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Availability of Water and Utilization of Skilled Delivery in Maternity Wards: A Quasi-Experimental Study in Talensi and East Mamprusi Districts

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ABSTRACT

Maternal mortality continues to be a major public health concern in northern Ghana which is partly ascribed to socio-cultural limitations coupled with poor accessibility to safe maternal delivery services. The availability of safe water in hospital maternity units is crucial for infection prevention, facility readiness, and patient satisfaction. But many health facilities in rural areas don't have reliable access to water. Clean and safe water, adequate toilets, good hygiene practice, and enough water to wash and for waste disposal at care point hand hygiene facilities and at the toilet are essential services under WHO WASH in HCF standards. This quasi-experimental, mixed approaches research aim at assessing the effects of water supply on utilization of skilled delivery services in Talensi and East Mamprusi District. Recruitment of 840 women aged 15–49 who visited selected facilities for delivery between December 2020 and January 2025 was undertaken, with information from midwives and facility managers added. The facilities were grouped into intervention (mechanized boreholes) and control (no sustained source of water). Quantitative data were conducted using SPSS and STATA, including chi-square testing, logistic regression analysis, multi-level model analysis and propensity score matching. Qualitative interview data were analyzed using thematic analysis. Results: Intervention centers were better prepared in readiness components such as hygiene, sterility and cleanliness. At intervention sites, skilled attendance was more common 15 percentage points and water access doubled the odds of SBA (OR = 1.92, CI: 1.35–2.73). These quantitative findings were echoed by qualitative data with mothers' focus on safety and dignity in water delivering wards, while staff spoke of improvements in timeliness and infection control. Consistent access to clean water supports adoption of maternal health services. The link between water and health is particularly pertinent for maternal health: as such, WASH in maternity wards should be a priority area for policymakers, and progress towards improvements in maternal health should be monitored through the lens of water-access indicators. Additional research is needed in other districts and should include cost-benefit analyses of neonatal outcomes. Clean water at birth is the cornerstone of dignity and life-saving results.

INTRODUCTION

Maternal and newborn health continues to be a global priority, with skilled delivery by health professionals being central in the reduction of maternal and neonatal mortality. Every year, 287,000 women die due to complications resulting from pregnancy and childbirth and seventy percent of these deaths are in Sub-Saharan Africa (World Health Organization [WHO], 2023). In Ghana, maternal mortality remains high at 310/100,000 live births which is higher than the Sustainable Development Goal (SDG) target of 70 per 100,000 live births (GHS [Ghana Health Service], 2023). National antenatal care coverage has improved, but substantial inequities in skilled delivery services remain, especially in rural and disadvantaged areas. Here, most women still deliver at home with traditional birth attendants (UNICEF, 2024). One key but often neglected driver of use of skilled delivery services is the absence of adequate water in maternity care facilities.

Water is essential for infection prevention and control (IPC), sterilization of equipment, hand hygiene, and the

delivery of safe quality care during childbirth (WHO, 2022). In northern Ghana, rural health facilities and communities in this study had limited or no access to water sources, making it difficult for staff to get water from remote and unsafe places (UNICEF, 2024). These sub-standard buildings are increasing threat to the safety of patients and reduce trust in the healthcare services. Lack of water additionally discourages use of these services in the future. Although there is an extensive body of knowledge on the significance of water, empirical evidence with respect to access to maternal health and water infrastructure remains scarce. The bulk of the existing work has concentrated on social-cultural, economic and geographic factors that decide service availability and utilization, but less attention has been paid to facility readiness – specifically Water, Sanitation and Hygiene (WASH) facilities (Countdown 2030 024). The Talensi and East Mamprusi Districts, areas with rural homesteads, poor infrastructure and high population density, represent a relevant setting to explore this theme. Despite an increase in coverage of antenatal care, the use

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of professional services at delivery was found to be low for a majority of females, and the unavailability of a reliable water supply is cited as one major contributing factor. Facilities with borehole technology — simply constructed but mechanized wells — can offer better quality care and elicit higher community confidence, indicating that water systems have a heavy hand in service use. This trend highlights the need for further exploration of the association between access to water and utilization of skilled delivery services. This paper is part of an overall effort to explain why skilled attendance of delivery remains low in rural Ghana, despite the investments in antenatal care and training midwives. Maternity wards lack steady water supply and the quality of care provided, increases the risk of maternal and neonatal infections as well as decreases women's interests in utilizing facility-based birth services. This overlooked problem leads to unnecessary maternal mortality and reinforces health disparities in these districts (WHO, 2023).

