

Associations of Cholera Outbreaks on Adolescent Sexual and Reproductive Health Indicators in Zambia and Uganda: Evidence from Demographic and Health Surveys

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Abstract

Background: Adolescents and young people (AYP) in sub-Saharan Africa face poor sexual and reproductive health (SRH) outcomes, which may be exacerbated during public health crises. We examined the association between cholera outbreaks and adolescent sexual and reproductive health (ASRH) outcomes across two countries which experienced recent cholera outbreaks (within the past 10 years) and have at least two DHS surveys.

Methods: We analysed Demographic and Health Survey (DHS) data on AYP aged 15–24 years, from Zambia (2013–2018; N=22,936) and Uganda (2011–2016; N=14,801), combined with sub-national cholera outbreak indicator data. Multilevel logistic regression was used to assess the associations between age, sex, education, urban residence, and parity (excluded for adolescent motherhood outcome and early sexual debut) with ASRH outcomes: early sexual debut, sex with multiple partners, condomless sex, early marriage, and adolescent motherhood. A Difference-in-Differences (DID) framework within a multilevel logistic regression was employed to evaluate the effect of cholera outbreaks, controlling for all possible confounders.

Results: In both countries, results from the no-interaction models show that older adolescents were more likely to report condomless sex and having sex with multiple partners. Female adolescents and urban dwellers were more likely to report condomless sex and early marriage. AYP with low educational attainment and those who already had children were at substantially higher odds of all outcomes except for having sex with multiple partners, and the results were similar for both countries. Exposure to a cholera outbreak was associated with higher odds of adolescent motherhood in Zambia (aOR=1.13; $p<0.01$), while in Uganda, exposure to cholera was associated with higher odds of condomless sex (aOR=1.64; $p<0.01$), early sexual debut (aOR=1.38; $p<0.05$), and adolescent motherhood (aOR=1.83; $p<0.05$).

Conclusions: Adolescent SRH behaviours are strongly influenced by demographic, structural and contextual factors. Public health crises, particularly in contexts with weaker service continuity, can exacerbate vulnerabilities. Ensuring continued access to adolescent-focused SRH services during outbreaks is critical to mitigate long-term adverse outcomes.

Introduction

Cholera remains a significant public health challenge in sub-Saharan Africa (SSA), with an estimated 140,000 suspected cases annually, and a particularly high burden in East and Southern Africa [1–3]. Cholera, a severe diarrheal disease caused by consuming food or water contaminated with *Vibrio Cholerae*, can be fatal within hours if not treated. In Sub-Saharan Africa alone, about 692 outbreaks were recorded between 2000 and 2019, with a median case fatality risk of up to 1.6% [4]. Despite being preventable, the persistence of outbreaks reflects structural deficiencies in health systems, including in the water, sanitation, and hygiene infrastructure, and limited surveillance capacity [3, 5, 6]. Many African countries continue to rely on model-based estimates rather than comprehensive surveillance data, constraining timely detection and control [7, 8]. Lessons from cholera outbreaks in Zimbabwe, Zambia and South Sudan, among others, show that cholera not only generates immediate health crises but also produces cascading socioeconomic and behavioural effects [9, 10]. While epidemiological research has primarily focused on transmission and case management, less attention has been given to the broader social dimensions of outbreaks. This is particularly evident in relation to the influence of cholera outbreaks on sexual and reproductive health (SRH) among adolescents and young people (AYP), who already face intersecting vulnerabilities linked to gender inequality, poverty, and high HIV prevalence and poor SRH outcomes [11–13].

The potential intersection between cholera outbreaks and SRH is an underexplored but critical dimension of epidemic impact on adolescents and young people in Sub-Saharan Africa [14]. Localised mitigation measures—such as restricted movement, school and market closures, forced displacement, and limits on public gatherings—though essential for infection control, may exacerbate existing socioeconomic vulnerabilities [7, 11, 12, 15]. As illustrated in Fig. 1, these disruptions can trigger a chain of indirect effects through economic distress, school closures, reduced mobility, and restricted access to contraception, all of which lead to poor sexual and reproductive health outcomes [14]. For AYP, such pressures could lead to transactional sex, early sexual debut, early marriage or motherhood, or relationships with older partners, frequently accompanied by condomless sex [14, 16]. The erosion of protective environments due to school and community closures further undermines access to SRH information and youth-friendly services, amplifying vulnerability [17, 18].

