Knowledge, attitudes, practices and behaviours (KAPB) around water, sanitation and hygiene (WASH) in villagers exposed to schistosomiasis in Zimbabwe

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Abstract

There is paucity of comprehensive studies on social, cultural and behavioural aspects that influence and constrain toilet and borehole adoption and use in rural Africa. The objective of this study was to provide an evidence base to inform policies on increasing end-user adoption of toilets and access to safe water sources. One hundred and twenty-seven households in the Murewa district of Zimbabwe were surveyed via questionnaire to determine the social, cultural and behavioural influences that drive ownership and use of toilets and safe water sources. Rates of the water borne schistosome infection amongst pre-school aged children (PSAC) in the community were determined as a marker of the relationship between water, sanitation and health. The study showed that the community’s water and sanitation (WASH) coverage was as follows: 60.62% had access to toilets and 48% had access to boreholes. Of those with access to toilets 16% of adults and 36% of children did not use the toilets, instead they practiced open defecation. Schistosomiasis prevalence in PSAC was 42.4%, with 13% of schistosome infection being attributed to open defecation and 27% to using river water. In relating WASH to status or wealth symbols, the study showed that 34% of the adults possessed livestock and 30.7% had a mobile phone but did not have a toilet. Reasons for non-uptake of WASH and non-adherence to toilet use included lack of suitable sanitation facilities, lack of cleanliness in existing facilities, cultural factors and sub-optimal health education. An integrative approach is needed to effectively improve uptake and adherence to WASH. The use of context relevant behavioural theories and interventions is required to influence prioritisation and subsequent adherence to WASH facilities.
Introduction

Access to clean water, adequate sanitation and hygiene (WASH) is critical in preventing several infectious diseases, including neglected tropical diseases (NTDs) such as schistosomiasis, soil-transmitted helminths, and trachoma. These NTDs affect more than 1.5 billion people, with a significant proportion being in sub-Saharan Africa [1] and can cause blindness, disfigurement, permanent disability or death. Additionally, apart from poor provision of adequate WASH facilities, existing toilets and boreholes are underutilized, compromising efforts to prevent and reduce contamination of the environment and domestic water sources [2].

The UNICEF—WHO Progress on Drinking Water, Sanitation and Hygiene Update 2021 [3] estimated that in 2020, 2.2 billion people lacked safely managed drinking water and over half of the global population (4.5 billion people) do not have access to safe sanitation. There is also widespread open defecation in low-middle income countries (LMIC) due to inadequate toilet facilities and underutilization of available facilities [3]. While other regions experienced a drop in the number of people practising open defecation between 2000 and 2015, the number of people practicing open defecation in sub-Saharan Africa increased from 204 to 220 million [4]. In Zimbabwe, where we conducted this study, 73% of the population has access to safe water and 60% to improved sanitation facilities, however, more than 60% of the rural water supply infrastructure is in disrepair and 44% of people in rural areas practice open defecation facilities [4–6], with the prevalence of schistosomiasis at 62.3% in parts of Zimbabwe [7].

Thus, there is a need to improve WASH uptake and adherence, which requires a two-stage approach. The first must address the poor provision of WASH facilities and the second must improve adherence to already existent and new WASH facilities. Policies and strategies for improved WASH requires a change in knowledge, attitude, practices and behaviour (KAPB). It is important to first understand the mechanisms for changing KAPB in the relevant populations. The theory of planned behaviour (TPB), proposed by Ajzen [8] recommends that the best predictor of behaviour is the intention to perform said behaviour (behavioural intent). Such theories can offer insights into non-adherence of WASH policies and frameworks of how to change this in rural communities to improve public health and community wellbeing. Behavioural intent summarises the individual’s motivation to act in a particular manner (e.g., adherence to WASH policies) and indicates how much they are willing to try and how much time and effort they are willing to expend to perform said behaviour [9]. Such theories can serve as a useful tool in formulating policies of change and informing WASH community education programmes. TPB proposes that intention can be predicted by the constructs of attitude, subjective norms and perceived behavioural control. Perceived behavioural control accounts for behaviours that require resources and opportunity [8, 10, 11] and is thought to influence intention and to the extent that perceptions of control accurately reflect the person’s actual control over a behaviour. However, prior to any interventions to improve KAPB and therefore, WASH uptake and adherence, there is a need to evaluate current KAPB and the factors giving rise to them. Thus, the objective of this study was to conduct this baseline assessment of current KAPB towards WASH.