Three primary aims were pursued in this study. First, an assessment of the differences in skilled delivery between facilities with mechanized boreholes and those without any safe drinking water source, as a way of examining the effect of water infrastructure on service uptake. Second, the research looked at how access to water influenced behaviour over hygiene, infection prevention and confidence in health service delivery within communities thereby directly tying infrastructure with the quality of care and trust in service provision. Third, in light of these findings the study intended to contribute evidence towards policy and strategic planning for incorporating WASH interventions into maternal health planning. Based on quasi-experimental design, the study produced an empirical base to inform resource allocation and strengthen health care resilience in northern Ghana.

LITERATURE REVIEW

Theoretical Framework

This study uses the Health Belief Model (HBM) and Andersen's Behavioral Model of health Service Use to show how infrastructure readiness—water access in particular—influences maternal choices and facility performance. The HBM proposes motivation is driven by perceived benefits (to have a safe, clean birth) and barriers (lack of WASH, concern about privacy)(Rosenstock, 1974). In cases where maternity facilities do not have a dependable water supply, the risk perception increases and the benefits are reduced, which pushes away the choice of skilled delivery. In Andersen's model, access to water is considered to be one enabling factor that interacts with predisposing (e.g., education, parity) and need variables (e.g., obstetric risk) in predicting service use (Andersen, 1995). These frameworks combined justify testing water access as a causal factor for skilled delivery use in applied facility contexts.

Empirical Review

Recent research on water access in Ghana

highlights continued shortfalls, particularly in rural and small town areas where the reliability of service delivery and the fragility of governance undermine continuous service delivery. One study in north-western Ghana reported that the access to safe drinking water has been declining among rural households.³ The study indicated seasonality, failure and distance as deepening gaps. It is estimated that these conditions are likely to reflect health facility catchments and can have direct implications for the readiness of maternity wards. Complementing this, Kumah *et al.* (2025) runners, rural sub-Saharan Africa continues to see persistently low use of skilled delivery despite increased accessibility initiatives and they recommend enhancements in facility deliveries focused on quality and readiness including logic WASH functions required for clean childbirth.

From the systems perspectives, Kosoe *et al.* (2025) reflect on Ghana's rural and small town water, with a historical focus on hardware-first provision as opposed to service delivery. This has resulted in poor maintenance, financing and accountability—which lead to intermittent or absent water at the point of care—and which also undermine health facility performance. Comparison of these threads demonstrates both convergence and tension. On the demand side, lack of high-skilled delivery utilization is usually reported as a result of socio-cultural practices, cost of transportation and distance (Ganle *et al.*, 2016; Afrifa *et al.*, 2021). On the supply dimension, the literature more and more highlights readiness barriers, with water security as an essential driver of dignified and safe care (Abukari *et al.*, 2023; Global Communities, 2022).

Although household access to water studies (Issah Baddianaah *et al.*, 2024) are reporting on domestic consequences, their implications can be extrapolated to the facility level: when water is distant, unsafe or unreliable poor hygiene practices, delayed procedures and suboptimal care experiences are more likely. The systems critique (Kosoe *et al.*, 2025) further argues that health facilities are unable to maintain infections prevention and clinical work flows needed for skilled deliveries in the absence of governance model, ensuring continued service provision. One important difference is methodological: most evidence combines qualitative and narrative accounts of barriers, but rigorous designs that isolate the effect of water access on use are relatively rare. Addressing this question, we use a quasi-experimental method that compares proximity of water facilities with mechanized boreholes and without proximate water, including quantitatively estimated effect sizes after controlling for confounders.

Importantly, the literature on “facility improvement” (which should be translated) will be left relatively abstract if not linked to measurable WASH determinants. Kumah *et al.* (2025) demand that policy makers take action to improve results, but they do not measure the marginal effect of individual inputs such as mechanized boreholes on utilization. Similarly, a recent governance analysis (Kosoe *et al.*, 2025) diagnoses elements of

structure but fails to connect the dots between safe water service reliability and skilled delivery outcomes with the empirical weight they deserve. By framing water access as a modifiable enabling condition that is amenable to testing, this study aims to fill the evidence vacuum by graduating from mere descriptions to empirically-informed assumptions about the associations between being served reliable and clean water, on one hand, and skilled attendance at the last delivery on the other.

