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Drinking Water Supply Challenges and Life Straw Use in Rural Zimbabwe

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Abstract

The lack of access to safe and clean drinking water plays a significant role in the rising burden of waterborne diseases. On the other hand, rapid climate variability patterns cumulatively lead to the present-day climate change status quo, which has accelerated the burden of disease (i.e., cholera and diarrhoea). This study sought to investigate the significance of Life Straw use in order to eliminate pathogens, reduce turbidity, and safeguard human health. Convenience sampling was utilised by selecting 68 participants (Mudanda village residents, trainers, Non-Governmental Organisations [NGOs], and medical personnel). Data was collected through self-administered questionnaires, Key Informant Interviews (KIIs), Focus Group Discussions (FGDs) and Field Observations (FO). Data was analysed using the Statistical Package for Social Sciences (SPSS) software version 21 and interpreted using descriptive statistics. The findings showed that more females participated in the study (64.2%), were more knowledgeable about Life Straw use (67.8%), and were concerned about waterborne diseases (67.7%) and clean-up campaigns (77.1%). A key observation by the majority (79.1%) was the reduction of turbidity after Life Straw use, as well as cleanliness and wholesomeness for consumption (92.5%). Engagements at the knowledge and attitude levels revealed a poor understanding of device use and functions (82.1%), leading to a medium level of adoption impact (53.7%). Furthermore, there is a need to improve education and awareness of Life Straw use in schools (98.5%) and rural areas (98.5%). Again, knowledge levels significantly decreased with increasing age ($P \leq 0.05$). The study recommends increased use of borehole water, Participatory Health and Hygiene Education (PHHE) sessions, and public awareness campaigns to ensure access to safe drinking water and to improve the regular use of Life Straws, including strategies for adaptation and adoption.

Keywords: Life Straw use, drinking water, human health, water supply, Zimbabwe

Défis liés à l'approvisionnement en eau potable et utilisation des filtres LifeStraw dans les régions rurales du Zimbabwe

Résumé

Le manque d'accès à une eau potable saine et propre contribue grandement à l'augmentation des maladies hydriques. D'ailleurs, l'accélération de la variabilité climatique cumulée mène au statu quo actuel du changement climatique, ce qui a accentué la propagation de maladies comme le choléra et la diarrhée. Cette étude visait à examiner l'intérêt de l'utilisation des filtres LifeStraw pour éliminer les agents pathogènes, réduire la turbidité et préserver la santé humaine. Un échantillonnage de commodité a été utilisé pour sélectionner 68 participants (habitants du village de Mudanda, formateurs, ONG et personnel médical). Les données ont été recueillies au moyen de questionnaires autoadministrés, d'entrevues avec des informateurs clés, de discussions de groupe et d'observations sur le terrain. Les données ont été analysées à l'aide du logiciel SPSS (Statistical Package for Social Sciences), version 21, et interprétées au moyen de statistiques descriptives. Les résultats ont montré qu'une plus grande proportion de femmes ont participé à l'étude (64,2 %), étaient mieux informées sur l'utilisation de la paille filtrante Life Straw (67,8 %) et se préoccupaient des maladies d'origine hydrique (67,7 %) et des campagnes de nettoyage (77,1 %). La réduction de la turbidité après utilisation de la Life Straw, ainsi que la propreté et la salubrité de l'eau pour la consommation (92,5 %), ont été des observations clés partagées par la majorité des participants (79,1 %). L'analyse des connaissances et des attitudes a révélé une faible compréhension de l'utilisation et des fonctions de l'appareil (82,1 %), ce qui explique un taux d'adoption moyen (53,7 %).

De plus, il est nécessaire d'améliorer l'éducation et la sensibilisation à l'utilisation de la vie sur la vie dans les écoles (98,5 %) et les régions rurales (98,5 %). Finalement, le niveau de connaissances a diminué significativement avec l'âge ($p \leq 0,05$). L'étude recommande un recours accru à l'eau de forage, des séances d'éducation participative à la santé et à l'hygiène (EPSH) et des campagnes de sensibilisation du public afin d'assurer l'accès à l'eau potable et d'améliorer l'utilisation régulière des pailles filtrantes LifeStraw, notamment par le biais de stratégies d'adaptation et d'adoption.

Mots-clés : Utilisation de LifeStraw, eau potable, santé humaine, approvisionnement en eau, Zimbabwe

1.0 Introduction

Access to safe and clean drinking water has been a global challenge in rural areas of developing countries (Oyekale, 2017; Khan et al., 2013; World Health Organization/United Nations Children's Fund [WHO/UNICEF], 2012). This has led to an increase in waterborne diseases, despite extensive research on the persistent knowledge gaps and their prevalence (Peletz et al., 2013; WHO, 2017). A rise in the incidence and prevalence of waterborne diseases is attributed to drinking water contamination (Rufener et al., 2010). Previous studies have shown that contaminated water is a medium of spreading several types of diseases, such as cholera, diarrhoea, guinea worm, typhoid and dysentery (Gupta & Misra, 2018; Clasen, 2015; Kanda et al., 2013; Peletz et al., 2011; Rosa & Clasen, 2010; UNICEF, 2010). In that regard, similar diseases have been

reported in Mudanda village. Furthermore, water-related diseases have contributed to the burden of disease in Africa (Sekgobela & Sibanda, 2024; Mahmood et al., 2011), with about 3.4 million deaths each year globally (Ilic & Ilic, 2023; WHO & UNICEF, 2014). An impact perspective of this investigation is premised on significant relevance to rural communities, where it seeks to unearth the risks of over-reliance on unsafe drinking water sources (Bazaanah, 2021; Onyango et al., 2015). On the other hand, building on the existing body of knowledge and assisting policy makers in proposing alternative low-cost methods for water purification. This could facilitate adoption and application in communities with similar challenges.

