Research Paper

Does self-reported water collection time differ from observed water collection time? Evidence from the Upper West Region of Ghana

Alfred Dongzagla, Abraham Marshall Nunbogu and Nicholas Fielmua

ABSTRACT

Water collection time is a key indicator in tracking access to drinking water. Over the years, water surveillance agencies have relied on water collectors for information on water collection time to measure progress of water supply. However, emerging evidence shows that water collection times reported by water collectors in developing countries are often imprecise. To contribute to knowledge about the validity or otherwise of self-reported water collection times, this study explored the association between self-reported water collection times and observed water collection times in the Upper West Region of Ghana. Data on water collection times were gathered from 412 water collectors in Daffiama-Issa-Bussie District and Lawra Municipality, first through interviews, and second by observation. From the results, self-reported water collection times were significantly ($P < 0.01$) lower than observed water collection times. The average round-trip water collection time reported by water collectors (32 minutes) was 8 minutes lower than observed water collection times (40 minutes). This implies that existing statistics on basic water coverage that are largely based on self-reported water collection times are overestimated. Going forward, we call on water surveillance agencies to collect data on water collection times through observation.

Key words | collection time, Ghana, observed time, self-reported time, water

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INTRODUCTION

Accessibility is an important determinant of water supply (UNESCO 2002; UN 2010). It is primarily a function of distance to water source or water collection time (Howard & Bartram 2003; WHO 2011). Distance to water source or total water collection time affects the volume of water households collect and use (Howard & Bartram 2003; WHO 2011). For instance, Howard & Bartram (2003) reported that when distance to water source is more than 1,000 m or 30 minutes' total collection time, less than 5 litres of water per person per day is likely to be collected; when distance is between 100 and 1,000 m or 5 to 30 minutes' total collection time, about 20 litres of water per person per day is likely to be collected; and when water is provided at the house or yard (e.g., single tap), about 50 litres of water per person per day is likely to be collected.

Post 2015, the time dimension of accessibility to water has gained much attention in monitoring access to drinking water. This is because the time devoted to water collection has been recognized as a constraint on the livelihoods of water collectors, largely women in developing countries (Cairncross & Cuff 1987; Blackden & Wodon 2006). High water collection time not only limits the quantity of water women and girls collect for household use but also their engagement in productive and other rewarding activities (Howard & Bartram 2003;

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Jonah *et al.* 2015; Oxfam 2017). Thus, a reduction in water collection time could free up time for women to undertake productive and households tasks, including learning and caring for children (Cairncross & Cuff 1987; Crow *et al.* 2013). High water collection time is also on record to limit cooking, water consumption and personal hygiene practices of households. For instance, in Mozambique, Cairncross & Cuff (1987) observed that a reduction in round-trip water collection from 5 hours to 10 minutes was associated with an increase in the average water consumption from 4.1 to 11.1 litres per person per day. Cairncross (1987) in his work titled '*The benefits of water supply*' showed that a person's level of water consumption is dependent on collection time. According to him, once water collection time exceeds a few minutes (typically around 5 minutes), water consumption decreased significantly from around 50 litres per capita per day to 15 litres per capita per day. Water consumption is likely to drop below 15 litres per capita per day when round-trip collection time is above 30 minutes.

Globally, spatial disparities exist in water collection time. Between developed and developing regions, water collection time is highest in the latter, particularly in sub-Saharan Africa. Over a third of the population in sub-Saharan Africa spends more than 30 minutes on a round-trip collection of water (WHO/UNICEF Joint Monitoring Programme 2011; United Nations Children; Fund & World Health Organization 2019), a situation that impacts negatively on livelihoods. According to Blackden & Wodon (2006: 91), 'time poverty has long been recognized as a constraint to development in sub-Saharan Africa, with women working especially long hours due in part to a lack of access to basic infrastructure services such as water and electricity.' Water collection times in Ghana are reported to be high. A recent study by Dongzagla (2019) revealed an average water collection time of 42 minutes in parts of Northern Ghana with 48.6% of the population spending more than 30 minutes on a round-trip collection of water. In cognizance of the consequences of high water collection time on livelihoods, the Sustainable Development Goals (SDGs) emphasized at least basic access to drinking water for all by 2030 with the indicator being the proportion of population whose round-trip water collection time from an improved source is not more than 30 minutes (WHO/UNICEF Joint Monitoring Programme 2015a).