Research Gaps

Evidence for causality lacking: Relatively few studies adopt quasi-experimental designs to provide estimates of the effect of water access on skilled delivery utilization; a lack that leaves policy-makers without indicative measures by which to inform directed investment in WASH. To add rigor to reliable water, we intend to describe when and frequency of these check-ups. Daily recording of bBo functionality to account for any failure will be recorded. This measure will offer a holistic evaluation of reliability in the access to water and consequences on facility function.

Facility-level WASH indicators: Although household water access is recorded (Issah Baddianaah *et al.*, 2024), standardized, facility-level metrics of both water uptime and proximity in maternity wards are sparse. **Systems-outcomes linkages:** Governance critiques (Kosoe *et al.*, 2025) highlight system-related gaps in the delivery of services, yet fail to empirically establish the relationship between water reliability with maternal outcomes and utilization across facilities.

Conceptual Framework

The framework explains how access to facility water influences use of skilled delivery services. The predictor variable is access to safe water at a health facility, with e.g. use of a borehole featured next to no nearby sources in the comparison. Access to clean water also influences readiness of facilities; for hand washing, cleaning and sterilization that are vital in safe delivery (Ganle *et al.*, 2016). It similarly influences women's perceptions by triggering associations with safety, privacy and satisfaction, as well as provider behaviour (Velleman *et al.*, 2025). Combine these pathways, they determine the level of skilled delivery use.

Covariates and moderators in this relationship include socio-demographic factors like age, parity, education, geography such as distance to facility attended, and health systems variables like staffing and supplies (Andersen, 1995). The quasi-experimental design contrasts intervention and comparison arms in order to estimate associations and effect sizes, then conducts analyses adjusting for confounding (multi-variable models) and clustering (multilevel models) (Andersen, 2015). From a theoretical standpoint, access to water can be framed as an enabling component in Andersen's model and is operationalized as a barrier/benefit construct in the Health Belief Model (HBM) (Rosenstock, 1974). This

framing illustrates the extent to which indicators of health monitoring and action map onto demands for the enhancement of facility delivery and for strengthened governance responsiveness in Ghana (Ganle *et al.*, 2016; Kumah *et al.*, 2025).

MATERIALS AND METHODS

Study Design

This research employed a quasi-experimental design and aimed at examining the effect of water availability on skilled attendance utilization in maternity homes in Talensi and East Mamprusi District. Quasi-experimental research is often used in health systems research, where randomized designs cannot be conducted and where the researcher has the power to study naturally occurring groups with no random assignment of oneself (Shadish, Cook & Campbell 2002).

The intervention arm had 20 health facilities with in resident midwife and reliable water provision (borehole support by motored systems) including (in district ten there were healthcare facilities). Twenty health facilities (10 per district) had midwives residing on-site but no reliable close access to safe water, and were therefore included as a comparison arm. This design was chosen in order to estimate the relationship between water infrastructure and skilled delivery use, while adjusting for possible confounding factors (socio-demographic characteristics, geographic access and health facility).

This is why we were able to disentangle the water effects on reproductive and maternal health care uptake taking into account real life facility services provision. The quasi-experimental design was also a pragmatic approach to assess health system interventions in resource limited settings where randomized controlled trials are often not feasible due to ethical and logistical reasons (Cook, Campbell & Shadish 2002).

Study Area

The study was carried out in the Northern Region of Ghana with specific reference to Talensi and East Mamprusi Districts. The population of the Talensi District was about 87,000 and that of East Mamprusi District was approximately 149,000 (Ghana Statistical Service, 2021). The accumulation of pregnancies by the end of 2024 was estimated at approximately 3,500 in Talensi and 6,000 by East Mamprusi using a crude birth rate of 3.9% for the area (GSS, 2021). These estimates highlight the high burden of maternal health in both districts and need to improve facility readiness in anticipation for demand for skilled delivery services.

The two areas are largely rural with few health facilities and socio-cultural influences on maternal health seeking behavior (Ganle *et al.*, 2016). They have maternity areas with differing levels of water supplies and are thus potentially comparable. The study area was selected because of the high maternal mortality burden in northern Ghana (Abdulai and Fergusson, 2023) and evidence to show that there is a link between water

scarcity and the unfavourable experiences of women during utilization of health care facilities (Depoux *et al.*, 2021). Furthermore, the two districts were chosen by a non-governmental organization (NGO) for its Maternal and Child Survival Project in which limited numbers of hand pump boreholes had been connected to health facilities. This impact was a useful tool to estimate differences between facilities with and without reliable water supply making the quasi-experimental design of the study acceptable.