An increase in waterborne diseases in communities without properly established water treatment infrastructure has led to the development of the Life Straw, a small-scale water treatment device for household use (see Figure 1). Life Straws are an innovation in individual point-of-use water treatment that can be used daily, temporarily, and during emergencies (Loo et al., 2012). Life Straw filters have been observed to successfully remove bacteria and pathogens that contaminate water in humanitarian projects across Africa (Burlison, 2016; Boisson et al., 2010). Life Straw water filters comply with the US Environmental Protection Agency (EPA) 1987 Guide Standard and Protocol for Testing Microbiological Water Purifiers (WHO, 2010). However, the lack of clean water and reliance on contaminated surface water (i.e., with faecal material) use by rural communities are major causes of the burden of waterborne diseases (Rosa et al., 2014; Guchi, 2015; Gerba & Onyango-Ouma, 2011). Globally, a significant population lacks safely managed sanitation and access to safe and readily available drinking water in their homes (WHO & UNICEF, 2014; Kanda et al., 2013). Hence, in order to promote Life Straw use, more evidence is needed to assess the long-term impacts and uptake of the device for value addition purposes (Usman et al., 2018). For instance, several rural households perceive their drinking water sources as safe, even when obtained from open sources such as rivers (Francis et al., 2015; Khan et al., 2013). This has seen a prevalent trend of reported diarrhoeal cases of children (under-fives), in developing countries (WHO & UNICEF, 2014). However, health authorities estimate that over 90% of diarrhoeal cases are preventable, especially when the availability of clean water, hygiene and sanitation is improved (Cairncross & Feachem, 2018; Nagata et al., 2011).

Zimbabwe has continued to experience incessant outbreaks of waterborne diseases in the last few decades, both in rural and urban centres as observed in other developing economies (Cleary, 2012; Mbereko et al., 2020; Juru et al., 2019; Imanishi et al., 2014). In 2008, the cholera outbreak claimed 4000 lives in Zimbabwe. As a result, a significant impact was experienced among the rural folk who were affected due to a lack of access to clean water provision, improper water facilities and a lack of knowledge. In the same manner, the rural folk still remain prone and exposed to waterborne diseases (WHO, 2016). Despite the immense success of Life Straw interventions and use, key factors to consider are the effective use of technology and the capacity of the affected population to improve on good hygiene practices and or behaviour (Clasen, 2015). Although waterborne diseases have been reported in developing countries, Life Straw use has not been exhaustively investigated, particularly the community's Knowledge, Attitudes and Practices (KAP) towards sanitation and their ideals in reducing adverse health outcomes (Özdemir et al., 2011). For instance, cholera cases in Zimbabwe have been recurrent in 2018, with morbidity patterns over the last ten years ranking diarrhoea as the fourth priority disease (Mutubuki, 2022). Hence, the use and adoption of the Life Straw have been encouraged in order to enhance coping strategies to safeguard human health in rural

communities (Cleary, 2012). This is tied to the Mudanda village case study, where it is prudent to assess the effectiveness of Life Straw use in safeguarding human health and to curtail the incidence of waterborne diseases (Bradley et al., 2018). Furthermore, to compare pre-Life Straw application water quality levels to the post-Life Straw levels and assess adoption challenges of Life Straw use as compared to other methods of water purification in Mudanda community.

Figure 1: Life Straws.



Source: www.lifestraw.com 25/06/2025).