These interconnected pathways point to overlapping health and social vulnerabilities linking cholera outbreaks and SRH outcomes; however, this relationship remains poorly understood due to limited empirical evidence [19]. SRH outcomes are mediated by broader social determinants, including gender norms, economic precarity, and community-level stigma, which shape AYP's ability to exercise agency in sexual relationships [20]. Consequently, cholera outbreaks can exacerbate existing inequities while intensifying adolescent and unintended pregnancy [14, 21] and maternal mortality [22].

This study aims to investigate the association between cholera outbreaks and SRH outcomes among adolescents and young people in Uganda and Zambia. By drawing on the pathways conceptualised in Fig. 1, the study aims to advance understanding of how epidemic control measures may generate unintended SRH consequences. Addressing this gap is critical for informing age-responsive epidemic preparedness and response strategies that safeguard adolescent and young people's sexual and reproductive health while strengthening broader public health preparedness and response.

Source

Compiled by the authors based on published reports from Save the Children, News24, ReliefWeb, and UNICEF.

Methods

Study Design and Population

This study employed a repeated cross-sectional design to investigate the impact of provincial-level cholera outbreaks on individual sexual and reproductive health outcomes among adolescents and young people (AYP) aged 15–24 years. The analysis employed a quasi-longitudinal approach, combining pre- and post-outbreak survey data over five years (approximately 2.5 years before and after the outbreak). This period was structured around the timing of the provincial-level cholera outbreaks, enabling a robust comparison of pre- and post-exposure events. Specifically, we compare outcomes measured by Demographic and Health Surveys (DHS) conducted before the outbreak against those measured by DHS surveys conducted after the outbreak, while controlling for individual characteristics and regional fixed effects. The study focused on two countries in Eastern and Southern Africa (Zambia and Uganda) that experienced cholera outbreaks during this period, as highlighted in the regional map. Table 1 shows a structured synthesis of the outbreak context for Uganda and Zambia. It outlines the epidemiological patterns, risk drivers and targeted response actions implemented by the respective governments during the outbreak periods. The two countries were selected for inclusion based on their documented history of major cholera outbreaks in the past 10 to 15 years and the availability of DHS data, which could be temporally linked to outbreaks.

Data Sources

To construct the necessary individual-level outcomes and regional-level exposure measures, data were compiled from two sources:

Individual-level data (Outcomes and Covariates)

For each country, individual-level outcomes and covariates were drawn from the nationally representative DHS datasets collected before and after cholera outbreaks. These surveys provide nationally representative data on population health and demographics, allowing for standardised measurement across the pre- and post-outbreak periods. The outcomes of interest included condomless sex, early sexual debut, multiple sexual partners, early marriage, and adolescent motherhood. The study population was restricted to Adolescents and Young People (AYP) aged 15–24 years who participated in the DHS surveys conducted during the five-year observation window. Countries were selected based on the availability of district- or subnational-level cholera outbreak data and two consecutive DHS rounds conducted within a five-year interval, allowing identification of one pre-outbreak and one post-outbreak survey. Based on these criteria, the study included Zambia (2013 and 2018 DHS) and Uganda (2011 and 2016 DHS).

Exposure data (Cholera Outbreaks): The timing and location of the cholera outbreaks were established using external administrative reports and academic publications [23–25], including documents published by the World Health Organisation (WHO) [26] and relevant national public health bodies [27]. This information enabled the creation of a regional-level (province) binary indicator coded as 1 if there was a cholera outbreak (at least one cholera case reported) during the critical intervention period between the two DHS surveys and 0 otherwise.

Table 1

Key characteristics, risk factors, and localised response measures in the Uganda (2012) and Zambia (2017) cholera outbreaks.