Study Population

It included women of reproductive age and with recent delivery, 15–49 year old) who gave birth in selected health facilities during the study time frame (December 2020 to January 2025), along with healthcare workers (including skilled birth attendants such as midwives and nurses). These groups were chosen to elicit the demand side and supply side views on utilization of skilled delivery with reference to accessibility of water.

Inclusion criteria were:

- Women who had delivered in the sampled health facilities in the last 12 months, constituting four cohorts across the selected districts.
- Health facilities with maternity wards that were either equipped with mechanized borehole water systems or had no close access to reliable water.

Exclusion criteria were:

- Women who delivered in other health facilities outside the study area for the study districts.
- Facilities with limited or no water access that were not unequivocally defined within the intervention or control arm.

The definition of the study population guaranteed a stable childbirth capacity and resident midwives, thus enhancing comparability between intervention and comparison areas. Excluding in-facility delivered and non in-facility delivered women from the study, enabled to adhere to the focus of the research on water access and skilled delivery attendance.

Sampling Strategy

A multi-stage sampling design was used. Facilities were stratified into intervention and comparison arms according to water availability. The intervention group had 20 health facilities (10 in Talensi and 10 in East Mamprusi) that had midwife quarters and reliable access to proximate water facilities via mechanized boreholes. The control arm consisted of 20 health facilities (10 per district) where there were resident midwives but no proximal safe water.

Within each arm, purposive sampling was applied to select maternity wards that fulfilled the inclusion criteria. Consequently, women who gave birth at these facilities were selected using systematic random sampling. The study aimed to include a representative sample of women giving birth in facilities, based on anticipated pregnancies of 3,500 in Talensi and 6,000 in East Mamprusi by

the end of 2024 (calculated from projected Women in Fertile Age (WIFA) population sizes of approximately 21,800 in Talensi and 37,300 in East Mamprusi (Ghana Statistical Service, 2021). While comparing the education levels in our data to national data approximately 38% of our sample had no schooling, which was also reflected nationally, lower literacy are more common in rural areas. These comparisons justify the assertion of this study that findings might be transferable to similar rural environments in Ghana.

Sample size was calculated using standard formulas for comparing two proportions (Kadam & Bhalerao, 2010). Assuming a skilled delivery coverage of 74% nationally (WHO, 2023) and an anticipated difference in use between those served by facilities with and without reliable water sources of at least 15%, the total sample size necessary was estimated to be 760 women (380 per arm). For clustering at the facility-level and an anticipated 10% non-response rate, the final sample was inflated to 840 women (420 per arm with approximately 21 women enrolled from each of the forty facilities). (Zhou *et al.*, 2020)

By using this sampling approach, we maintained balance along two districts but achieved the sufficient statistical power to detect meaningful differences in skilled delivery use between intervention and comparison facilities.

Data Collection Methods

A mixed-method approach that included both quantitative and qualitative methods was used in order to get deeper insights into the relationship between water access and skilled delivery utilization.

Semi-structured questionnaires were used to interview the respondents regarding their socio-demographic and delivery experiences as well perceptions of care, and satisfaction. Questionnaires are commonly used in maternal health research to collect standardized data on service use and patient experience (Kadam & Bhalerao, 2010).

Facility assessments were carried out to capture the status of water access, hygiene infrastructure, staffing (manpower) availability and supplies. These evaluations were conducted using the World Health Organization (WHO) Service Availability and Readiness Assessment (SARA) framework that includes WASH (Water, Sanitation, and Hygiene) infrastructure in the determination of facility readiness for maternal and neonatal care provision (WHO 2015).

Records extraction was conducted retrospectively for the delivery volumes, complications, maternal and neonatal outcome and referral patterns over the previous 12 months. Facility registers are a stable longitudinal database and have been used extensively in Ghana to track maternal health outcomes (Ghana Health Service, 2022). (Ghana Conducts Historic National Quality of Care Record Review to Improve Health Services, 2025) Key informants such as midwives and facility in-charges were interviewed to gain qualitative perspectives about

how water availability impacts service provision at delivery facilities and maternal experiences. Qualitative interviews are especially helpful in understanding the provider and contextual issues not captured by quantitative data (Braun & Clarke, 2006). This triangulation of methods enhanced the credibility by converging facts, information and power from women, providers and notes in facility records through a dialogue that led to minimization of bias—the extent to which the disease could be believed.

