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Access to water sources and intimate partner violence against women in 26 Sub-Saharan African countries

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ABSTRACT

Background: Intimate partner violence (IPV) against women is a serious problem in many developing countries. Longer distance traveled to access water services may affect women's ability to meet domestic obligations and results in violence. However, the associations between times spent by women to access water services and intimate partner violence against women in Sub-Saharan Africa (SSA) remain unknown.

Methods: We used population-based data collected from demographic and health surveys (DHS) in 26 SSA, to examine the associations between round-trip time to water sources and IPV. We estimated round-trip time to water sources based on the self-reported experience of women through their time spent collecting water during the period of 2008 and 2020 as presented in the DHS surveys. Primary outcomes were all self-reported and were derived from the DHS questionnaires about IPV, especially physical violence. We categorized IPV into two groups (Severe and less severe IPV). Respondents who reported being kicked, strangled, threatened with a knife/gun or other weapons by their husbands, or hurt were pooled together and labelled as having experienced severe IPV. Those who claimed to have been pushed, had their arms twisted, or had their hair pulled were grouped and classified as less severe forms of violence. Multivariable logistic regression was performed by fitting crude models and adjusted models. We also conducted a sensitivity analysis, stratification, and country-specific analysis to examine the contributions of these factors to the associations between round-trip time to water sources and IPV. The estimated results are presented as an odds ratio (OR) and their 95% confidence interval (CI).

Results: A total of 14,714 (11.2%) women faced severe IPV and 38,222 (28.9%) faced less severe IPV. Results showed that a 30 min increase in round-trip fetching time was associated with an increase in severe IPV and the crude OR was 1.06 (95% CI: 1.05, 1.07) for all 26 countries. After adjusting for covariates, the association of round-trip time to water sources and severe IPV remained positive and significant with an OR of 1.03 (95% CI: 1.01, 1.05). Furthermore, there were positive and significant associations between round-trip time and less severe IPV before and after adjusting for covariates. There were positive associations between round-trip time to basic access to water sources and severe IPV with an OR of 1.08 (95% CI: 1.05, 1.10). For potential effect modifiers, our results revealed disparities in IPV estimates stratified by husbands who consumed alcohol, level of education of husbands, and age of respective women. There were differences in the estimates between countries, the largest increment in severe IPV was observed in Comoros, Sierra Leone, and Namibia.

Conclusions: This cross-sectional study provides persuasive evidence for the association between round-trip time to water sources and IPV. Our results highlight the need to protect women against IPV by ensuring proper access to water services in communities faced with water insecurity.

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1. Introduction

Intimate partner violence (IPV) against women is a serious violation of human rights and a worldwide public health issue (Sardinha et al., 2022). IPV involves a sequence of assaultive and aggressive behaviour that may include physical injury, psychological abuse, sexual abuse, progressive isolation, harassment, deprivation, intimidation, and reproductive coercion. While IPV can affect both men and women, women are more likely to be impacted, suffer serious injuries, or would likely be killed by men (Wado et al., 2021). It is estimated that 27 % of women aged 15–49 years have experienced some form of IPV between 2000 and 2018 globally, with low- and middle-income countries (LMICs) reporting a higher prevalence (Sardinha et al., 2022). However, many countries have made efforts to reduce IPV by implementing Sustainable Development Goals (SDGs) - Goal 5, Target 5.2 on gender equality and women empowerment and countries-specific interventions. The solutions requires not only identifying social, economic, and behavioural risk factors but also understanding environmental factors that contribute to IPV and developing alternative strategies.

Safe and accessible water is a critical public health resource. According to WHO (2021), only 367 million people use improved water services and 282 million have limited water services (WHO and UNICEF 2021). The vast majority either do not have access to improved water services (Over 2 billion people worldwide) while over 1 billion have access to basic drinking water (WHO and UNICEF 2021). The percentage of people without access to water services is high, and the most affected communities are from LMICs, including Sub-Saharan Africa (Nygren et al. 2016, WHO and UNICEF 2021). Although efforts have been made to ensure access to water supply in most countries through implementation of SDGs goals 6 target 6.1 to 6.6, water insecurity remains one of the major problems affecting many communities, especially women. In most Sub-Saharan settings, women and girls are frequently assigned the tasks of collecting water, and long distances to water sources put their life in danger. Furthermore, the distance to obtain water services may cause a time delay in returning home, thus contributing to inability to meet other domestic obligations and also reduce trust to their partners and may result in violence (Mushavi et al., 2020). Therefore, improved water supply and better management of water resources can reduce such problems associated with violence against women and girls.