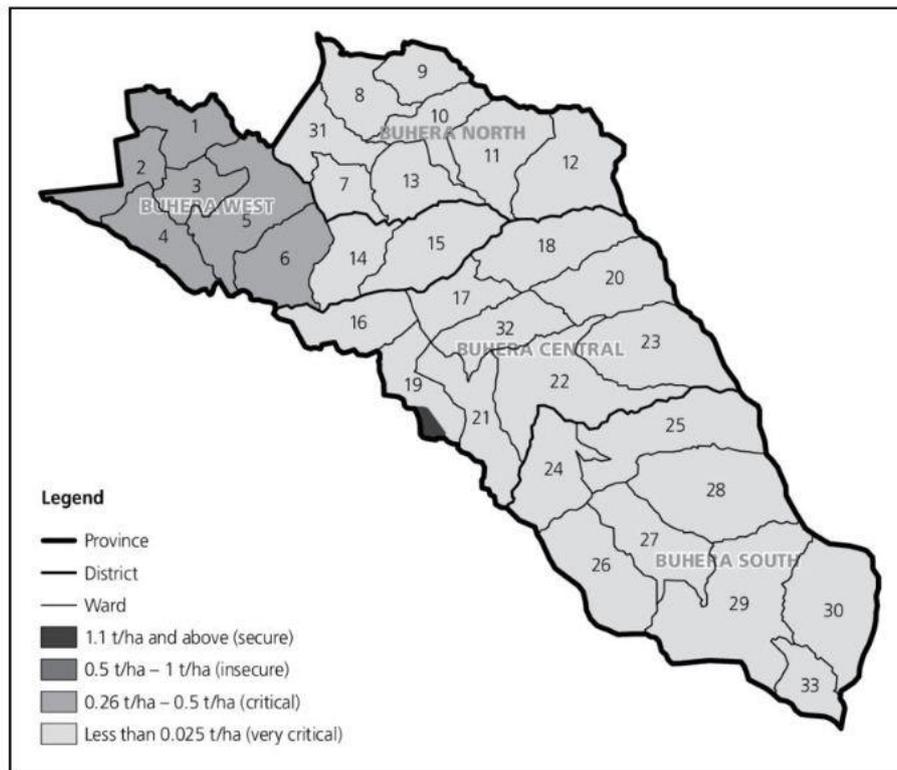
2.0 Materials and Methods

Mudanda village is located approximately 20 km south of Murambinda in Buhera District in Manicaland Province (see Figure 2). The area is situated at 19.36° South, 31.71° East and is 1021.00m/33.49.74ft above sea level. The estimated population is 1340 people (Zimbabwe National Statistics Agency, 2012). The main sources of portable water are boreholes, despite a low coverage, as some boreholes are defunct due to poor maintenance. Hence, most villagers use shallow wells, rivers and dams as alternative water sources, notwithstanding exposure to animals and human waste (open defecation) that may contaminate the drinking water sources (Messeret, 2012).

A descriptive survey design involving both qualitative (i.e., using discussion guides and thematic analysis) and quantitative approaches was applied. A stratified random sampling method was used for villages, while purposive sampling was utilized for key informants. Sixty-eight household questionnaires were administered, two KIIs, two FOs conducted on different dates on water storage containers and two FGDs. The FGDs were comprised of 10 (e.g., seven females and three males) and 13 (i.e., nine females and four males) respondents, respectively, at the well-known borehole sites where most community members fetched water. The questionnaire included closed and open-ended questions (i.e., on health and hygiene, Life Straw use), while KIIs and FGDs (e.g., waterborne diseases, pathogenicity, and frequency of seeking medical attention) followed a

guideline at the onset while allowing sufficient coverage and flow of the investigations. Data analysis commenced in the field, where it was sorted and checked for correct completion and consistency. Data was coded, entered, cleaned, transformed, analysed and interpreted. Descriptive statistics were used to analyze the data using the Statistical Package for SPSS version 21, and the results were presented using frequency tables, percentages, and tables. Inferential statistics were applied for qualitative characterisation and explanations. Ethical research practices were observed throughout the study through the application of informed consent, confidentiality and ethical approval from relevant authorities.

Figure 2: Map of Study Area (Ward 16).



Source: Mapanje et al. (2020).

3.0 Results

3.1 Demographic Characteristics

Table 1 indicates the demographic characteristics of the respondents, where the majority were females (64.2%) and have attended secondary school education (62.7%), with the highest proportion of respondents being married (47.85%).

Most (92.5%) of the respondents received health and health hygiene education (see Table 2) and reported the highest knowledge scores in point-of-use water treatment (65.7%), a similar trend observed in other studies on water quality interventions at household level (Bartram & Cairncross, 2010). Just over half (50.7%) of the respondents used wells as water sources and the majority of respondents (97%) reported that they have heard about a Life Straw and have seen it in use. However, with regard to consistency, most respondents (82.1%) experienced gaps in Life Straw use, reported cases of disease outbreaks in the community (97%) and linked health risks to garbage dumping (91%).

Table 1. *Demographic Characteristics of Participants*

Category	N	%
Age		
Below 20	27	40.3
21–30	8	11.9
31–40	3	4.5
41–50	24	35.8
51–60	5	7.5
Gender		
Male	24	35.8
Female	43	64.2
Marital Status		
Married	32	47.85
Single	26	36.8
Divorced	2	3.0
Widowed	5	7.5
Separated	2	3.0
Level of Education		
Primary	22	32.8
Secondary	42	62.7
Tertiary	3	4.5

Table 2. *Respondents' Knowledge Levels*

Knowledge attributes of respondents	(%)
Health and hygiene education	92.5
Safe disposal of excreta	3
Food hygiene	6
Refuse disposal	1.5
Water storage methods	10.4
Handwashing	9
Point-of-use water treatment	65.7
Knowledge of water sources (%)	
Boreholes	35.8
Wells	50.7
Tanks	4.5
Rivers	3.0
Dams	0
Others	6.0

Table 2 continued

Knowledge about Life Straw device	Yes (%)	No (%)
Heard about Life Straw and seen it in use	97	3
Satisfaction with the frequency of Life Straw use	53	47
Gaps experienced when using Life Straw	82.1	17.9
Community experienced any cases of disease outbreak	97	3
Health risks associated with dumping garbage	91	9

On the basis of usage, most respondents (53.7%) were satisfied with the frequency of Life Straw use in their area of jurisdiction corroborating observations from previous studies elsewhere (Kioko et al., 2012). Hence, most (79.1%) of the respondents were satisfied with the Life Straw performance and the majority (52.2%) participated in clean-up campaigns of waste (see Table 3).