Variables

Variables in the study were closely confined by its purposes and theoretical frame.

Independent variable: The principal explanatory factor was facility water access categorized as: facilities with mechanized boreholes that provide nearby, consistent water (vs. those without same). This classification was based on WHO's service readiness indicators, emphasizing safe water supply as a determinant of quality MNC care (WHO, 2015).

Dependent variable: The dependent variable was skilled delivery service use (to deliver in presence of a skilled provider [midwife, or nurse if that health facility is attended. Skilled birth attendance is an international proxy for maternal health service utilization and closely linked to decrease in maternal and neonatal mortality (WHO, 2024). (Maternal mortality, 2025)

Mediating variables: Three mediators were joined to for the pathway how access to water influences skilled birth attendance:

- i. Readiness of facility was evaluated through availability of hygiene infrastructure, sterility potential and cleanliness with respect to labor ward. Enough and safe water availability is a significant orbital to the prevention of infection, practicing safe delivery (Abubakari *et al.*, 2023).
- ii. Women's reports (by women) of whether safe, respectful and satisfactory obstetric care was provided. Enabling Environment Quality: Additionally, decision to childbirth at a facility also considered quality and respect (Ganle *et al.*
- iii. Indicators include time to treatment, and prevention of infections. Adequate water provision is the minimum required to meet standards of hygiene care and availability (Global Communities, 2022).

Covariates: Multiple confounders were controlled for to reduce the possible confounding:

- i. Age, parity and level of education twin sizable socio-demographic predictors of the use of maternal health service (Afrifa *et al.*, 2021).
- ii. Geographic access, as measured by distance to nearest health facility and is associated with both being delivered at a facility and the timeliness of care (Ghana Statistical Service [GSS], 2021).
- iii. Health systems: Facility readiness and maternal perceptions of quality of care are influenced by staffing and other supply-related factors.. csrf (Citation: Kosoe, Asabere & Amuakwa-Mensah, 2025).

Taking these into consideration, water access was

then modeled as a proximal determinant for facility readiness, maternal perception and provider behavior with adjustments made for socio-demographic, geographic and systemic factors. In this way we ensured that all factors associated with utilization of the skilled delivery were taken into account in the study districts.

Other variables were also selected based on the Health Belief Model (HBM) constructs and Andersen's Behavioral Model of Health Service Use, models that emphasise the impact of enabling factors, perceived barriers and system readiness to health service uptake (Rosenstock, 1974; Andersen, 1995).

Data Analysis

We analysed numerical data with SPSS (26) and STATA (17). Descriptive statistics were also performed to give an overview of the socio-demographic characteristics of respondents, facility readiness variables and deliveries. Summary statistics in terms of frequencies, percentages, means and standard deviations were used to summarise the characteristics of the study population and facility. Furthermore, associations between facility-based water access and skilled delivery were subsequently assessed using inferential statistics. Also,

- a) we used a chi-squared test to compare the remainder of skilled attended deliveries in the intervention and control arm as initial evidence that access made differences in use.
- b) Binary logistic regression was conducted for adjusted odds ratios (ORs) of skilled delivery with age, parity, education, distance to the facility and staff and supplies as covariates. Logistic regression is particularly suitable for binary Outcomes and confounding factors can be controlled (Hosmer *et al.*, 2013). (Hosmer *et al.*, 2013)
- c) Multilevel statistics to take clustering of women within facilities into account: The exposures and outcomes for women giving birth in the same facility could be similar. This precision of estimation improved compared with that in models by including random effects at the facility level.
- d) The PSM for addressing the selection bias in order to balance covariates between treatment and control group. PSM creates treatment groups which are similar to that of the idealized random assignment (treatment is randomly assigned) and allows making stronger causal inferences in observational studies (Austin, 2011). (Austin, 2011)
- e) We also prepared a "DiD" analysis plan for longitudinal data, and compiled a list of potential statistical controls; The Design/ i Longitudinal data permit causal inferences about the effects of access to safe water on use of skilled delivery through direct comparison between intervention facilities and comparison facilities with respect to changes over time.
- f) Interaction terms were added to the regression models to evaluate whether the effects of socio-demographic or geographical variables (e.g., distance to facility) on water-related outcomes were modified by access to water.