Apart from known risk factors of IPV, such as low self-esteem, economic stress, low level of education, history of physical or emotional abuse in childhood, poor behavioural and relationship factors, and other societal factors may be involved (Clare et al., 2021). Other indirect factors may include problems for the community to access important infrastructure like a water supply systems, safe and stable housing, and lack of access to medical care and mental health services (Cardoso et al., 2016). A previous study revealed that household water insecurity elevates women's exposure to emotional and physical forms of IPV as punishments for failure to complete socially expected household tasks that rely on water, such as cooking and cleaning (Choudhary et al., 2020). However, Choudhary et al. (2020) used a readily available, safe household water source as a reasonable proxy for access to water sources. In this paper, we use round-trip time to water sources to assess the water access level in terms of needs met. The most common indicator of the relationship between time spent collecting water and IPV is an increased risk of physical violence for women who walk long distances to access water. This is followed by the inability to meet domestic obligations due to household water inadequacy and overstaying at the water sources to wait for water (Tallman et al., 2022). For example, a previous study revealed that women were punished by their in-laws for failing to provide sufficient water on a reasonable timeline because of the time spent collecting water (Sultana, 2011). Therefore, understanding multilevel factors, including community service, can assist to identify various prevention opportunities for IPV in LMICs, particularly sub-Saharan African countries.

This study tested a hypothesis that, time delay to collect water may significantly contribute to IPV. We looked at other important risk factors apart from the known factor that may cause IPV in the community. Our study involved different forms of IPV categorised into severe IPV and less severe IPV and linked to time spent collecting water. In addition, country-specific analysis, sensitivity analysis and analysis stratified into different subgroups were performed.

2. Material and methods

2.1. Study population

We used (DHS) surveys between 2008 and 2020 in 26 Sub-Saharan Africa (SSA) as indicated in Map 1. We limited our study to 26 SSA countries with recent standard DHS collected in respective countries. The DHS provides nationally representative and routine survey data for multiple countries in developing countries. It involves a cross-sectional survey with a stratified 2-stage cluster sampling design. More information can be obtained from the DHS website (https://dhsprogram.com/data/). In addition, other studies that utilised data on IPV using DHS have been published elsewhere (Choudhary et al., 2020; Epstein et al., 2020; Wado et al., 2021).

In this study, participants were enrolled following the method used in the DHS to collect maternal data. All the data in the DHS were gathered using the multilevel sampling approach, and the information on clusters used for data gathering was taken from the most recent census for each country. We included all women whose IPV information was accessible in the DHS and whose records indicated they had been married. In general, the total number of women included in our study for all 26 countries of SSA were 131,939. Information on the inclusion and exclusion of the participants are presented in the supplemental information Table S1.

The DHS follows strict rules to ensure participants' confidentiality and protection during and after data collection. Therefore, we received permission to use the dataset and were approved by the ICF Macro International, Inc. and the Institutional Review Board (IRB) from the host country. Hence no further ethical clearance was required.

2.2. Source of water

We used DHS data to assess the availability and accessibility of water to the community in all 26 countries. We defined the accessibility of water as classified by the World Health Organisation (WHO) and described from previous studies (Choudhary et al., 2020; Howard et al., 2003). Three categories were considered: optimal access, intermediate access and basic or no access. Optimal sources imply all communities that obtain water on their premises either through piped systems or owning the wells. Intermediate sources include communities that depend on neighbouring or improved public sources to receive water. Basic or no access includes all unimproved sources that do not meet water sources criteria as proposed by the WHO and make poor hygiene practices to the community. However, if the water source is outside the premises but within 30 min, round-trip fetching time is considered intermediate service, while above 30 min and unimproved are considered a limited sources (Cassivi et al., 2018; Unicef, 2017). More information on the water source type description can be found in Supplemental Information Table S4.

2.3. IPV outcomes

Domestic violence occurs at all levels of society and in all population groups. It includes partners and ex-partners, immediate family members, other relatives, and family friends. Women form the largest group of victims. However, men, children, and elderly people can also be victims of domestic violence. Violence in any form has serious health consequences for the victim. Our focus in this study is IPV which is common

in Sub-Saharan settings. We categorized our outcome variables into two groups (Severe and less severe IPV). The definition was based on the survey's methodology as documented in the DHS surveys methodology. Our study focused on the physical violence, we obtained valid information from all countries included in this study. All respondents who reported being kicked, strangled, threatened with a knife/gun another weapon by their husband, or hurt were pooled together and labelled as having experienced severe IPV. Nevertheless, those who claimed to have been pushed, had their arms twisted, or had their hair pulled were grouped together and classified as less severe forms of violence.

We included other covariates that may influence the IPV, these covariates were selected based on other previous studies that demonstrated the influence of social and environmental characteristics on IPV (Choudhary et al., 2020; Epstein et al., 2020; Wado et al., 2021). In addition, the selection was done based on the availability of the information across all 26 countries and were included in the DHS. These include woman's age, woman's employment status, women's education, Husband's average age, husband consume alcohol, husband's employment, husband's education, place of residence for both mother and her husband, and wealth quantile. The Wealth Index was classified based on the socioeconomic level of each household. The consideration includes ownership of some of the appliances such as television set, refrigerators, vehicles, bicycles, and other facilities such as the presence of electricity, water and sanitation system, types of houses, and materials used to construct such houses.