Country (outbreak year)	Characteristics	Key risk factors	Localised measures implemented (in addition to the broader Water, Sanitation, and Hygiene (WASH) programs).
Uganda (2012)	• Cholera has been recurrent since 2011. • 11,030 confirmed cases between 2011–2016, largest spike in 2012 with 6,226 cases. • 37 of 112 districts were affected, and 22 of the 37 districts were hotspots. • Outbreaks cluster along international borders (DRC, Kenya) and around internationally shared lakes and the Nile River. • Seasonality varies by region. • Hotspots experience repeated outbreaks across years. • Fishing communities or villages, as well as border trading hubs, are most affected. • 2 + years in length [23].	• Proximity to lakes/rivers and/or international borders (sustained cross-border transmission). • High incidence in neighbouring districts • Heavy rainfall	• Rapid case identification, surveillance, treatment, and isolation of suspected/confirmed cholera patients. • Restrictions on food vendors/market controls • Screening at the border/quarantine of symptomatic individuals (e.g. refugee camps).
Zambia (2017)	• 3,916 cases and 81 deaths • Mostly in Lusaka province/region, particularly the pre-urban, high-density informal settlements (geographically concentrated). • Occurred predominantly in urban informal settlements. • Took place during the typical cholera season (rainy season: Oct–May/June) • Spread intensified by flooding, poor sanitation, and the urban water table being contaminated. • Approximately 5 months in length [28].	• Water and sanitation infrastructure failure. • High population density • Rainfall season.	• Zambia implemented some of the strictest local restrictions in the region, including: • Banned street vending, public gatherings • Closed markets, schools, universities, and colleges • Imposed curfew (18:00–06:00) in worst-affected districts (e.g., Kanyama)

Measures

Outcome Variables: The primary outcome variables are five individual-level indicators of sexual and reproductive health; all derived from the DHS data. These outcomes include: *Condomless sex*, defined as not using a condom during the last sexual encounter among respondents who had sex in the past 12 months; *early sexual debut*, defined as first sexual experience before age 15; *multiple sex partners*, measured as reporting having two or more sexual partners in the last 12 months; *early marriage* defined as being married or cohabitating before age 18; and *adolescent motherhood* defined as having ever given birth by age 19. *Adolescent motherhood* applies only to female participants.

Independent variables

These variables included age, sex, educational level, and number of living children (parity). It has been demonstrated that educational attainment is related to young people's sexual behaviours. Educated youth are more likely to be aware of reproductive health services, which may lead to healthier behaviours. The educational level was classified as 'no education', 'primary education', 'secondary education' or 'tertiary or higher education'. Place of residence was categorised as "urban and rural".

Ethics approval and consent

Permission to use the data was granted by the Measure DHS Program. The datasets analysed in this study are publicly accessible in the form of aggregated secondary data that contain no personal identifiers and cannot be traced to any individual, community, or participant. Data confidentiality was preserved through full anonymisation.

Data Analysis

We employed a difference-in-differences framework to assess changes in SRH behaviours associated with cholera outbreaks, including unprotected sex, early sexual debut, multiple sexual partners, early marriage, and adolescent motherhood. By comparing outcomes before and after outbreak periods

across affected and unaffected regions, we aimed to isolate the potential effect of cholera exposure while controlling for underlying temporal and regional trends.

Data analysis was done at three stages. First, we summarised the characteristics of the participants for pre- and post-data. Chi-square tests were used to assess differences between participants in the pre-cholera and post-cholera DHS surveys, adjusted for survey weights. Survey design was specified using DHS sampling weights (v005), primary sampling units (v021), and strata (v022). Second, we used a multilevel logistic regression to investigate the association between all covariates, including the exposure, and each SRH outcome at a 5% significance level. Third, to estimate the association between provincial cholera outbreaks and AYP SRH outcomes, we employed a multilevel difference-in-differences (DID) framework (see full specification in the Supplementary material) [29, 30]. Each outcome was analysed separately using multilevel logistic regression to account for the hierarchical survey design, with a random intercept for cluster (region). The models included individual-level covariates (age, education, and other relevant demographics) and fixed effects for survey year. The key interaction term, *exposure * survey year*, captured the interaction of cholera exposure with post-outbreak periods, thereby isolating the potential effect of cholera. This model is ideal for controlling for unobserved time-invariant confounders at the regional level, as well as common secular trends affecting all study regions. For all models, we used robust standard errors and adaptive quadrature integration to ensure reliable estimation of odds ratios for all outcomes.