Since water collection time gained prominence in water scholarship around the late 1980s, water and health surveillance agencies such as the JMP, UNICEF and WHO have relied on water collectors for data on water collection time (herein refers to as self-reported water collection time). In developing countries, the validity of self-reported water collect time is in doubt. There is emerging evidence that self-reported water collection times in developing countries are imprecise due to the high illiteracy level of the population, lack of record keeping and inability of water collectors to recall water collection time (Davis *et al.* 2012; Crow *et al.* 2013; Pearson 2016). For instance, a comparison of GPS-based measurements of water collection time (through mapping of travel paths) and self-reported water collection times by Pearson (2016) and Davis *et al.* (2012) revealed that self-reported water collection times are often overestimated and may lead to inaccurate conclusions about access to water. Although the findings of Pearson (2016) and Davis *et al.* (2012) showed that GPS-based measurement of water collection time is reliable, it is not a suitable approach for estimating basic access to water because it does not account for waiting time at source. Crow *et al.* (2013) recommend direct observation as a more reliable method of collecting data on water collection time, especially in rural areas where many people use a small number of water sources. This method, however, is rarely used by water surveillance agencies because it is time-consuming. To contribute to knowledge about the validity or otherwise of self-reported water collection time, this study, for the first time, has explored the association between self-reported water collection time and observed water collection time in the Upper West Region of Ghana. Before data collection and analysis, we hypothesized that self-reported water collection time was significantly higher than observed water collection time. The remainder of the paper is divided into four sections, comprising Methodology, Results, Discussion and Conclusions.

METHODOLOGY

Study setting

The study was conducted in the Upper West Region of Ghana. The choice of the Upper West Region for the

study was informed by two main reasons: (a) the authors hail from the region and are thus familiar with the geography of the area and (b) as the poorest region in Ghana (GSS 2015), we wanted the findings to feed directly into policies, programming and planning of water interventions in the region. Due to limited funds, two out of the 11 districts/municipalities in the Upper West Region were selected through simple random sampling for data collection. Sampled districts were Lawra Municipality and Daffiama-Issa-Bussie District, as shown in Figure 1.

Lawra Municipality lies between latitude 10° 35′–10° 40′ north and 2° 50′–2° 53′ west (GSS 2014a). In the 2010 Population and Housing Census (PHC), the municipality recorded a total population of 54,889 with 88.2% of the population living in the rural area (GSS 2014a). The educational attainment of population in the municipality is low. About 47.8% of the population have never attended school. Of the population that is currently attending school or attended school in the past, only 40.6% have completed at least senior high school or its equivalent (GSS 2014a). The low educational attainment in the district partly explains why over two-thirds (82.4%) of the working population are engaged in subsistence agriculture, mainly crop farming (GSS 2014a). From the 2010 PHC, 93.9% of the population in the Lawra Municipality were estimated to have access to improved water sources with the main source being borehole (66.4%) (GSS 2014a). Only 15.9% of the population have access to piped-borne water (GSS 2014a).