Table 3: *Practices of Respondents*

Frequency of Life Straw use	Yes (%)	No (%)
Every day	34.3	65.7
Once a week	9.0	91
Twice a week	7.5	92.5
More than twice a week	46.3	53.7
Satisfaction with the performance of LifeStraw	79.1	20.9
Participation in clean-up campaigns	52.2	48.8
Methods of Handwashing and Detergents	Yes (%)	No (%)
Place water in a dish and wash hands	47.8	52.2
With running water	32.8	67.2
Other (using wet dish towel to clean hands)	1.5	98.5
Washing hands with water only	44.8	55.2
Water and soap or ash	37.3	67.7

Most users (92.5%) were concerned about waterborne diseases and perceived Life Straw use as the best method for water purification (83.6%), (see Table 4). While focusing on peer observations, most (52.2%) of the respondents were happy with the way their neighbours store water. The majority (79.1%) acknowledged the benefits of Life Straw use as compared to other water purification methods. Most (98.5%) respondents attributed the highest attitude scores on Life Straw use to the water education programmes (98.5%), while there was a clarion call on the need to teach waterborne diseases management in schools (98%). Most respondents felt Life Straw use enhanced water quality (79.1%) while garbage collection and clean-up campaigns was their responsibility (76.1%).

Table 4: *Safety Hygiene Behaviour*

Safety hygienic behaviours	Yes (%)	No (%)
Concern about waterborne diseases in the community	92.5	7.5
View on Life Straw as the best way of water purification	83.6	16.4
Happy with the way neighbours store water	52.2	47,8
Benefits of Life Straw use as compared to other water purification methods	79.1	20.9
Necessity for Mudanda Community to have Life Straws and water education programmes	98.5	1.5
Proper waterborne diseases management should be taught in schools	98.5	1.5
Difference between using a Life Straw or not on water quality	79.1	20.9
Picking up garbage and clean-up campaigns is my responsibility	76.1	23.9

3.2 Attributes of Age on Knowledge Attitudes Practices and Behaviours (KAPB)

The age groups < 20 years and 41–50 years show high levels of knowledge, attitudes, behaviours, and practices. This may have been due to the impact of formal school curriculum on health and hygiene education and their experiences on waterborne diseases over time (see Figure 3). The age group with the highest responses of attitudinal, knowledge and practice levels was the <20 years age group, followed by the 41–50 years age group. There is a general decline in the number of responses with regard to attitudes, knowledge and practice with increasing age. The general decline in the number of responses with regard to attitudes, knowledge and practice with increasing age was not significant (N=67), ($\tau=0.46$, $p<0.05$).

Respondents who had undergone secondary education had the highest responses of knowledge and attitude with regard to the following attributes: (i) Life Straw purification methods and processes, (ii) waterborne diseases, (iii) clean – up campaigns, (iv) Life Straw performance, and (v) frequency of Life Straw use. This could be attributed to health and hygiene education in schools and the community (see Figures 3, 4 and 5). Furthermore, females had a high regard for waterborne disease management as compared to males. This could be attributed to water, sanitation, and hygiene being reserved for women and the school – going age group being educated (Chimusoro, 2015). The category of secondary education had the highest attitude levels as compared to primary and tertiary education (see Figure 6). There is a general decline in terms of responses for secondary and tertiary education, while there is a steady increase of responses from respondents who had attained primary education. The general decline in terms of responses for secondary and tertiary education was not significant (N=67), ($\tau=0.73$, $p<0.05$), while the general increase of responses for primary education was also not significant (N=67), ($\tau=0.73$, $p<0.05$).

Figure 3: Attributes of age on knowledge levels.

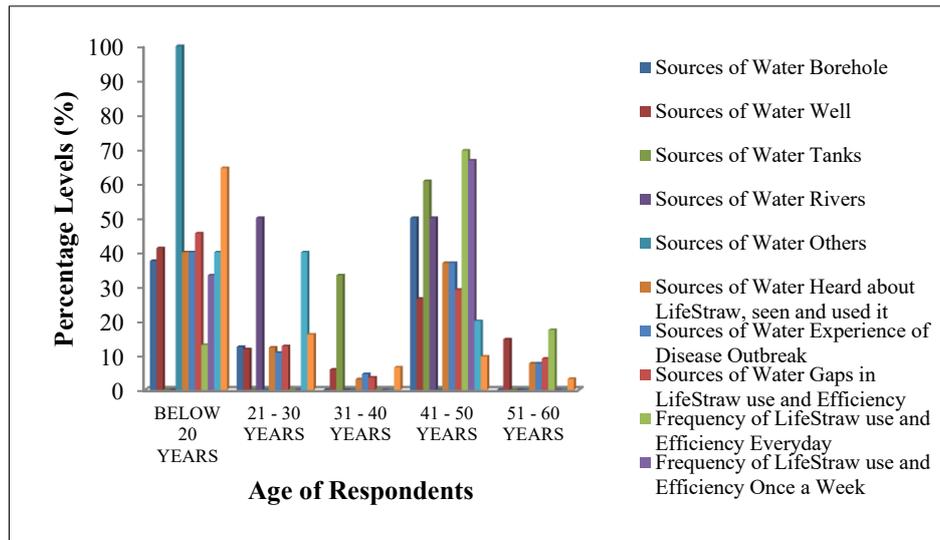


Figure 4: Attributes of age on attitudes.