Results

Distribution of individual-level characteristics

A total of 37737 participants were included across Zambia (N = 22936; 2013 vs. 2018) and Uganda (N = 14801; 2011 vs. 2016) in the Demographic and Health Surveys (DHS). Overall, participant age (approximately 19 years) and sex distributions were largely stable across survey periods in both countries. In contrast, the Zambian sample, although stable in age and sex, exhibited a significant decline in urban representation, from 50.1% to 39.0% ($p < 0.001$). In Uganda, the proportion of female respondents decreased modestly from 80.4% to 78.5% ($p = 0.008$). Urban residence declined from 31.7% to 23.4% ($p < 0.001$). While most demographic shifts were small, the notable change in urban-rural distribution in both the Zambian and Ugandan samples is the primary potential source of bias, and adjusting for age, sex, and residence is critical for ensuring comparability in subsequent analyses.

Sexual and reproductive health outcomes

In both countries, the proportion of youth reporting condomless sex increased over time. In Zambia, condomless sex increased from 36.7% in 2013 to 40.3% in 2018 ($p = 0.016$), while in Uganda it increased from 40.4% in 2011 to 45.3% in 2016 ($p < 0.001$). Other sexual behaviours remained largely stable in both countries (Table 2). The distribution of SRH outcomes by region in Zambia and Uganda is shown in Supplementary Figures S1 and S2.

*Hypothesis tests account for DHS sampling weights, clustering, and stratification.

Individual-level characteristics associated with sexual and reproductive health outcomes

The multilevel logistic regression results for Zambia (2013–2018) in Table 3 consistently show that older adolescents were significantly less likely to report early marriage (aOR = 0.92, 95%CI 0.89–0.95, $p < 0.001$), but significantly more likely to report condomless sex (aOR = 1.22, 95%CI 1.19–1.25, $p < 0.001$), sex with multiple partners (aOR = 1.19, 95%CI 1.14–1.23, $p < 0.001$), and adolescent motherhood (aOR = 1.37, 95%CI 1.35–1.39, $p < 0.001$). Female adolescents had higher odds of early marriage (aOR = 9.21, 95%CI 7.1–11.9, $p < 0.001$) and condomless sex (aOR = 1.38, 95%CI 1.22–1.56, $p < 0.001$) than males, but were less likely to report early sexual debut or having sex with multiple partners. Low educational attainment was a strong risk factor; those with no education faced particularly high odds of condomless sex, sex before age 15, early marriage, and adolescent motherhood. All outcomes were highly consistent across the 2013 and 2018 survey years, except for lower odds of adolescent motherhood in 2018.

*Parity was excluded from Models 2 and 5 because of temporal ordering concerns and potential collinearity with the outcome variables. Model 5 was run among girls only. Odds ratios reported with 95% confidence intervals in parentheses. Robust standard errors clustered by region. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Findings from the multilevel logistic regression models for Uganda (Table 4) consistently demonstrated that age, sex, education, and parity were significant factors associated with most adolescent sexual and reproductive health outcomes. Older adolescents were significantly less likely to report early marriage (aOR = 0.88, 95%CI 0.86–0.89, $p < 0.001$), but significantly more likely to report condomless sex (aOR = 1.33, 95%CI 1.29–1.36, $p < 0.001$), sex with multiple partners (aOR = 1.20, 95%CI 1.15–1.26, $p < 0.001$), and adolescent motherhood (aOR = 1.54, 95%CI 1.48–1.59, $p < 0.001$). Female adolescents had notably higher odds of early marriage (aOR = 7.39, 95%CI 5.86–9.32, $p < 0.001$) and condomless sex (aOR = 2.04, 95%CI 1.75–2.38, $p < 0.001$) but lower odds of early sexual debut and sex with multiple partners. Urban residence was associated with higher odds of having sex with multiple partners in Uganda (aOR = 1.25, 95%CI 1.01–1.54, $p = 0.041$). Furthermore, educational attainment showed a clear gradient: adolescents with no or only primary education had substantially higher odds of early marriage and adolescent motherhood than those with higher education. Having any children (parity) was strongly associated with condomless sex (aOR = 2.42, 95%CI 2.05–2.87, $p < 0.001$) and early marriage (aOR = 4.83, 95%CI 4.28–5.44, $p < 0.001$). Few differences were observed between survey years, though adolescents in the later period (2016) were slightly more likely to report condomless sex and having sex with multiple partners. Overall, these findings highlight the persistent structural and demographic influences on adolescent sexual and reproductive health behaviours in Uganda.