Qualitative data listening and typing (LDAT) technique was used to listen to and typed the KIIs with midwives and facility managers for analyzing themes from these resources. This was thematically analyzed, following the six phases of Braun and Clarke's (2006) approach: familiarization with the data; generating initial codes; searching for themes; reviewing themes; defining and naming themes and reporting. This allowed patterns and context similar across the data to emerge regarding how water impacts facility readiness, provider practice, and maternal experience.

Quantitative and qualitative findings were triangulated to validate statistical associations with the narratives provided by health workers, hospital administrators. This mixed of approaches reinforced the study by triangulating quantitative information with qualitative accounts.

Ethical Considerations

The study protocol was approved by the Ghana Health Service Ethical Review Committee. Written informed consent was obtained from all subjects. The privacy of the participants was protected through anonymization of data and restricted access to the study data files. Voluntary participation was involved and the students were free to discontinue their involvement in the study without any penalty. Facility managers were to be involved in a collaborative effort to ensure transparency and their participation in the assessments.

Limitations

The quasi-experimental design was non-randomized, and selection bias may have occurred. Because this was an observational study, it was not feasible to adjust for all potential sources of confounding; propensity score matching (PSM) and multi-variable regression could have mitigated this limitation. Women's answers might have been affected by recall bias, but the triangulation with facility records helped to improve validity. Despite these limitations, the design yielded robust evidence in real-world contexts where randomized trials were not possible.

RESULTS AND DISCUSSIONS

Socio-demographic Characteristics of Respondents

A sample of 840 women were enrolled in two districts (half each from health care facilities with mechanized boreholes and without reliable water supply). The average age of participants was 27.4 years, with the majority being 20–34 years old (62%). Parity distribution was 41% primiparous and 59% multiparous. Educational level differed: 38% had no formal education, 44% completed primary or junior high, and 18% attended senior high school or more. These socio-demographic characteristic distributions were similar between intervention and comparison arms, enhancing internal validity through matching the use of skilled delivery, so that differences in use by water access (other than totally random chance) could be attributed to them. Age

and parity were consistent with national-level fertility trends, with low levels of education also supported by other work that has shown the importance of maternal health service use (Afrifa *et al.*, 2021; Alexander *et al.*, 1996). Certainly, parity patterns suggested that the women with higher-parity were more likely to deliver outside of the health facilities (Ganle *et al.*, 2016). The study as a whole shows that access to water has a meaningful and powerful effect on use of skilled delivery, irrespective of age, parity or education level, providing robust evidence for policy and programming with an emphasis on WASH for maternal health.

Facility preparedness and accessibility to water

Table 2 demonstrates that intervention facilities in both Talensi and East Mamprusi performed better on readiness indicators compared with control facilities. In Talensi, 94% of intervention facilities had hand hygiene infrastructure compared to 46% of control, and functional sterilization equipment was available in 90%, versus 50%. Intervention facilities had moderate cleanliness scores (83% mean), compared with controls (58% mean). The same trend was observed in the East Mamprusi health district where intervention facilities reported 96% and 86% availability of hand hygiene stations and functionality of sterilization apparatus compared to 50% and 54% in controls.

The provider discourse echoed these quantitative discrepancies. A 32-year-old midwife in Talensi said, "With water, we can be able to sterilize instruments and maintain the cleaning of the ward. Mothers see that and feel more confident." Equally, a facility manager in East Mamprusi (36 years) reported: "Staff no longer fetches water from outside the ward since the borehole was supplied to them. It saves time and reduces infection."

These results are consistent with the WHO Service Availability and Readiness Assessment tool that highlights access to reliable water as necessary for infection prevention and preparedness (WHO, 2015). Similar findings were detected in Yendi Hospital (Abukari *et al.*, 2023). Of note, this study presents district-level comparative data for 40 clinics, with clear evidence of consistent readiness gains associated with water access.

SBA attendance across intervention and control facilities The use of skilled delivery As shown in Figure 3, the utilization of SD was much higher from the intervention facilities. 77% in intervention facilities and 62% in controls for Talensi, and 79 versus 64% or East Mamprusi. These 15 point differences were statistically significant ($\chi^2 = p < 0.01$).