The second study district, Daffiama-Issa-Bussie, covers a total land area of 1,456 square kilometres, representing 7% of the total land area of the Upper West Region (Daffiama-Issa-Bussie District Assembly 2014). In the 2010 PHC, the district recorded a total population of 32,827 with 16,856 being females and the remaining males. The mainstay of the inhabitants is agriculture. About 85% of the population are engaged in agriculture. Crop farming

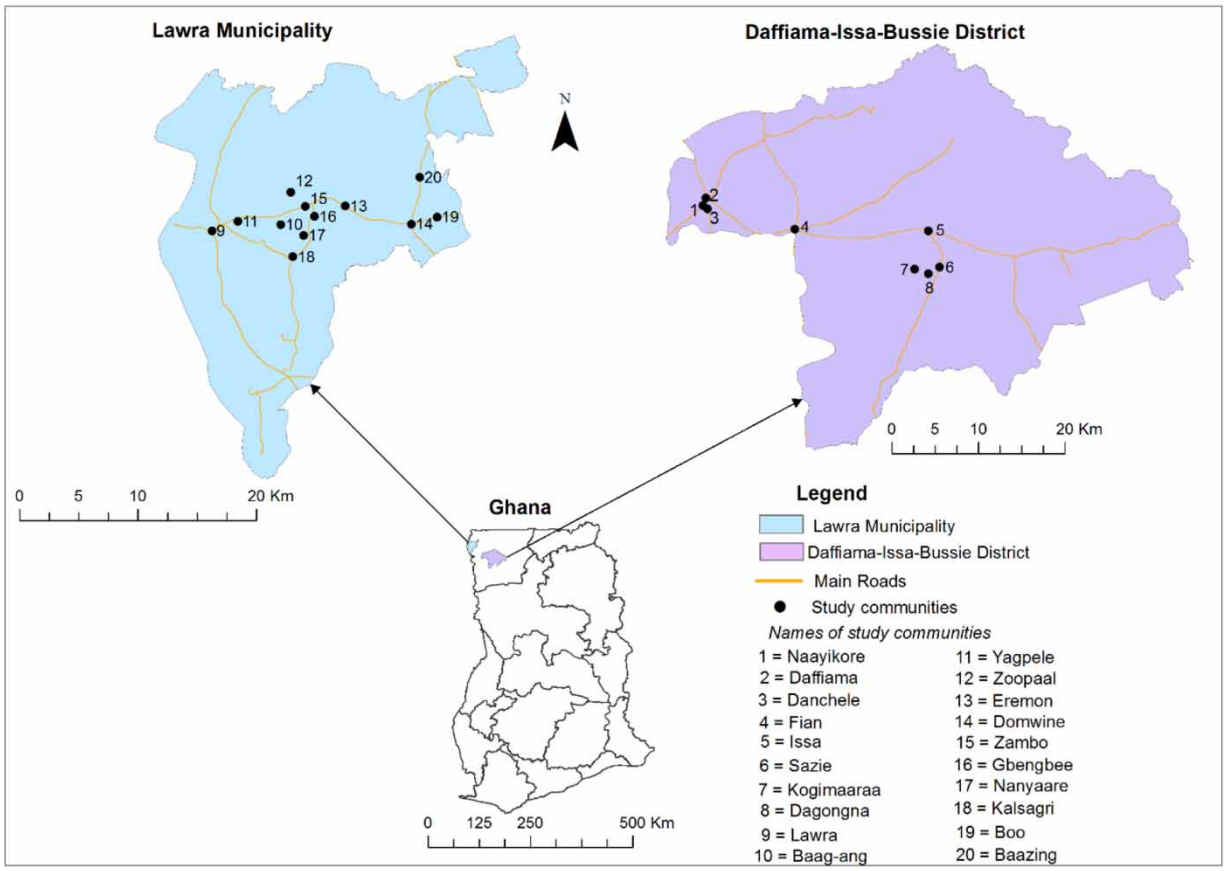

Figure 1 | Map of Ghana showing locations of study districts.

and livestock production characterize the agriculture sector. In terms of drinking water, Daffiama-Issa-Bussie District has varied sources of water, with the main source being borehole. Overall, 85.2% of households use improved water (GSS 2014b), representing 78.8% of the population (Daffiama-Issa-Bussie District Assembly 2014). Only one out of every ten households used pipe-borne water.