2.4. Sensitivity analysis

We assessed the relationship between water source types and IPV. This was accomplished by grouping the water sources into three categories and analysing how each type of source affects IPV for all 26 SSA countries. We considered a hypothesis that basic or no access to water sources would have more significant consequences on IPV, especially for women. We also considered the presence of effect modifiers, which were included in the analysis.

2.5. Statistical analysis

We used a multivariable logistic model to estimate the association between round-trip time to water sources and IPV against women in 26 Sub-Saharan African countries. In our regression models, we categorised analysis into two: crude model and adjusted models. For the crude model, we did not add any covariates that may confound our results, while the adjusted model was conducted by adding other covariates. Some covariates were adjusted and how they were coded including maternal demographic characteristics such as maternal age (≤ 35=1, ≥ 36=0), maternal education (No education = 0, with education =1) and maternal employment (Employed =1, not employed =0). Fathers' demographic characteristics such as husband age (≤ 35=1, ≥ 36=0), if the husband consume alcohol (Yes =1, No =0), and husband's level of education (No education =0, with education =1). Family and households' demographic characteristics such as number of children, place of residence (Urban = 1, Rural = 0), and sources of water.

We conducted stratified analyzes to explore how the impact of access to water sources influence IPV prevalence differed by individual characteristics. We stratified analyzes by women had employment (Yes, No), husband had employment (Yes, No), Husband consumes alcohol (Yes, No), Women had education (Yes No), Husband has education (Yes, No), Husband's age (≤ 35, ≥ 36), Women's age (≤ 35, ≥ 36), and Place of residence (Rural, Urban). To account for potential confounding by water source types, we performed a sensitivity analysis to check for the association between IPV and round-trip time to reach three different water sources (Optimal was coded as 0, Intermediate was coded as 1, and Basic or no access was coded as 2).

All statistical analyzes were conducted using R software (Version 4.1.3). The statistical tests were two sided, and p-values < 0.005 were considered statistically significant. The estimated results from the multivariable logistic model are presented as odds ratio (ORs) and their 95% confidence interval associated with 30 min increase in round-trip fetching time in all countries.

Table 1
Characteristics of the study population for all 26 countries (Angola, Benin, Burkina Faso, Burundi, Ivory Coast, Cameroon, Chad, Comoros, D.R.Congo, Ethiopia, Gabon, Kenya, Liberia, Malawi, Mali, Mozambique, Namibia, Nigeria, Rwanda, Sierra Leone, South Africa, Togo, Uganda, Tanzania, Zambia, and Zimbabwe).

Variables, N (%)	Values / Number of cases (%)
Woman's average age	31.4 ± 8.35
Woman's employment	
Not employed	37,272 (28.2%)
Manual	11,860 (9.0%)
Agriculture	43,790 (33.2)
Professional	2414 (1.8%)
Sales and services	36,603 (27.7)
Woman's education	
No education	47,852 (36.3%)
Primary	47,029 (35.6%)
Secondary	32,202 (24.4%)
Higher	4,856 (3.7%)
Husband's average age	39.4 ± 11.00
Husband consume alcohol	
Yes	49,188 (37.3%)
No	82,751 (62.7%)
Husband's employment	
Not employed	28,439 (21.6%)
Manual	45,772 (34.7%)
Agriculture	50,146 (38.0%)
Professional	5,693 (4.3%)
Sales and services	1,889 (1.4%)
Husband's education	
No education	38,915 (29.5%)
Primary	44,476 (33.7%)
Secondary	40,051 (30.4%)
Higher	8,497 (6.4%)
Sources of water	
Optimal	18,883 (14.3%)
Intermediate	73,962 (56.1%)
Basic or no access	39,094 (29.6%)
Wealth quantile	
Poorest	29,616 (22.4%)
Poorer	27,280 (20.7%)
Middle	26,480 (20.1%)
Richer	25,358 (19.2%)
Richest	23,205 (17.6%)
Place of residence	
Urban	45,069 (34.2)
Rural	86,870 (65.8)

Notes: Wealth quantile was calculated using easy-to-collect data on household ownership of certain assets.

3. Results

3.1. Descriptive statistics

The descriptive statistics of the study participants are presented in Table 1. Our study comprises 131,939 women from 26 countries of SSA, of which 14,714 (11.2%) women experienced severe violence and 38,222 (28.9%) experienced less severe violence. This was obtained after excluding cases that were missing some covariates, as shown in Table S1 of supplementary information. In general, most participants residing in rural areas (65.8%), had intermediate sources of water (56.1%), women depended on agricultural activities as sources of employment (33.2%). In comparison, their husbands most depended on manual and agriculture activities (34.7%) and (38.0%) respectively.