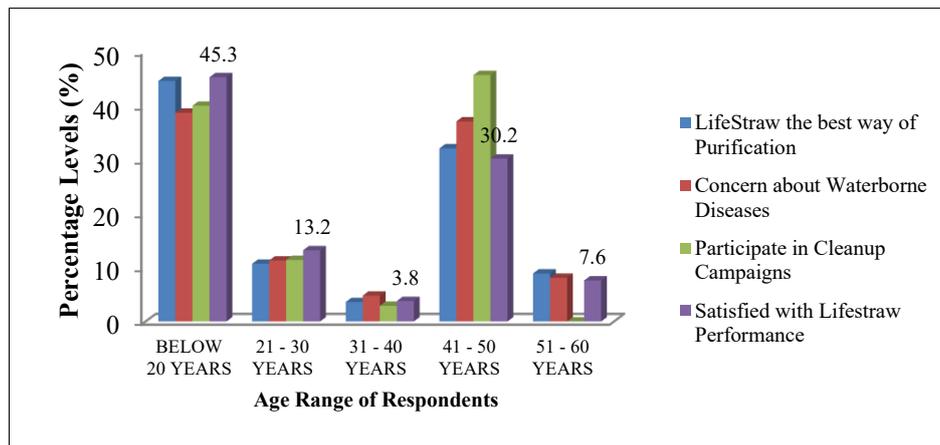


Figure 5: Attributes of age on practices/behaviours.

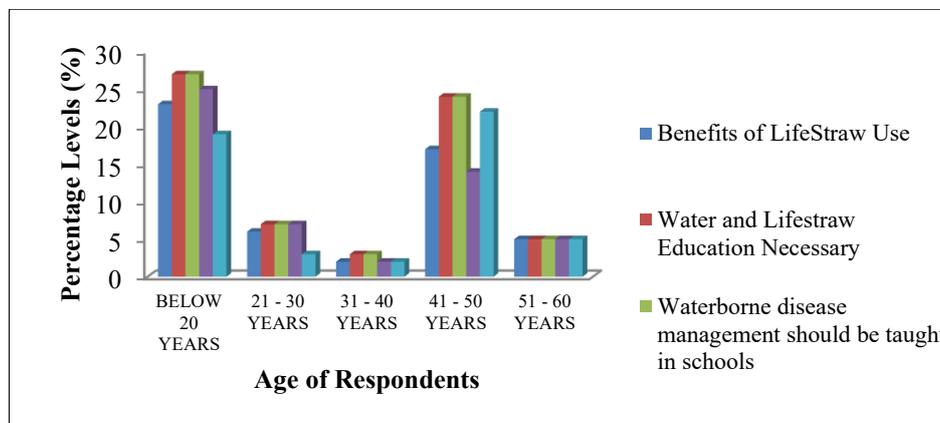
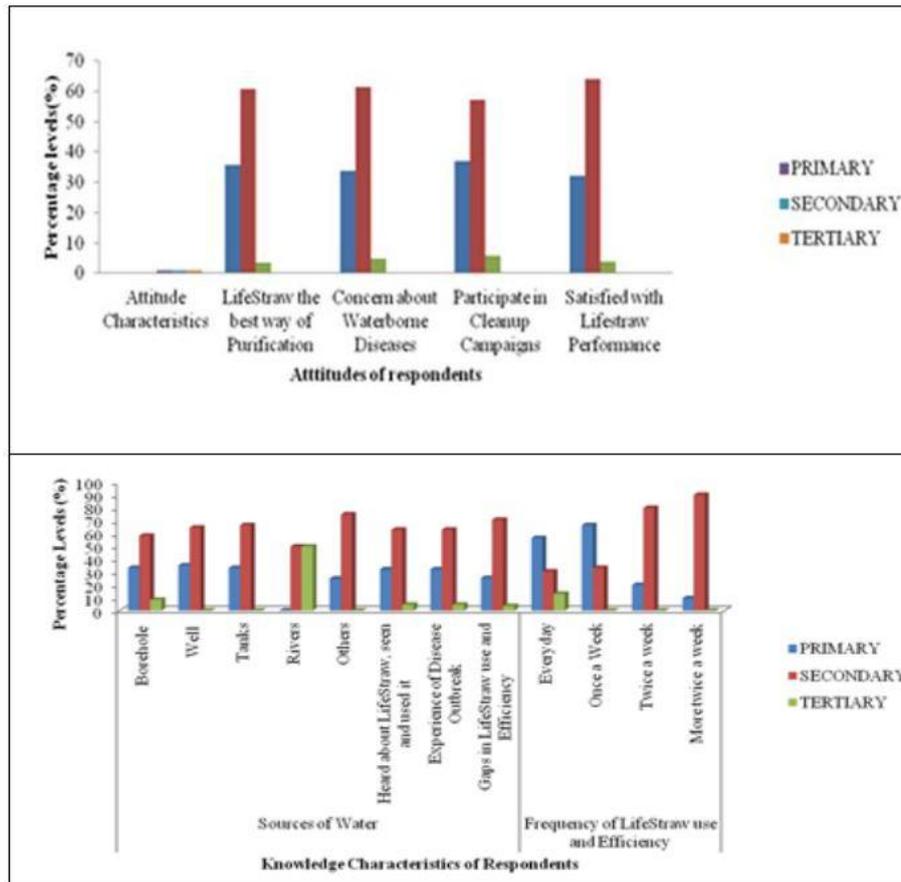


Figure 6: Knowledge and attitudes versus level of education.