Study design

The study adopted a quantitative approach in data collection, analysis and presentation of results. A survey was conducted with a sample of 412 households across Lawra Municipality and Daffiama-Issa-Bussie District. The sample was determined using Taro (1973) sample size formula:

$$n = \frac{N}{1 + Ne^2}; \quad (1)$$

where n = sample size, N = population (15,438) (comprising 9,633 households in Lawra Municipal and 5,805 in Daffiama-Issa-Bussie District as at 2018 (GSS 2019) and e = level of precision or sampling error (±5%).

Based on the formula, a representative sample of 386 households was obtained, and distributed proportionally between Lawra Municipality (241) and Daffiama-Issa-Bussie District (145). However, data were collected from 412 households; 234 in Lawra Municipality and 178 in Daffiama-Issa-Busie District. Although the sample size was exceeded by 26 households, the distribution of households between the two districts was not proportional. This can limit comparison of the findings between the two study districts. The survey was carried out in 20 communities, comprising Lawra, Baa-gang, Yagpele, Zoopaal, Domwine, Kalsagri, Eremon, Baazing, Boo, Zambo, Gbengbee, Nanyaare (in the Lawra Municipality), Daffiama, Sazie, Naayikore, Danchele, Kogimaaraa, Dagonga, Issa and Fian (in the Daffiama-Issa-Busie District). Lawra and Daffiama, the only towns in Lawra Municipality and Daffiama-Issa-Busie Districts were purposively selected to avoid the findings being rural biased. The other 18 communities, which were generally rural, were selected by means of a simple random sampling.

Due to lack of sampling frame at the community level, households were evenly drawn from communities. In the Lawra Municipality, in total, 19/20 households were conveniently selected whereas in Daffiama-Issa-Bussie District, 22/33 households were selected from each sampled community. In each community, the choice of a household was largely dependent on the availability of a qualified and willing surveyor. To qualify as a surveyor, the person must have completed at least senior high school. This criterion was set to enhance the quality of data. In each household, a trained surveyor administered a brief questionnaire containing 11 questions to the main water collector. All surveyors were trained and the questionnaire pretested to assess the validity of questions. Due to high illiteracy in the study area, the medium of communication was Dagaare, the main local language in the Lawra Municipality and Daffiama-Issa-Bussie District. Data gathered from water collectors included their socio-demographic characteristics, households' main source of water for domestic use and round-trip water collection time. In addition, surveyors also timed and recorded round-trip water collection time of the main water collector (herein referred to as observed water collection time). A surveyor starts timing a water collector immediately the person steps out of the compound with a container to go and collect water and ends when he/she steps into the compound with water. To avoid biases on the part of surveyors, they were made to understand during training that the data to be collected would be used solely for academic purposes with no direct benefit or cost to their respective communities. The same information was communicated to research participants in the course of seeking informed consent to also minimize biases on their part. Field data collection spanned from February to March 2019.

Data analysis and presentation of results

Data were analysed using version 24 of the Statistical Package for Social Sciences (SPSS v24) software program. Descriptive statistics were generated on socio-demographic characteristics of respondents (water collectors), main sources of drinking water, self-reported water collection times and observed water collection times. Furthermore, a Wilcoxon signed rank test was conducted to establish

whether self-reported and observed water collection times were significantly different. A Wilcoxon signed rank test was found to be appropriate because the data were not normally distributed ($P < 0.05$). The normality of the data was verified through Kolmogorov–Smirnov (K–S) and Shapiro–Wilk tests. Both tests yielded a *P*-value of less than 0.05, implying that the data are not approximately normal (Field 2013). The results were presented in tables and interpreted.

RESULTS

The results of the study are presented in four topics. They include drinking water sources, self-reported water collection times, observed water collection times and, lastly, the association between self-reported and observed water collection times.