The average round-trip fetching time for all 26 countries and each respective country are presented in Figs. 1, 2 and Table S2 of supplementary information. The average time for round-trip fetching water

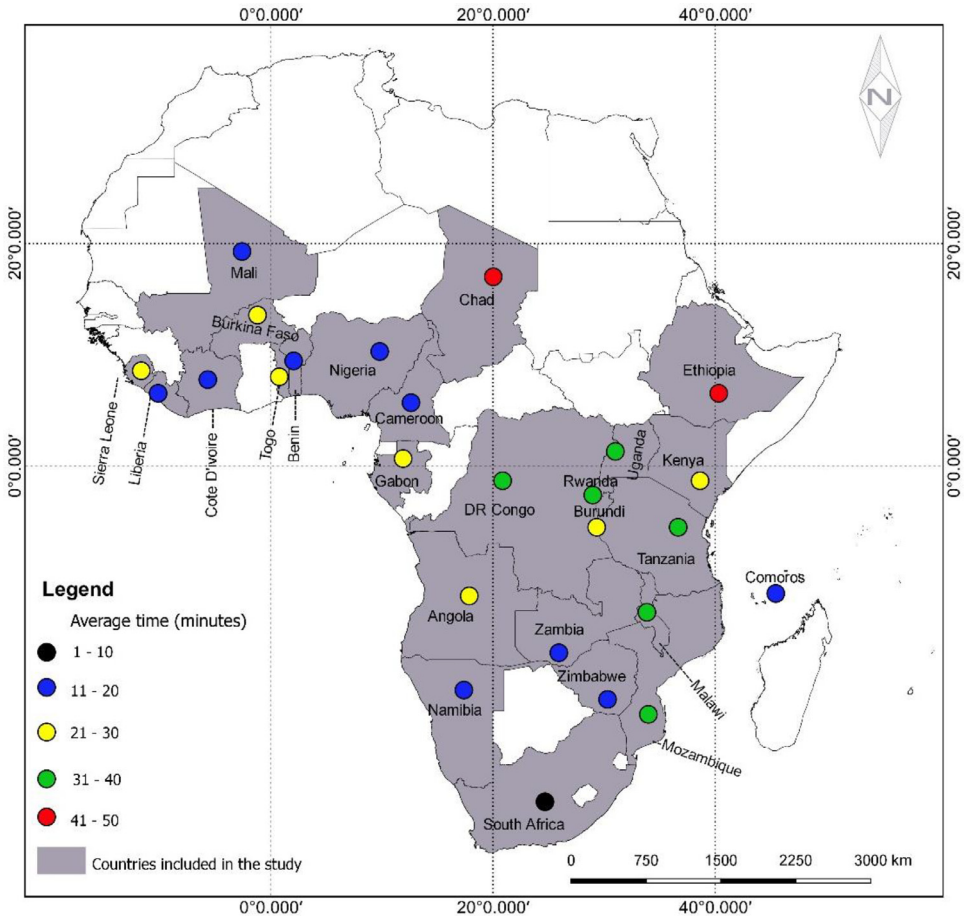

Fig. 1. An average round-trip fetching time for 26 Sub-Saharan African countries based on the year of which Demographic and Health Survey data were collected per each country.

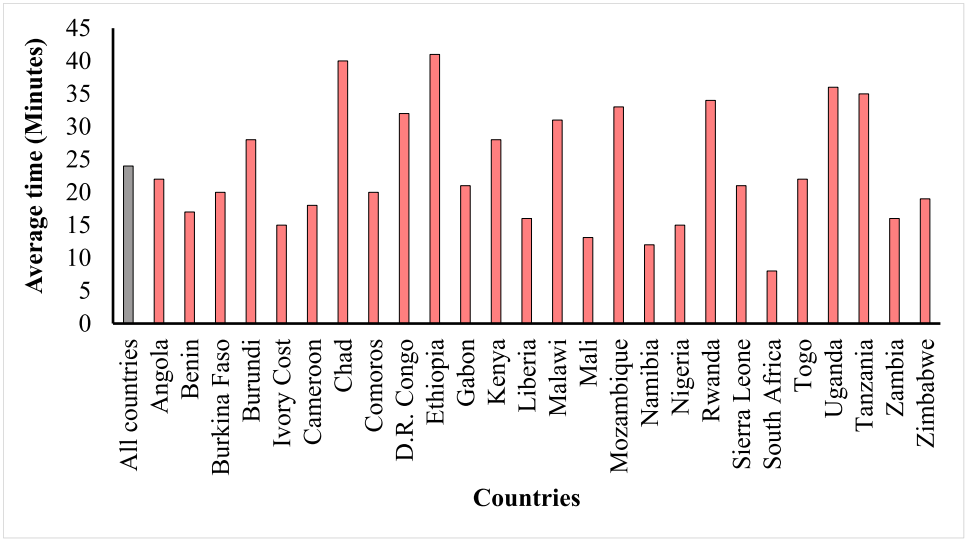

Fig. 2. Descriptive statistics of average round-trip fetching time for all 26 countries included in this study.

is 24 min for all countries. Ethiopia and Chad spent more time to collect water, with 41- and 42 min average round-trip fetching time, respectively. The time spent on water collection from these countries is above the recommended time by the WHO/UNICEF joint monitoring programmes of a 30 min threshold (Cassivi et al., 2018; Unicef, 2017, 2019).

