** |
| | Children under 5 vs. neonates | 5.229 | 3.52 | 0.001 | Significantly higher odds of complications |
| | Children over 5 vs. neonates | — | — | — | Undefined due to 0 count in CCD = 0 |
| | Adolescents vs. neonates | 8.736 | 3.71 | 0.001 | Significantly higher odds of complications |
| | Adults vs. neonates | — | — | — | Undefined due to 0 count in CCD = 1 |
| **Parental Education** | Tertiary vs. secondary | 0.209 | — | 0.011 | Significantly lower odds of complications for tertiary education |
| **Residence** | Peri-urban vs. urban | 9.84 | — | <0.0001 | Significantly higher odds of complications in peri-urban areas |
| | Rural vs. urban | 6.56 | — | <0.0001 | Significantly higher odds of complications in rural areas |
| **Ethnicity** | Akan vs. Ewe | 2.74 | 1.372 | 0.17 | Higher odds for the Akan group, but not statistically significant |
| | Northern vs. Ewe | 1.23 | 0.225 | 0.82 | Higher odds for Northern groups, but not statistically significant |
| **Religion** | Muslim vs. Christian | 1.76 | — | 0.448 | No significant difference in complication risk |
| | Traditional vs. Christian | 3.03 | — | 0.448 | No significant difference in complication risk |
| **Occupation** | Educational/research vs. health professor | 2.04 | 1.197 | 0.551 | Not statistically significant |
| | Admin/clerical vs. health Prof | 1.70 | 1.469 | 0.718 | Not statistically significant |
| | Farmer/service/artisan vs. Health professor | 4.08 | 1.062 | 0.185 | Not statistically significant |
| | Students vs. health professor | 4.25 | 1.298 | 0.265 | Not statistically significant |

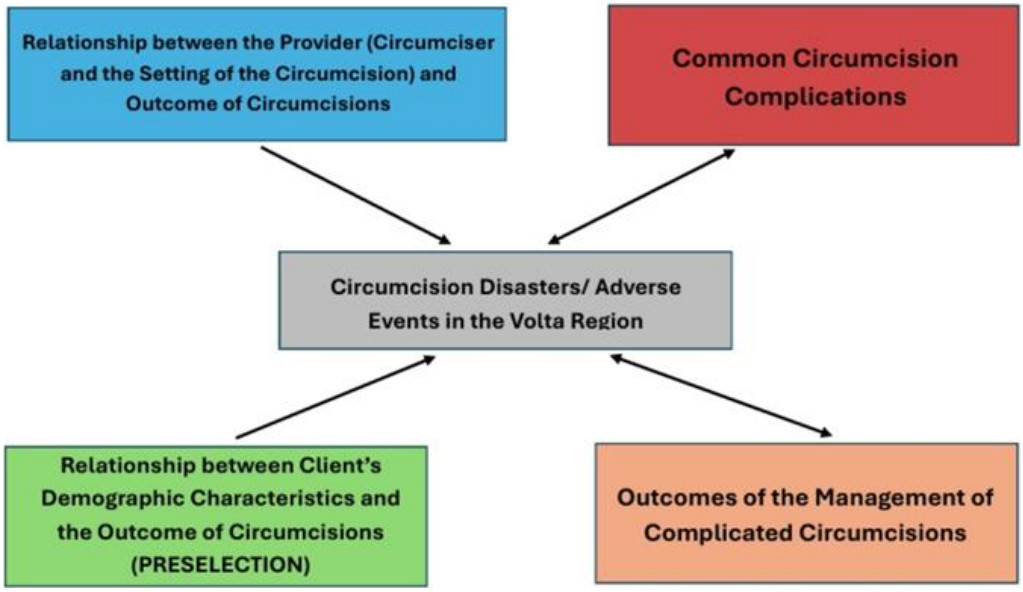


**Figure 1:** conceptual framework diagram (source author's construct, based on reviewed literature

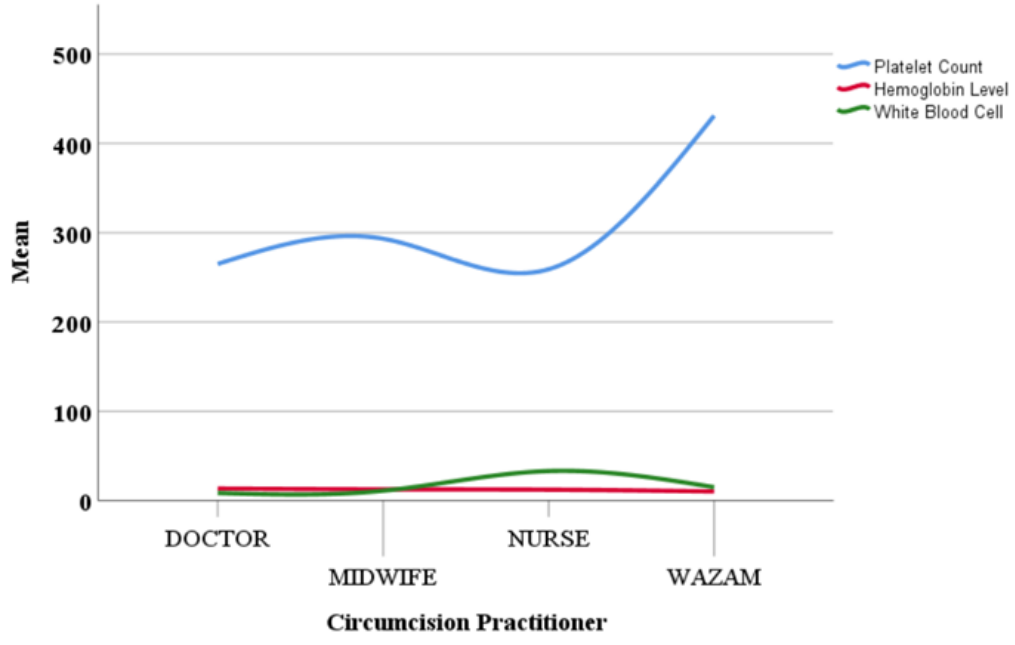


**Figure 2**: a comparison of clinical parameters by a circumcision practitioner