Drinking water sources

The main sources of drinking water in the study areas were pipe borne, standpipes/public taps, boreholes, protected hand-dug wells, unprotected hand-dug wells and rivers/streams (Table 1). A majority (86.4%) of households' drink from boreholes fitted with a hand pump. A few others drink from pipe-borne water systems (7.8%) through taps located on compounds, public taps (2.9%), hand-dug wells (1%) and rivers/streams (1.9%) (Table 1). Slight differences exist in households' sources of drinking water in Daffiama-Issa-Bussie District and Lawra Municipality. For instance, the proportion of households that depend on a borehole is 6.1 percentage points higher in Daffiama-Issa-Bussie District than in Lawra Municipality (Table 1).

Table 1 | Distribution of households by main drinking water source

	Percentage (%) of households		
Main drinking water sources	**Daffiama-Issa-Bussie District**	**Lawra Municipality**	**Total**
Pipe borne inside yard	3.4%	8.5%	6.3%
Pipe borne but from neighbour's house	22.2%	0.9%	1.5%
Public tap/standpipe	0%	5.1%	2.9%
Borehole	89.9%	83.8%	86.4%
Protected hand-dug well	0%	0.9%	0.5%
Unprotected hand dug well	0%	0.9%	0.5%
River/stream	4.5%	0%	1.9%
Total %	100%	100%	100%
Total no. of households	178	234	412

Source: Field survey, February–March, 2019.

Self-reported water collection times

Round-trip water collection times reported by water collectors ranged from 2 to 120 minutes (Table 2). The mean and median self-reported round-trip water collection times were 32 and 30 minutes, respectively (Table 2). Although the maximum reported water collection time was recorded in Daffiama-Issa-Bussie District, collection time in Lawra Municipality was generally higher than in Daffiama-Issa-Bussie District. A cross tabulation of households by various time intervals revealed that 61.1% of households collect water within 30 minutes in a round-trip (Table 3). The remaining 38.9% of households spend more than 30 minutes on a round-trip, with 3.9% of households spending more than 60 minutes. Of the 97.6% of households that drink mainly from improved water sources, 38.4% spend more than 30 minutes on a round-trip for water (Table 3). Between Daffiama-Issa-Bussie District and Lawra Municipality, the proportion of households that spend less than 30 minutes on a round-trip for water was 25.1 percentage points higher in the former than the latter.

Observed water collection times

Observed round-trip water collection times ranged from 2 to 135 minutes (Table 4). The mean and median round-trip

Table 2 | Descriptive statistics of self-reported water collection times

	Round-trip collection time (minutes)		
Measures	**Daffiama-Issa-Bussie**	**Lawra**	**Totals**
Minimum	2	5	2
Maximum	120	92	120
Mean	28	36	32
Median	25	30	30
Standard deviation	23	19	21

Source: Field survey, February–March, 2019.

Table 3 | Distribution of households by self-reported water collection time

	Round-trip water collection time			
Spatial scale/source type	**≤30 minutes**	**31–60 minutes**	**>60 minutes**	**Totals**
Daffiama-Issa-Bussie District				
Totals	75.3%	21.3%	3.4%	100%
Unimproved sources	3.4%	1.1%	0%	4.5%
Improved sources	71.9%	20.2%	3.4%	95.5%
Lawra Municipality				
Totals	50.4%	45.3%	4.3%	100.0%
Unimproved sources	0.9%	0%	0%	0.9%
Improved sources	49.6%	45.3%	4.3%	99.1%
Both districts				
Totals	61.1%	35.0%	3.9%	100%
Unimproved sources	1.9%	0.5%	0.0%	2.4%
Improved sources	59.2%	34.5%	3.9%	97.6%

Source: Field survey, February–March, 2019.