3.2. Regression results

Our main results are presented in Table 2 as ORs and 95% CIs for the association between round-trip time to water sources and women experiencing severe and less severe IPV. Results showed that, 30 min increase in round-trip fetching time was associated with an increase in severe IPV and the crude OR for all 26 countries was 1.06 (95% CI: 1.05, 1.07). After adjusting covariates, the association of roundtrip time to water sources and severe IPV remained positive and significant with an OR of 1.03 (95% CI: 1.01, 1.05). Furthermore, there were positive and significant associations between round-trip fetching time and less severe IPV before and after adjusting covariates as shown in Table 2.

According to the sensitivity analysis results (Table 3), there were strong associations between round-trip time to basic or no access to water sources and severe IPV. For example, per 30 min increase in round-trip fetching time OR was 1.08 (95% CI: 1.05, 1.10). Furthermore, women who used intermediate sources of water had more signif-

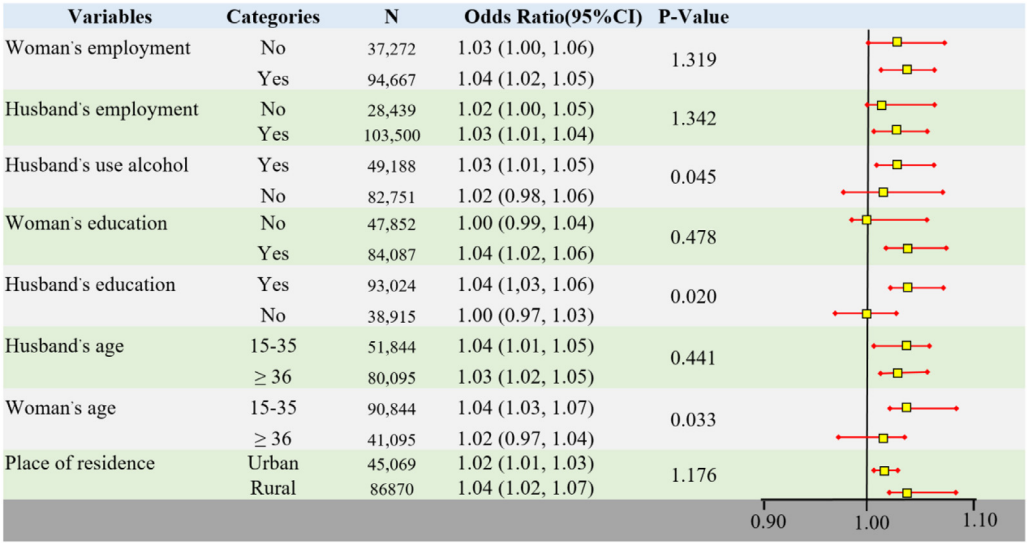

Fig. 3. Odds Ratio (and its 95% confidence interval) of severe intimate partner violence associated with 30 min increase in round-trip fetching time in all countries, stratified by potential modifiers.
Note: In each sub-group, the model was adjusted for the remaining characteristics such as, maternal demographic characteristics such as maternal age, maternal education and maternal employment. Fathers' demographic characteristics such as husband's age, if husband consume alcohol, and husband's level of education. Family and households' demographic characteristics such as number of children, place of residence, and sources of water.

Table 2
Odds ratio of severe intimate partner violence and less severe intimate partner violence associated with 30 min increase in round-trip fetching time in all countries.

Forms of IPV	Crude model		Adjusted model	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Severe IPV	1.06 (1.05, 1.07)	< 0.001	1.03 (1.01, 1.05)	< 0.001
Less severe IPV	1.05 (1.04, 1.06)	< 0.001	1.02 (1.01, 1.03)	< 0.001

Abbreviations: IPV, Intimate partner violence, OR, Odds Ratio, CI, Confidence Interval.
Estimates were presented as ORs of IPV associated with 30 min increase in round-trip fetching time for all countries. Adjusted model included, maternal demographic characteristics such as maternal age, maternal education and maternal employment. Fathers' demographic characteristics such as husband's age, if husband consumes alcohol, and husband's level of education. Family and households' demographic characteristics such as number of children, place of residence, and sources of water.

icant chance of receiving less severe violence (OR= 1.02: 95% CI: 1.01, 1.04) as per 30 min increases in round-trip fetching time, which was different compared to other sources of water for all 26 countries. However, Optimal sources of water did not show a positive significance associations for both severe and less severe IPV, implying that access to water sources contributes to some forms of violence.