3.3 Gender and Knowledge Attitudes Practices and Behaviours (KAPB) Attributes

3.3.1 *Health and Hygiene Education.* There are more females (58%) who have received health and hygiene education as compared to males (30%) which is similar to previous studies (Aladuwaka & Momsen, 2010). The highest level of health and hygiene education received by respondents was point-of-use water treatment (66%), followed by water storage methods (10%) and food hygiene (6%), these observations corroborate previous studies elsewhere (Peletz et al., 2012; Rane, 2011). On the other hand, in all the three levels of education, there were more females as compared to males; point-of-use water treatment (females 36%, males 30%), water storage methods (female 9%, males 1%) and food hygiene (females 5%, males 1%). A chi-square test of independence was performed to examine the relationship between gender and the receipt of health and hygiene education. The relationship between these variables was significant, $\chi^2 (1, N=67) = 4.028, p=.045$. Females were more likely than males to receive health and hygiene education in Mudanda.

3.3.2 *Water Sources, Use and Treatment, Health Risks and Diseases.* Wells were the highest type of water source utilised (51%) followed by boreholes (36%), a trend similar to other studies elsewhere (Albert et al., 2010). While more females utilised wells (females 31%, males 19%) and boreholes (females 24%, males 12%) than males respectively. More females (61%) have heard about Life Straw, seen it and utilised it for water treatment. Most of the respondents (82%)

highlighted that there were more gaps experienced in Life Straw use and remedial action for use. Similarly, there were more females (49%) than males (33%) that have experienced gaps in usage and remedial action. A chi-square test of independence was performed to examine the relationship between gender and experiencing gaps in Life Straw use and remedial action. The relationship between these variables was significant, $\chi^2(1, N=67) = 3.857, p=.050$. Females were more likely than males to experience gaps and challenges in Life Straw use and remedial action. Hence, the highest proportion of respondents not satisfied with the frequency of Life Straw use were females (31%). Disease outbreaks (97%) and health risks (91%) were reported by the majority of the respondents' respectively. On the other hand, more females (63%) than males (34%) reported the prevalence of disease outbreaks, and similarly, more females (60%) than males (31%) reported health risk association with waste dumping.

3.4 Age and Knowledge Attitudes Practices and Behaviours (KAPB) Attributes

3.4.1 Health and Hygiene Education. The age group below (<20 years) had the highest proportion of respondents (39%) receiving health and hygiene education, followed by the 41–50 years age group (31%) and the 21–30 years age group (12%). There was a general decline in the receipt of point-of-use water treatment education with increasing age. All age groups reported the point-of-use water treatment type of health and hygiene education. The highest proportion of respondents (30%) was in the age group below 20 years of age (<20 years), followed by the 41–50 years age group (19%), 21–30 years (8%) and 51–60 years (8%), respectively. A chi-square test of independence was performed to examine the relationship between age and the type of health and hygiene education received. The relationship between these variables was significant, $\chi^2(20, N=67) = 40.156, p=.005$. The young age group had more access to point-of-use water treatment than the older age groups.

3.4.2 Water Sources, Use and Treatment, Health Risks and Diseases. There was a general decline in the use of wells as water sources with increasing age, while there was a general increase in the use of boreholes with increasing age. Well use was highest (21%) in the age group below 20 years of age (<20 years), while borehole use was highest in the 41–50 years age group (18%). There is a general decline in knowledge about Life Straw utilization with increasing age. The highest proportion (39%) is reported by the age group below 20 years of age (<20 years) followed by the 41–50 years age group (36%). A chi-square test of independence was performed to examine the relationship between age and knowledge about Life Straw utilisation. The relationship between these variables was significant, $\chi^2(4, N=67) = 21.323, p=.001$. The young age group had more knowledge on Life Straw utilization as compared to the older age groups.

There is a general decline in the satisfaction frequency of Life Straw use with increasing age. The age group with the highest (25%) level of satisfaction is below 20 years of age (<20 years), followed by the 41–50 years age group (22%). Similarly, the dissatisfaction levels show a similar trend of decline with increasing age. There is a general decline in the observation of gaps experienced in Life Straw use and remedial action for efficient use with increasing age. The highest proportion of respondents was in the age group <20 years of age (37%), followed by the 41–50 years of age (24%). A chi-square test of independence was performed to examine the relationship between age and gaps experienced in the efficient use of Life Straws. The relationship between these variables was

significant, $\chi^2(4, N=67) = 9.467, p = .050$. The young age group experienced more challenges on Life Straw utilization as compared to the older age groups.

There is a general decline in the reporting of disease outbreaks related to poor water, sanitation and hygiene management. The highest proportion reporting disease outbreaks is the <20 years of age group (39%), followed by the 41–50 years age group (36%). There is a general decline in the reporting of health risks associated with dumping garbage with increasing age. The age group <20 years (39%) reported more health risks, followed by the 41–50 years age group (30%).

3.5 Level of Education and Knowledge, Attitudes, Practices, and Behaviours (KAPB) Attributes

3.5.1 Health and Hygiene Education. The highest level of respondents who have received health and hygiene education are those who have attained secondary education (60%), followed by primary education (30%). Spearman's rank correlation was computed to assess the relationship between receipt of health and hygiene education and level of education. There was a positive correlation between the two variables, $r(65) = .85, p=.023$. The highest level of respondents who have received point-of-use water treatment type of education are those that have attained secondary education (43%), followed by primary education (22%).