Table 5 | Distribution of households by observed water collection times

	Round-trip water collection time			
Spatial scale/source type	**≤30 minutes**	**31–60 minutes**	**>60 minutes**	**Totals**
Daffiama-Issa-Bussie District				
Totals	47.2%	44.9%	7.9%	100.0%
Unimproved sources	1.1%	2.2%	1.1%	4.5%
Improved sources	46.1%	42.7%	6.7%	95.5%
Lawra Municipality				
Totals	35.0%	47.9%	17.1%	100.0%
Unimproved sources	0.9%			0.9%
Improved sources	34.2%	47.9%	17.1%	99.1%
Both Districts				
Totals	40.3%	46.6%	13.1%	100.0%
Unimproved sources	1.0%	1.0%	0.5%	2.4%
Improved sources	39.3%	45.6%	12.6%	97.6%

Source: Field survey, February–March, 2019.

water collection times were 40 minutes and 35 minutes, respectively (Table 4), with moderate variations between districts. The observed mean water collection time in Lawra Municipality was 10 minutes higher than in Daffiama-Issa-Bussie District. A cross tabulation of households by observed water collection times showed that 40.3% of households collect water within 30 minutes, 46.6% collect water between 31 and 60 minutes while 13.1% spend more than 60 minutes on a round-trip for water (Table 5). Of the 97.6% of households whose main water source was improved, only 39.3% collect water within 30 minutes. The remaining 58.2% of households spend more than 30 minutes on a round-trip for water. The proportion of households that spend less than 30 minutes on a round-trip for water was higher in Daffiama-Issa-Bussie District (47.2%) than Lawra Municipality (35%). In other words, more households in Lawra Municipality (65%) spend more than 30 minutes on a round-trip for water compared to Daffiama-Issa-Bussie District (52.8%).

Table 4 | Descriptive statistics of observed water collection times

	Round-trip water collection time (minutes)		
Measures	**Daffiama-Issa-Bussie**	**Lawra**	**Totals**
Minimum	4	2	2
Maximum	135	135	135
Mean	34	44	40
Median	32	40	35
Standard deviation	25	25	25

Source: Field survey, February–March, 2019.

Association between self-reported and observed water collection times

A visual analysis of the descriptive statistics revealed variations between self-reported and observed water collection times. From Tables 2 and 4, the mean, median and maximum water collection times of observed are higher than that of self-reported. A Wilcoxon signed rank test was conducted to ascertain if the observed differences from the descriptive statistics are statistically significant. The test was guided by the following hypotheses:

- Null hypothesis: the median difference between self-reported and observed water collection times is zero.
- Alternate hypothesis: the median difference between self-reported and observed water collection times is not zero.

From the Wilcoxon signed rank test, 66.5% of households' water collection times observed by surveyors were

higher than that reported by water collectors, 30.1% showed otherwise while in 3.4% of households, they were the same. The test statistics reveal that observed water collection times were significantly different from self-reported water collection times at $P < 0.01$. We therefore reject the null hypothesis that the median difference between self-reported and observed water collection times is zero, and accept the alternate hypothesis, which says that the median difference between self-reported and observed water collection times is not zero. From the descriptive statistics (Tables 2 and 4), it can therefore be concluded that observed water collection times are significantly higher than self-reported water collection times.

DISCUSSION

The results of the study showed that a majority of households in the study areas (Lawra Municipality and Daffiama-Issa-Bussie District) drinks from improved water sources with the main source being borehole. The Ghana Statistical Service reported similar findings for Lawra Municipality and Daffiama-Issa-Bussie District in the 2010 Population and Housing Census (GSS 2014a, 2014b). However, the proportion of households with access to improved water source as recorded in this study (97.6%) is slightly higher than that reported for Lawra Municipality (93.9%) and Daffiama-Issa-Bussie District (85.2%) in the 2010 Population and Housing Census (GSS 2014a, 2014b). Although improved water coverage is high, it does not necessarily translate into access to safely managed water, the indicator for monitoring target 6.1 of the SDG, which seeks to achieve universal and equitable access to safe and affordable drinking water for all by 2030 (WHO/UNICEF Joint Monitoring Programme 2015a, 2015b). A safely managed water in the words of the Joint Monitoring Programme is an improved water source, which is located on premise, available when needed and free from faecal coliforms and other priority chemicals contamination (WHO/UNICEF Joint Monitoring Programme 2015a). Meanwhile, of the 97.6% of households that used improved water, only 6.3% collect water on their compounds. Also, it has been well established in the literature that improved water sources are not necessarily safe and reliable (Bain *et al.* 2014; Kumpel & Nelson 2016; Dongzagla *et al.* 2019).