Fig. 3 results show the associations between round-trip time to water sources and severe IPV stratified by potential effect modifiers. Results indicated that 30 min increase in round-trip fetching time was associated with severe IPV for subgroups such as those with husband who consumed alcohol (OR= 1.03: 95% CI: 1.01, 1.05), women with age ≤ 35 (OR = 1.04: 95% CI: 1.01, 1.05), and those married to educated husbands (OR = 1.04: 95% CI: 1.03, 1.06). In addition, their *p*-values remained significant after comparing two categories in the same groups. On the other hand, subgroups did not show any positive associations between round-trip time to water sources and severe IPV.

Finally, we estimated the association between round-trip time to water sources and different forms of IPV (Severe and less severe IPV) for each country. Results are indicated in Figs. 4 and 5. Generally, there were differences in the estimates between countries. As per 30 min increase in round-trip fetching time, the largest increment in severe IPV was observed in Comoros 1.38 (1.12, 150) followed by Sierra Leone (OR = 1.13, 95% 1.02, 1.25) as indicated in Fig. 4. Whereas for less severe IPV, the largest increments were observed in Namibia with an

Table 3
Odds ratio of severe intimate partner violence and less severe intimate partner violence associated with 30 min increase in round-trip fetching time in all countries by sensitivity analysis.

Water sources	N	SEVERE IPV		LESS SEVERE IPV	
		OR (95% CI)	P-value	OR (95% CI)	P-value
Optimal*	18,883	1.10 (0.96, 1.25)	0.146	1.01 (0.89, 1.14)	0.879
Intermediate	73,962	1.03 (1.02, 1.06)	< 0.001	1.02 (1.01, 1.04)	< 0.001
Basic or no access	39,094	1.08 (1.05, 1.10)	< 0.001	1.01 (0.99, 1.02)	0.694

Abbreviations: IPV, Intimate partner violence, OR, Odd Ratio, CI, Confidence Interval and * represent reference category.
All models were adjusted for, maternal demographic characteristics such as maternal age, maternal education and maternal employment. Fathers' demographic characteristics such as husband's age, if husband consume alcohol, and husband's level of education. Family and households' demographic characteristics such as number of children, place of residence.

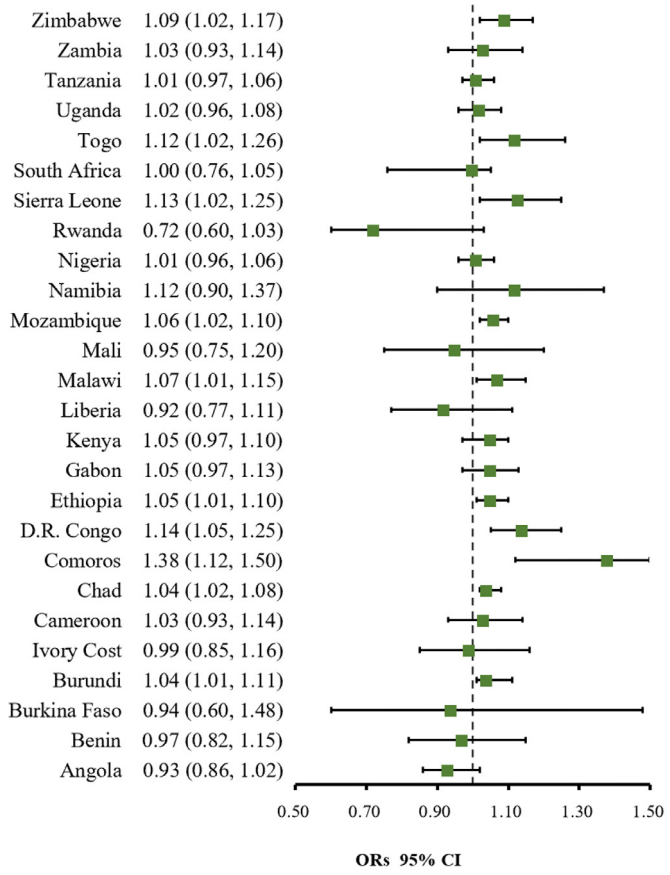

Fig. 4. Odds ratios of severe intimate partner violence associated with 30 min increase in round-trip fetching time.
Note: All models were adjusted for, maternal demographic characteristics such as maternal age, maternal education and maternal employment. Fathers' demographic characteristics such as husband's age, if husband consume alcohol, and husband's level of education. Family and households' demographic characteristics such as number of children, place of residence, and sources of water.