3.5.2 Water Sources, Use and Treatment, Health Risks and Diseases. The highest level of respondents who utilised water sources are those who have attained secondary education (33% for wells and 21% for boreholes), followed by primary education (18% for wells and 12% for boreholes). Spearman's rank correlation was computed to assess the relationship between types of water sources utilised and level of education. There was a positive correlation between the two variables, $r(65) = .85, p=.024$. The highest level of respondents who have heard about Life Straw, seen and utilised it, are those who have attained secondary education (61%), followed by primary education (31%) and tertiary education (5%). The highest level of respondents expressing dissatisfaction with Life Straw use, are those who have attained secondary education (33%), followed by primary education (9%). At the same time, those who expressed satisfaction had a similar trend, although with lower responses (28% for secondary education and 22% for primary education). The highest level of respondents experiencing gaps in Life Straw use and remediation are those who have attained secondary education (58%), followed by primary education (21%). The highest level of respondents experiencing disease outbreaks are those who have attained secondary education (61%), followed by primary education (31%) and tertiary education (5%). The highest level of respondents highlighted the possibility of health risks associated with dumping garbage, are those who have attained secondary education (60%), followed by primary education (27%) and tertiary education (5%).

3.6 Marital Status and Knowledge, Attitudes, Practices and Behaviours (KAPB) Attributes

3.6.1 Health and Hygiene Education. The highest level of respondents who received health and hygiene education was married (43%), followed by the single (37%) and widowed (8%). Of all the five categories of marital status, four categories recorded the point-of-use water treatment as the highest. While the highest number of respondents using point-of-use water treatment was single (30%), followed by those who were married (25%). All five categories of marital status recorded the use of wells, while three categories recorded the use of

boreholes. The highest number of respondents who used the boreholes were married (22%), followed by the single (12%). The highest number of respondents using wells were single (21%) and married (19%). All five categories of marital status had heard about Life Straw use, seen and utilised it. The highest number of respondents who heard about Life Straw, saw or used it were married (22%), followed by the single (12%).

3.6.2 Water Sources, Use and Treatment, Health Risks and Diseases. None of the five categories of marital status were satisfied with the frequency of Life Straw use. The highest number of respondents who were satisfied with the frequency of Life Straw use were married (27%), followed by the single (25%). All five categories of marital status experienced gaps and remedy challenges in Life Straw use. The highest number of respondents that experienced gaps and remedy challenges in Life Straw use were married (37%) followed by the single (36%). All five categories of marital status experienced disease outbreaks related to poor water, sanitation, and hygiene management. The highest number of respondents who experienced disease outbreaks related to poor water, sanitation and hygiene management were married (46%), followed by the single (37%). All five categories of marital status associated health risks with dumping garbage. The highest number of respondents associated health risks with dumping garbage were married (40%), followed by the single (37%).

3.7 Field Site Observations

The main observations were as follows: there was no water filtered on site or in homes, while there were a number of shallow hand-dug wells. Open-lined wells covered to prevent agents of contamination were noted (see Figure 7).

Figure 7: Household water sources.



3.7.1. Household Water Treatment, Collection and Storage. Households' practices include boiling and filtering as a form of water treatment, however other studies have noted the deleterious impact of using firewood on deforestation levels (Okpara et al., 2011). No further water treatment was done as villagers have been using the same water sources without any health challenges. Containers used for water collection were wide open and ranged from 20-litre buckets and pails to five-litre and two-litre bottles, commonly made from reused High-Density Polyethylene (HDPE) material (see Figures 7 and 8).

Figure 8: Containers for collecting water in Mudanda Village water sites.



3.7.2. *Water, Sanitation, and Hygiene (WASH) Facilities, Diseases and Waste Management.* Households were observed to have latrines for males and females, while bathrooms were shared. While most households had rubbish pits, there was no waste collection or separation from the pits except for burning of the waste when the pit was full (see Figure 9). No handwashing was done after (i) using a latrine, (ii) doing dirty work like ploughing, (iii) before breastfeeding, (iv) food preparation, and (v) food serving. At the household level, latrines and bathrooms lacked access to hygiene materials such as soap. Villagers were observed to be (i) drinking contaminated water from hand-dug wells; (ii) storing water in wide open containers; and (iii) not washing hands after visiting latrines, while flies were observed all over fruits and vegetables. Furthermore, households diligently utilised latrines, disposed of waste in refuse pits, and dried cleaned utensils on racks. Households also kept oral rehydration salts and knew how to use them, implying a good level of understanding of health and hygiene promotion. The environment around the waste disposal sites was clean, far from rubbish, wastewater, and open drains. Water vessels were normally cleaned using sand and water. However, sanitary wear was poorly disposed of, and open defecation in the maize fields posed a risk to the rural population. Furthermore, water filtration and purification methods were not utilised regularly in comparison to the Life Straw method (De Ver Dye et al., 2011; Pickering et al., 2016).

Figure 9: Household Latrine and Rubbish Pit.