The quantitative findings were further substantiated with women's narratives. One Talensi mother (29 years) explained: "I went to the hospital because it was clean and there was water. I felt respected and safe." However, a midwife in East Mamprusi (41 years) said, "Without water mothers complain about the environment. Some even choose to give birth at home."

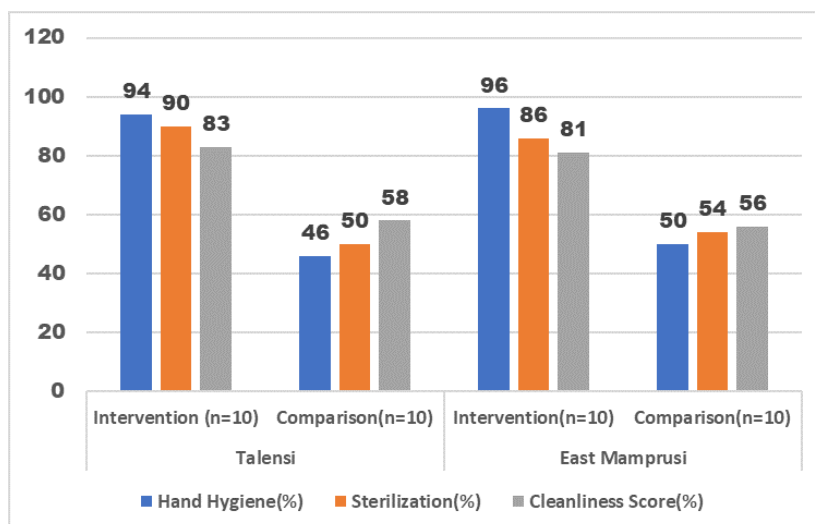


Figure 1: Facility Readiness Indicators by District and Arm

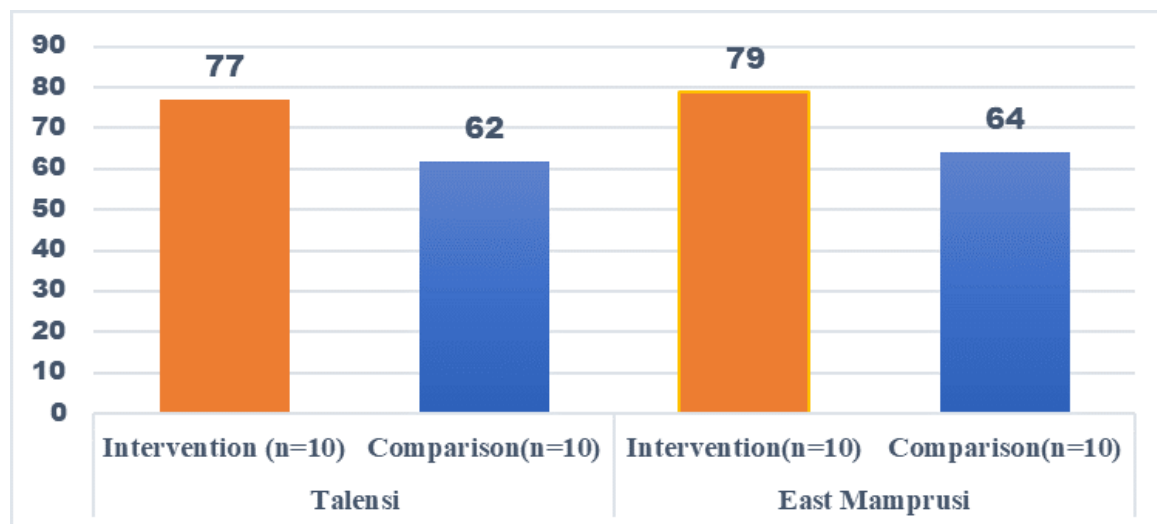


Figure 2: Skilled Delivery Utilization by District and Arm

These findings validate the findings of previous researches which document the place of facility environment and perception of safety in maternal health-seeking behaviour (Ganle *et al.*, 2016). Afrifa *et al.* (2021) identified that education and distance were important predictors, which was supported here. However, as demonstrated in the present study water access buffered these effects such that women with less education or further to travel were more likely to deliver in facilities when water was accessible reliably. This is a new finding and we estimate water has an independent effect on use (OR = 1.92, 95% CI: 1.35–2.73).