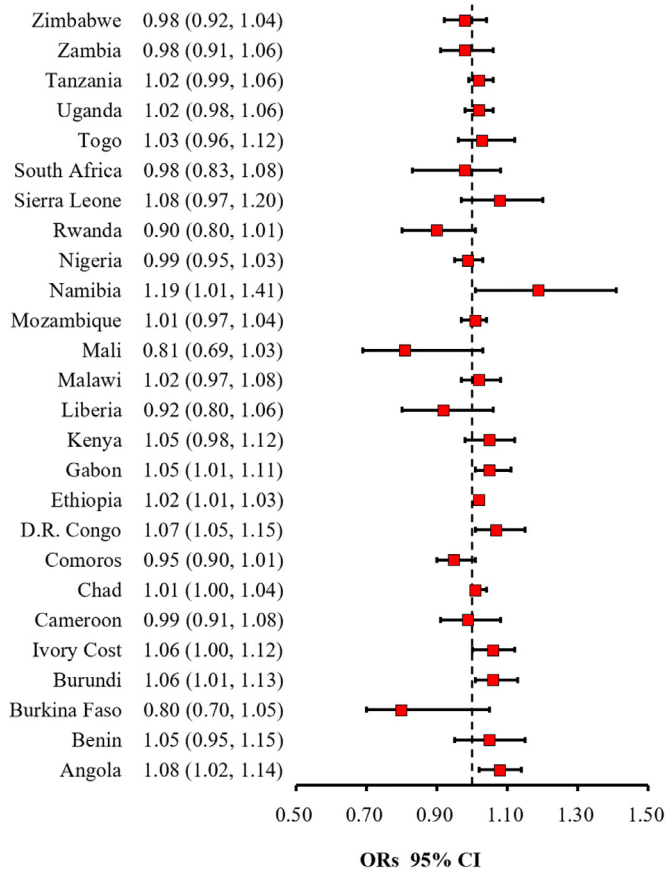

Fig. 5. Odds ratio of less severe intimate partner violence associated with 30 min increase in round-trip fetching time.
Note: All models were adjusted for, maternal demographic characteristics such as maternal age, maternal education and maternal employment. Fathers' demographic characteristics such as husband's age, if husband consume alcohol, and husband's level of education. Family and households' demographic characteristics such as number of children, place of residence, and sources of water.

OR of 1.19 (1.01, 1.41) followed by Angola (OR = 1.08 (1.02, 1.14), as shown in Fig. 5. On the other hand, some countries showed the smallest increments of both severe and less severe IPV as per 30 min increase in round-trip fetching time. These countries include Burkina Faso, Rwanda, Liberia, and South Africa.

4. Discussion

In this study, we analyzed individual-level data for women and their respective husbands in 26 Sub-Saharan Africa. We examined the relationship between round-trip time to water sources and different types of IPV (severe and less severe violence) against women. We find that per 30 min increase in round-trip fetching time was associated with an increase in both severe and less severe IPV. Sensitivity analysis revealed larger associations between round-trip time to basic water sources and severe IPV. Furthermore, alcohol consumption especially for husband and education backgrounds modifies the association of IPV. On the other hand, country-specific analysis revealed stronger and positive associations between round-trip time to water sources and severe IPV in Comoros and Sierra Leone. Our results may assist on reduction of different forms of IPV contributed by lack of accessible water services in most communities in African.

The relationship between water accessibility and different forms of IPV has not been well established. Our findings showed that per 30 min increase in round-trip fetching time was associated with increase in severe IPV, crude OR was 1.06 (95% CI: 1.05, 1.07). After adjusting some covariates, the association of round-trip time to water sources and severe IPV remained positive and significant with an OR of 1.03 (95% CI: 1.01, 1.05). These results are similar to a study conducted in 19 countries in Sub-Saharan Africa that looked at experiences of drought and some different forms of violence (Epstein et al., 2020), the study reported that women living in severe drought had higher risk of experiencing sexual violence with RD of 3.0 (95% CI 0.4, 2.0, p = 0.001). A study conducted in Nepal to examine the associations between sub-optimal household water access and women's exposure to IPV using the nationally-representative data from Nepal Demographic and Health Survey of 2016, revealed that household water access consistently elevates women's exposure to different forms of IPV (Choudhary et al., 2020). Furthermore, another study from SSA revealed that inadequate living conditions such as housing with unimproved water, unimproved sanitation, insufficient space, and unfinished materials were associated with higher likelihood of experiencing different forms of IPV (Gao et al., 2021). The similarity of these results provides more evidence on the association of poor community services such water accessibility and occurrence of different forms of IPV in households. This is because the husbands have mistrust when their wives take longer than expected to collect the water, which happens frequently in African families (Aboagye et al., 2022). However, some studies reported different results, for example, a study conducted by (Abramsky et al., 2011), did not report water accessibility to the community as one of the factors that may contributes to some forms of IPV. In addition, most studies relied

on the resources available at individual levels to establish association with IPV, while ignoring other factors such as community level access to important services (Cools and Kotsadam, 2017).