Water collection times in the study areas were found to be high. Regardless of the approach employed to measure water collection time, the mean water collection time per trip was more than 30 minutes. The mean self-reported water collection time recorded in this study (32 minutes) is 10 minutes lower than that reported by Dongzagla (2019) in his study in the Jirapa and Kassena Nankana Municipalities (42 minutes) in Northern Ghana. When water collection time is more than 30 minutes, the quantity of water collected is likely to fall below the basic requirement of 20 litres/capita/day, leading to poor consumption, limited hygiene practices and health problems (Howard & Bartram 2003). It also limits water collectors' engagement in productive activities, learning and domestic work (Jonah *et al.* 2015; Oxfam 2017; Dongzagla 2019). High water collection times in the study areas largely reflect the over-reliance of population on communal water facilities. In the Upper Regions of Ghana, about 98% of the population depends on communal facilities, largely boreholes (Dongzagla 2019). Meanwhile, the nature of borehole design does not promote fast water collection because water is sourced manually from only one outlet.

The study revealed significant disparities between self-reported water collection times and observed water collection times. From the means, observed water collection times were 8 minutes higher than self-reported water collection times. Consequently, the proportion of households with access to basic water based on self-reported water collection times (59.2%) was 20 percentage points higher than observed water collection times (39.3%). This implies that water surveillance agencies like UNICEF, WHO and the JMP risk overestimating the population with access to basic drinking water in developing countries if they continue to rely on self-reported water collection times for their analysis. The generally low water collection times reported by water collectors compared to observed water collection times could be due to the low educational attainments of water collectors and lack of record keeping.

From the literature, a comparison between self-reported water collection time and direct observation of water collection time is lacking. A few studies however examined the relationship between self-reported water collection time

and GPS-based measurements of water collection time through mapping of collection paths (Crow *et al.* 2013; Pearson 2016). Crow *et al.* (2013) observed that self-reported water collection times in the popular Kibera slum in Kenya were significantly higher than GPS-based measurements of water collection times. In the same study, the results showed otherwise in Nyalenda slums. Similar to the findings of Crow *et al.* (2013) in the Kibera slum, Pearson (2016) also found that self-reported water collection times in south-western Uganda were significantly ($P < 0.05$) higher than GPS-based measurements of water collection times. Whereas the findings of Crow *et al.* (2013) and Pearson (2016) showed that self-reported water collection times are generally higher than GPS-based water collection times, this study showed that self-reported water collection times are generally lower compared to observed water collection times. It can, therefore, be inferred that GPS-based measurements of water collection times may be lower than observed water collection times. This discrepancy can be explained by failure of the GPS-based measure to capture waiting time at source. Hence, GPS-based measurement of water collection time is not suitable for monitoring access to basic drinking water which, in part, emphasized waiting time at source.

CONCLUSION

The results of the study show that self-reported water collection times were significantly ($P < 0.01$) lower than observed water collection times, possibly due to the high illiteracy level of the population, lack of record keeping and inability of water collectors to recall water collection time. The average round-trip water collection time reported by water collectors (32 minutes) was 8 minutes lower than observed water collection times (40 minutes). Consequently, the proportion of households estimated to have basic (round-trip water collection time of not more than 30 minutes from an improved source) access to drinking water based on self-reported water collection times (59.2%) was 20 percentage points higher than that of observed water collection times (39.3%). In view of this, we argue that existing statistics on basic water coverage reported by water surveillance agencies like USAID, UNICEF, WHO and WHO/UNICEF Joint Monitoring Programme at the national and global scales are overestimated because they are based on self-reported water collection times. Water surveillance agencies further risk overestimating households and population with basic access to drinking water if they continue to rely on water collectors for data on water collection times. To enhance the reliability of water collection times data and statistics on basic water coverage in the SDG era, especially in developing countries, we recommend observation of water collection time.

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