*Parity was excluded from Models 2 and 5 because of temporal ordering concerns and potential collinearity with the outcome variables. Model 5 was run among girls only. Odds ratios reported with 95% confidence intervals in parentheses. Robust standard errors clustered by region. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Impact of the Cholera Outbreak on Adolescent Sexual and Reproductive Health

The Difference-in-Differences (DID) analysis isolates the specific impact of the 2016 cholera outbreak on adolescent sexual and reproductive health (SRH) outcomes. In Zambia (Table 5), the results show that the outbreak had a limited but significant impact, primarily on long-term reproductive outcomes. The key finding from the DID estimate (interaction between the 2017 and 2018 cholera outbreaks) is that exposure to the outbreaks was associated with significantly increased odds of adolescent motherhood (aOR = 1.13, 95%CI 1.05–1.46, $p = 0.039$). In contrast, the outbreak did not significantly alter any of the other measured SRH outcomes.

Table 5
Difference-in-Differences Estimates of the Impact of the 2017 Cholera Outbreak on Adolescent Sexual and Reproductive Health Outcomes, Zambia DHS 2013–2018

Factors	(1) Condomless sex	(2) Sex before age 15	(3) Sex with multiple partners	(4) Early marriage	(5) Adolescent motherhood
Cholera outbreak 2017	0.91 (0.71–1.16)	0.59** (0.36–0.96)	0.71 (0.43–1.17)	1.39 (0.80–2.40)	0.85** (0.72–0.99)
Survey year 2018	1.16* (0.99–1.36)	1.01 (0.87–1.18)	0.97 (0.70–1.35)	0.91 (0.79–1.05)	1.01 (0.90–1.12)
Cholera outbreak 2017 × 2018 (Interaction term)	0.89 (0.70–1.12)	0.94 (0.71–1.24)	0.97 (0.59–1.62)	0.94 (0.70–1.26)	1.13** (1.05–1.46)
Observations	22926	22926	22672	22926	12488
Number of regions	10	10	10	10	10

All models control for age, sex, urban residence, education, and parity. Odds ratios with 95% confidence intervals in parentheses. Robust standard errors clustered by sampling strata. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In Uganda, the results (Table 6) indicate that the outbreak had a significant adverse effect on several key outcomes among the exposed group. Specifically, exposure to the cholera outbreak was associated with significantly increased odds of condomless sex (aOR = 1.64, 95%CI 1.31–2.06, $p < 0.01$), sex before age 15 (aOR = 1.49, 95%CI 1.13–1.98, $p = 0.005$), and adolescent motherhood (aOR = 1.83; 95%CI 1.10–3.05, $p = 0.035$). The confidence intervals suggest that the strongest impact was on adolescent motherhood. In contrast, the odds of reporting having sex with multiple partners and early marriage increased, but these increases were not statistically significant.