3.8 Key Informant Interviews

Two key informant interviews were conducted, and the respondents affirmed the importance of water filtration with notable benefits, including the removal of all insoluble substances and the attainment of clean water. Life Straw use reduced risk of infection, while other available methods of water treatment included boiling water, applying the Water Guard chemical for water treatment, and chlorination. Respondents applied Life Straw use for water purification on all water sources in order to reduce contamination. Most water sources were kept hygienic and in good condition and were regularly cleaned through sweeping and chlorination. Water collected was normally filtered and stored in covered 20-litre buckets, while unfiltered water is stored in uncovered buckets. Common symptoms of waterborne diseases included stomach pains and diarrhoea (e.g., for cholera, dysentery, and diarrhoea). Respondents indicated that when infected, they notified primary health care workers or presented themselves to the hospital for medical attention, while utilising the salt and sugar solution to prevent excessive dehydration. Respondents also indicated that they could prevent themselves from contracting waterborne diseases by drinking safe, clean water that has been boiled, chlorinated or from protected wells, boreholes, or taps. Handwashing with soap after toilet use goes a long way toward preventing waterborne infections. On the other hand, respondents indicated that the reasons for non-Life Straw use were negligence.

Respondents indicated that handwashing after toilet use, before handling the Life Straw technology, and after doing their work was effective for health and wellness. The respondents indicated that keeping long fingernails has a negative impact on one's health. Respondents demonstrated handwashing as follows: running their hands under water, applying soap all over their hands, and then squeezing them one to the other thoroughly between the fingers, in palms and outside the palms, and allowing them to dry after. Waterborne and foodborne diseases such as typhoid, diarrhoea, cholera and dysentery can be contracted when respondents do not wash their hands properly, while soap or ashes can be used as detergents in the handwashing and cleaning processes. Respondents highlighted that water quality is important at the workplace as it protects and promotes good health. To ensure that the workplace has good water quality, they access safe and clean water from tanks set up by the Ministry of Health and Child Care, while also ensuring regular water quality monitoring is conducted. Respondents emphasised that employees must be educated on the dangers of water and foodborne diseases. The need for education and training of employees on proper integrated water management at the workplace was emphasised. Awareness activities conducted at regular intervals included 'avoiding the use of any available water without establishing the levels of portability' as well as 'proper handwashing after toilet use.'

3.9 Focus Group Discussions (FGDs)

The respondents indicated that it is important to safeguard humans from waterborne diseases and that they practice boiling water as a method of water purification. At the same time, the unavailability of clean water has negative effects on human health, leading to the incidence of cholera and typhoid. Respondents reported that Life Straw use required more local people to be educated and trained on monitoring the use process. Contaminated water was associated with most waterborne diseases, while the Life Straw challenges observed were compared to other methods showing the following outcomes: clogging of Life Straw, shortage of the device, improper usage and handling, as well as ignorance and lack of education on its use. On the other hand, there was

a lack of knowledge, poor understanding of the concept, and continued doubt about the effectiveness of device use, limited frequency of cleaning the device through backwashing, and the unavailability of device management expertise. The FGDs agreed that the main remedy for Life Straw use was the provision of education and awareness on health and hygiene matters.

Contamination and disease prevention were reduced through handwashing when using Life Straws. Poor hygiene, such as open defecation, affected participants' health, increased the health risks (through water pollution) and inherent costs of seeking medical attention when disease outbreaks occur. Observations show that the prevalence of waterborne diseases was a major concern in the community. Life Straw was perceived to be a better water purification method as its simplicity in usage reduced the potential of waterborne diseases. Life Straws have been observed to be clean, fast, efficient, and less expensive, while reducing the burden of chores, hence advancing women's empowerment. Furthermore, limited costs are incurred once the device is secured, as it has a capacity to process 1000 litres of filtered water per individual per annum and, at the same time, abate any potential carbon pollution through the boiling of drinking water (i.e., after Life Straw use).

Community members were committed to adhering to proper water sanitation and hygiene standards through participation in clean-up campaigns and being receptive to awareness trainings and education provided by the primary health care workers, similar scenarios have been observed in previous studies elsewhere (Peacock, 2015). Waterborne disease management education is strongly encouraged in schools through training and monitoring by the Ministry of Health and Child Care and Participatory Health and Hygiene Education (PHHE) tool kits. It was observed that there is a need for regular, consistent hygienic use of toilets, the provision of more Life Straws to a larger population with more advanced technology, and training of teachers in schools and community leadership.

4.0 Conclusion and Recommendations

4.1 Conclusion

Waterborne diseases affect communities through disease prevalence and loss of lives; hence, there is a need to design control measures to safeguard human health, especially where water access is a major challenge. Life Straws have the potential to safeguard against water-related burden of disease, and its effectiveness depends on the full adoption, implementation, and management of the device. The study revealed that the respondents had good knowledge of the Life Straw water purification method, despite a significant population having poor attitudes and practices towards its use. This indicates the need to increase awareness and education about the potential challenges posed by unsafe water sources, such as rivers, streams, shallow hand-dug wells, as well as poorly lined wells.

4.2 Recommendations

Local authorities are implored to develop appropriate strategies, with a special focus on the benefits of water filtration, to foster the adoption and uptake of Life Straw water purification devices for water treatment in rural households. Recommendations for households focus on the need to increase the level of provision of Life Straws in the community. For the community, there is a need to establish safe and clean water source points that adhere to the recommended sanitation guidelines that meet the drinking water thresholds. A common recommendation for all groups is health and hygiene education, which must be

promoted in the community and in the school setup through educational awareness campaigns. There is a need for training programmes on drinking water safety that advocate for appropriate water use, hygiene and sanitation strategies.

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