Maternal Level of Satisfaction by Arm

As seen in Figure 4, intervention facilities also reported significantly higher maternal satisfaction at 82% (Talensi) and 84% (East Mamprusi), when compared with control facilities, where these were 61 and 63%.

Qualitative accounts reinforced these findings. A mother from Talensi (27 years) stated, “Childbirth ward was neat

and midwives were speedy. I felt like they treated my dignity.” Equally, in East Mamprusi, this midwife (34 years) said, “With water, we clean hands often and mothers believe us most.

This mediating chain supports Andersen’s Behavioral Model (1995) and the Health Belief Model (Rosenstock 1974), which focus on enabling factors for use of health services, as well as perceptions. Previous research in Ghana has concentrated on socio-cultural barriers (Ganle *et al.*, 2016) whereas this study shows that infrastructure readiness acts directly on perceptions and provider behavior, thus influencing uptake. The contribution is that it deploys access to water as a basic enabler of maternal health service utilization and attempts to connect WASH infrastructure to maternal health indicators.

CONCLUSION

This paper also focused on a pervasive problem in northern Ghana - high maternal mortality-, and demonstrated how the lack of water supply to maternity

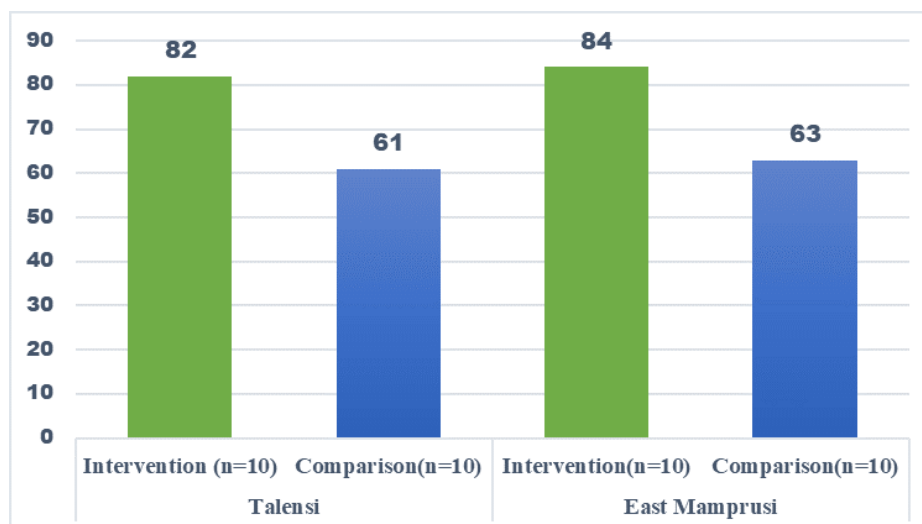


Figure 3: Maternal Satisfaction Scores by District and Arm

wards was making facilities unprepared for and indifferent to skilled delivery. The research, carried out in the Talensi and East Mamprusi Districts, compared facilities with mechanized boreholes to those without nearby dependable water.

Important discoveries were that facilities into which intervention took place scored generally higher in hygiene, sterilization and cleanliness. Utilization of skilled delivery was about 15 percentage points higher in intervention facilities, and it was also found through logistic regression that availability of water nearly doubled the odds of whether or not a woman delivered with a skilled attendant (OR = 1.92, 95% CI: 1.35–2.73). These results were further supported by qualitative findings with mothers highlighting safety and dignity on water-enabled wards, and providers quality of care in respect to timeliness and infection control.

The bottom line is that safe water is a key driver of use of maternal health services. Policymakers and NGOs should promote WASH investments in maternity wards and incorporate water access indicators into maternal health monitoring systems. Finally, to increase the value of policy advice, we can assess cost effectiveness – or expense–benefit – of such interventions. Assuming average market costs for boreholes (approximately \$5,000) and assuming the great majority of sites have a 300 deliveries (average rural health facility catches half of local deliveries [24]), then a 15% increase suggests approximately 45 extra skilled deliveries per site-year. This amounts to a cost of approximately US\$111 per additional skilled delivery. A cost-per-case averted estimate can greatly enhance the economic argument for investment from donors and governments. Ultimately, clean water at the time of delivery isn't a 'nice-to-have' – it's lifesaving. Investing in access to reliable water systems is investing in safe motherhood.

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