Table 6
Difference-in-Differences Estimates of the Impact of the 2012 Cholera Outbreak on Adolescent Sexual and Reproductive Health Outcomes, Uganda DHS 2011–2016

Factors	(1) Condomless sex	(2) Sex before age 15	(3) Sex with multiple partners	(4) Early marriage	(5) Adolescent motherhood
Cholera outbreak 2012	0.62*** (0.55–0.69)	0.73*** (0.61–0.86)	0.60 (0.33–1.10)	0.92 (0.67–1.26)	0.82 (0.54–1.24)
Survey year (2016)	1.09 (0.96–1.24)	0.89 (0.72–1.11)	1.27 (0.87–1.86)	0.84* (0.69–1.0)	0.69*** (0.56–0.86)
Cholera outbreak × 2016 (Interaction term)	1.64*** (1.31–2.06)	1.49** (1.13–1.98)	1.66 (0.75–3.66)	1.25 (0.83–1.89)	1.83** (1.10–3.05)
Observations	14801	14801	14516	14796	11702
Number of regions	10	10	10	10	10

All models control for age, sex, urban residence, education, and parity. Odds ratios with 95% confidence intervals in parentheses. Robust standard errors clustered by sampling strata. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Discussion

This study examined the association between cholera outbreaks and sexual reproductive health outcomes in two Southern and East African contexts: Zambia and Uganda. The study period coincides with the rollout of the Determined, Resilient, Empowered, AIDS-free, Mentored and Safe Women

(DREAMS) initiative in HIV-burden countries, including Uganda and Zambia, under the US President's Emergency Plan for AIDS Relief (PEPFAR). DREAMS is primarily an HIV-prevention programme, but it also delivers sexual reproductive health services, including sexuality education, condom provision, and economic strengthening, among others [31, 32]. Across these two counties, patterns of SRH outcomes were shaped by individual and structural factors such as age, sex, educational attainment, parity, and place of residence, consistent with prior research in the region [33–35]. The stability of these patterns across survey waves underscores how deeply embedded social structures continue to shape sexual behaviour and reproductive outcomes among AYP, even in the face of external shocks such as epidemics.

The findings from the multilevel interaction models also provide new insight into how cholera outbreaks intersect with these baseline vulnerabilities. In Zambia, cholera exposure did not substantially affect the impact of structural determinants on most outcomes, which may suggest resilience or protective buffering through community structures and service continuity [36, 37]. However, the significant rise in adolescent motherhood in Zambia following the outbreak suggests that reproductive consequences may emerge indirectly, likely via disrupted access to contraception or facility-based care rather than behavioural change alone [38, 39]. By contrast, in Uganda, cholera exposure was associated with increases in condomless sex, earlier sexual debut, and adolescent motherhood. In low- and middle-income countries, AYP already face heightened risks of early pregnancy, sexually transmitted infections, and gender-based violence, compounded by limited access to adolescent-friendly sexual and reproductive health (SRH) services and structural barriers such as restrictive policies and cultural constraints [40]. In contexts characterised by high household precarity and disrupted service continuity, outbreaks such as cholera can intensify these risks. Therefore, the resilience of local health, education, and social protection systems is central in determining whether outbreaks exacerbate or merely coexist with adolescent SRH risks.

These findings underscore the value of viewing cholera not solely as an acute infectious disease event but as a multidimensional crisis with potential cascading effects on adolescent wellbeing. Similar secondary impacts have been observed during Ebola and COVID-19, where school closures, mobility restrictions, and reduced SRH service access contributed to heightened adolescent pregnancy and altered sexual risk behaviours [41, 42]. The variation observed across the two contexts reflects the differences in outbreak duration, geographic spread and exposure intensity [23, 28]. Uganda's outbreak was prolonged, multi-district, and recurrent across the border and fishing communities, thus adolescents may have been exposed to sustained social and economic disruption that could plausibly influence multiple sexual and reproductive health outcomes over time [23]. In contrast, Zambia's outbreak was shorter, geographically concentrated and characterised by strict but time-bound containment measures [28], which may have limited broader behavioural spillovers, resulting in fewer detectable changes across SRH outcomes.