Sensitivity analysis revealed that types of water sources contribute to the delay of women to collect water. Our study revealed that, there was positive and significant associations between round-trip time for basic access to water sources and severe IPV with an OR of 1.08 (95% CI: 1.05, 1.10). In addition, women who depend on intermediate sources of water had greater chance of receiving less severe violence from their partners (OR= 1.02: 95% CI: 1.01, 1.04). These results are similar to other previously mentioned studies that demonstrate association of water insecurity and violence. For instance, a previous review study revealed that women walked long distances to access water were associated with higher risk of sexual and physical violence especially in SSA (Tallman et al., 2022). Furthermore, women are not only at risk of violence because of the distance to collect water but also the type of water sources they access, this has been revealed from the qualitative studies conducted previously in four countries from SSA (Pommells et al., 2018). For examples, most violence were documented as happening both enroute to fetching water and while collecting water, particularly if the water source is a river or swamp (Pommells et al., 2018). IPV is contributed to by many factors, however, social infrastructures play role in ensuring peace to the family. Therefore, types of water sources could significantly contribute to the physical violence especially in most developing countries.

For potential effect modifiers, our results revealed disparities in IPV estimates stratified by husbands consuming alcohol, level of education of husband, and age of respective women. Based on a previous study, women whose husbands drank alcohol were at higher risk of experiencing domestic violence compared to those who did not drink with an AOR of 2.12 (95% CI: 1.05, 1.10) (Bhatta et al., 2021). This evidence was acquired without taking into account their social-demographic status or any other social amenities they may have on their property that might support the findings on the relationships. In addition, another study conducted in India demonstrated that prevalence of IPV among women married with husbands who consume alcohol was 27% and mostly IPV episodes occurred when husband are totally drunk (Wagman et al., 2018). These results are similar to our results were husbands who consumed alcohol were associated with IPV with an OR of 1.03 (95% CI: 1.01, 1.05). Our study revealed husbands with higher education contributed to IPV to their women. This observation could be related to the relatively lower number of participants with no education compared with those with education, because of this, the effect estimate per unit increase in round-trip time would be larger. Age of women has been linked with the risk of IPV per unit increase in round-trip time to water sources. Our study indicated that women with an age range of 15-35 years were at higher risk of experiencing IPV compared to those older than 36 years (OR = 1.04, 95% 1.03, 1.07). This study's findings are consistent with prior research that showed early marriage and youngers women had higher chance of IPV risks (Sardinha et al., 2022; Speizer and Pearson, 2010). However, most studies contradict with our findings whereby older women had higher risks of IPV compared to younger one (Pathak et al., 2019). These disparities maybe attributed by the other ethnic and cultural considerations from different countries, although further investigation is required to validate these findings.

Furthermore, we performed country specific analysis to check for the association between round-trip time to water sources and IPV in each country of SSA. Our results revealed disparities of the association between round-trip time to water sources and both severe and less sever IPV. For instance, per 30 min increase in round-trip time to water sources, the largest increment in severe IPV were observed in Comoros 1.38 (1.12, 150) followed by Sierra Leone (OR = 1.13, 95% 1.02, 1.25). In addition, we observed positive and significant associations of round trip time to water sources and less severe IPV, the largest increments were observed in Namibia, followed by Angola, D.R Congo, Ivory Coast, Burundi, and Gabon. Previous results demonstrated similar findings in SSA where Gabon and some of the Central African Countries had higher prevalence of IPV (Wado et al., 2021). However, the results did not show that the distance travelled to reach water sources was a significant contributor to both severe and less severe IPV. Therefore, further study that can link the associations of round-trip time to water sources and IPV to women in SSA are required to validate this findings.

This study had some important strengths. First, this is the first cross-sectional study in Africa that included large population across African countries and is the first study to assess the associations between round-trip time to water sources and different forms of IPV in SSA. Second, we used the most recent DHS databases, which provide an opportunity for straightforward comparison and cover a significant number of women from several nations. Finally, our study considered both sensitivity analysis (types and access to water sources) and effect modification by individual demographic characteristics as well as socio-economic status of each family. This can offer a chance to address the existing issues.

However, our results should be treated with caution due to the following limitations. First, time to collect water was subjective and may have measurement error. This is because the round-trip time between each family and the water sources was not quantitatively measured, and instead, the duration was estimated based on the self-reports information from the respondents of the questionnaires. Second, we were not able to gather information on the specific causes of both severe IPV and less severe IPV. Third, the most information were collected from self-reports of women and therefore may be subjected to recall and information bias.

5. Conclusion

In conclusion, IPV is a serious problem that affects millions of people especially the women. This cross-sectional study revealed significant positive associations between round-trip time to water sources and both severe and less severe IPV in 26 countries of SSA. Furthermore, there were larger associations between round-trip time to basic or no access to water sources and severe IPV. For potential effect modifiers, our results revealed disparities in IPV estimates stratified by husbands who consumed alcohol, level of education of husband, and age of respective women. There were differences in the estimates between countries, the largest increment in severe IPV were observed in Comoros. The findings of this study may help policy makers prioritize viable strategies to avoid and lessen the risks of IPV linked to the long distances most households in SSA must walk to access water.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.heha.2023.100063.

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