This study has several limitations that should be considered when interpreting the findings. First, cholera exposure was measured using region- or province-level outbreak occurrence rather than individual exposure, which may introduce ecological bias or misclassification. Second, the analysis relied on self-reported sexual behaviour, which is vulnerable to under-reporting or social desirability bias, particularly among adolescents [43]. Third, the spacing between the pre-outbreak and post-outbreak survey rounds limits the ability to detect immediate behavioural changes. Given that DHS surveys are conducted every 5 years, while cholera outbreaks evolve within weeks, the effects captured here are more reflective of medium-term or sustained impacts rather than short-term behavioural changes. Fourth, outbreaks often co-occur with other socio-economic shocks such as inflation or food insecurity, making it difficult to isolate cholera-specific effects [44]. Fifth, although nationally representative surveys aim for consistent sampling frames, shifts in population structure, internal migration following cholera outbreaks, and periodic enumeration updates may introduce differences in the underlying population captured across waves. Sixth, in Zambia, the outbreak occurred near the end of the selected 5-year analytic period, whereas in Uganda, outbreaks occurred almost every year, albeit with varying severity. For Zambia, this may bias the effects, as the impact of an outbreak may show years later. In contrast, for Uganda, the intensity of the outbreak may lead to overestimation of effects. Furthermore, while the Difference-in-Differences (DID) approach allowed estimation of the cholera outbreak's impact on adolescent sexual and reproductive health outcomes, it relies on the assumption of parallel trends between exposed and unexposed groups. Lastly, we could not adjust for the length or severity of the outbreak due to the limited availability of case-level data at the administrative or regional level. However, our models used a random intercept for each region to account for any unobserved region-level differences. Changes in urban-rural composition, other regional shocks, or unmeasured confounders over time may violate this assumption, potentially biasing the estimated effects. Despite these constraints, the consistency of observed patterns across multiple outcomes suggests that the identified associations are meaningful and warrant further investigation. Further research could extend this analysis by incorporating additional countries from similar outbreak contexts and integrating alternative data sources beyond DHS that capture adolescent SRH outcomes. Future work could also leverage region- or district-level cholera case data to examine how variation in outbreak severity and intensity shapes differential impacts on SRH behaviours and indicators.

Conclusion

Overall, this study highlights that cholera outbreaks, while fundamentally waterborne public health crises, can also produce secondary social and reproductive harms when they disrupt the structural environments that shape adolescent wellbeing. The evidence demonstrates that the impacts of cholera on adolescent sexual and reproductive health are not uniform by geography nor specific outcomes, but instead may vary according to health system resilience, continuity of SRH services, and the degree of economic and educational disruption that outbreaks trigger. These findings underscore the need for epidemic preparedness and response strategies that move beyond biomedical containment to explicitly protect sexual and reproductive health. Maintaining contraceptive supply lines, safeguarding adolescent access to SRH information, and sustaining school and community support structures should be considered core components of cholera response planning, rather than optional social add-ons. Recognising cholera as a multi-dimensional public health crisis with sexual and reproductive health repercussions, therefore, shifts policy focus toward integrated, equity-oriented approaches that mitigate both immediate spread and the longer-term consequences for adolescent life trajectories. This is essential to advancing

progress toward SDG 3 (health and well-being), SDG 5 (gender equality), and SDG 6 (safe water and sanitation), where the protection of young people's rights and futures depends on integrated, rather than siloed, public health action.

Declarations

Ethics approval for the original Demographic and Health Surveys was obtained by the survey organisers. For the Zambia DHS surveys, ethical approval was obtained from the Institutional Review Board of ICF International/ICF and the Tropical Diseases Research Centre (TDRC) Ethical Review Committee in Zambia, while for the Uganda DHS surveys, the survey protocols were reviewed and approved by the Institutional Review Board of ICF International/ICF. The present study is a secondary analysis of anonymised DHS public-use datasets. Permission to access and use the data was granted by the DHS Program. The datasets analysed contained no direct personal identifiers, and no individual participant could be identified from the data used in this analysis. Therefore, no additional ethics approval was required for this secondary analysis.

Data availability

The datasets used and analysed in the current study are available from the MEASURE DHS Program upon reasonable request, subject to its data access requirements.

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Author Contributions

SZ, LC and ET conceptualised the study. SZ, RA, and TM contributed to data analysis and interpretation; SZ led drafting of the manuscript. SZ, LC, ET, RA, TM and GM contributed towards critical revision of the manuscript and approved the final version. All authors take responsibility for all aspects of the work.

Ethics Approval and Participant Consent were Obtained

Ethical approval for the original SHDS surveys was obtained by the survey organisers. This study constitutes a secondary analysis of publicly available, anonymised data and therefore did not require further ethical approval.

Consent for Publication

Not applicable.

Competing Interest

The authors declare no competing interests.

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Table 2 To 4

Table 2 To 4 are available in the Supplementary Files section.

Figures

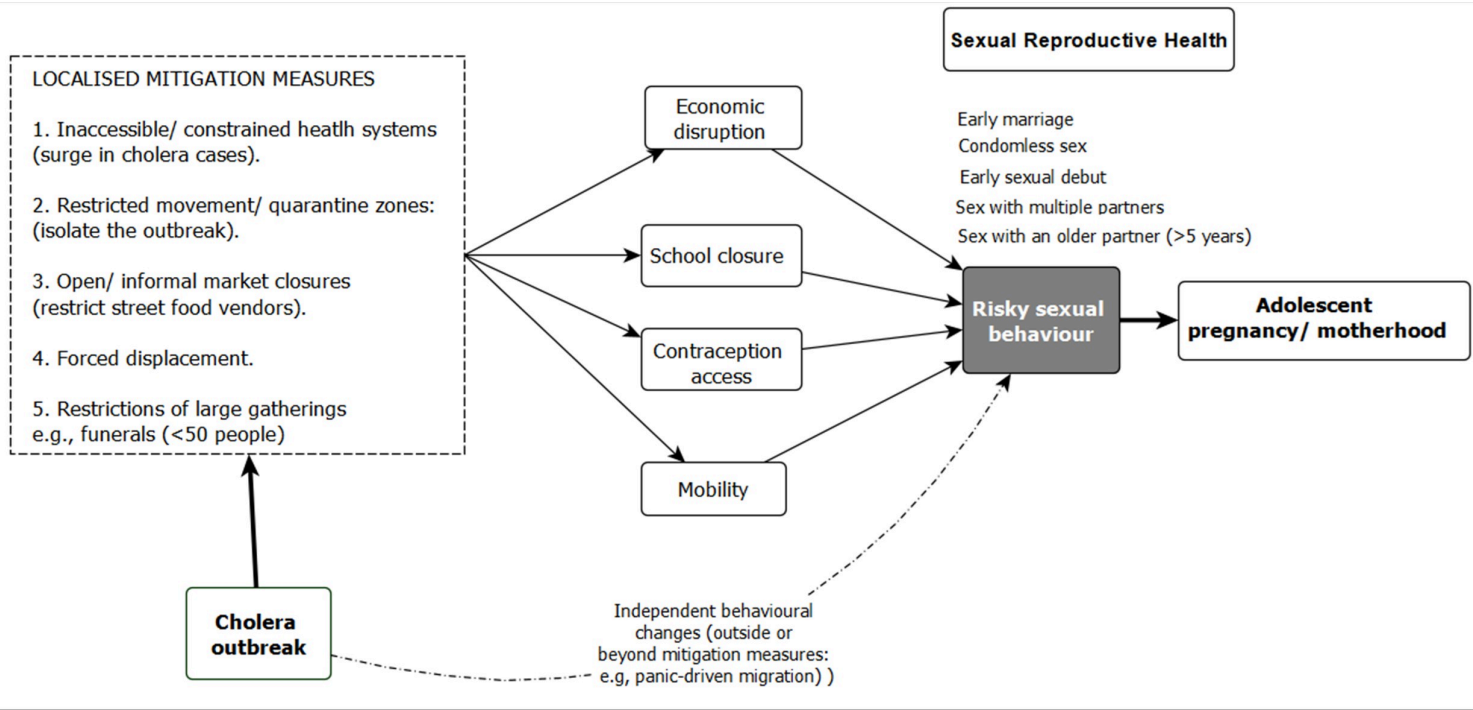


Figure 1

Hypothesised pathways for the effect of cholera outbreaks on adolescent sexual and reproductive health

Source: Compiled by the authors based on published reports from Save the Children, News24, ReliefWeb, and UNICEF.

Supplementary Files

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