Whilst there have been studies in some parts of Africa and previous studies in Zimbabwe, none of those conducted in Zimbabwe are within the past five years and few have explored non-adherence to WASH. Thus, this study had three aims, i) to determine the value and symbolic attachment that communities place on home toilets and safe water source, ii) determine factors contributing to effective utilization of homestead toilets and safe water sources and iii) determine perceptions regarding toilet ownership among people with and those without toilets.
Methodology

Ethics statement
Ethical approval for the study was obtained from the University of Edinburgh’s Ethical Review Committee and the Medical Research Council of Zimbabwe (MRCZ/A/2587 and MRCZ/A/1710) respectively. Local permission for the study was obtained from the Provincial Medical Director and Village Heads. The study aims and procedures were fully explained in Shona (the local language) to all participants prior to them giving written informed consent to participate in the study. Participation was voluntary and participants were free to withdraw at any stage.

Study population/area
The study was conducted in Murewa district, located about 75 km northeast of Harare, Zimbabwe, with centre coordinates 17° 39’ 0” S and 31° 47’ 0” E and about 1400 m above sea level. The average annual rainfall ranges from 600 mm to 700 mm while the average annual temperature is 28°C. The inhabitants are predominantly subsistence farmers. Murewa has extensive wetlands and perennial rivers used by rural communities as sources of water for domestic use (Fig 1).

The district has health service providers consisting of rural district council-managed health facilities and one referral hospital called Murewa hospital. Murewa district is endemic to Schistosomiasis due to the abundant surface water. Epidemics such as cholera and malaria also occur in the district due to various reasons, including poor sanitation [12]. One hundred and twenty-seven households were recruited into the study. The sample size was obtained through a sample size calculation which gave the sample size of 127, working from the guideline of 75% toilet and borehole coverage in the region [13].

Study design
A cross-sectional study using qualitative approaches was used to address the social, cultural and behavioural aspects that influence toilet adoption and use. WASH baseline knowledge in rural districts was collected on existing KAPB towards WASH. This baseline survey also gathered data regarding behaviour and knowledge on vectors of communicable diseases in the district. Data were collected and recorded electronically Open Data Kit (ODK, https://opendatakit.org/). The systematic and integrative data collection approach is both quantitative and qualitative. Social, cultural and behavioural influences that drive the uptake and use of toilets and safe water sources were documented.

Knowledge, attitude, perception and behaviour data collection
An inception meeting was held with the district health personnel and village and health workers to explain the project background, aims and procedures prior to sensitization of participating communities. In the pilot phase we trialled and validated data collection techniques such as Key Informants Interviews (KII), Focus Group Discussions (FGD) and study questionnaires, were trialled and validated prior to commencement of the study. Primary data collection included the Household (HH) questionnaire, KII and FGD. The HH questionnaire was administered by a pair of researchers who recorded the participant responses electronically and took photographs of the toilet and mobile phone owned by the family. The questionnaires (S1 Text) collected information on WASH practices and their social cultural and economic drivers. We also investigated the symbolic value attached to WASH facilities relative mobile phone ownership (mobile phones have been reported as status symbols from other studies...
from Africa [12, 14, 15] and livestock ownership, as livestock has been identified as a symbol of wealth in some African countries [16–18].

**Survey of toilet and mobile phone ownership**

We gathered data on toilet and mobile phone ownership using the Fieldtask application on a tablet, when going to homesteads with an identified kindergarten toddler, who consented to being interviewed. The homesteads included were those with children already in another study looking at rates of schistosomiasis in the area. When going to the households/ homesteads we were accompanied by village health workers to indicate which homesteads we were looking for. Photographs were then taken of the respondents’ toilets and mobile phones (if they possessed one). The geographical coordinates were also captured of each homestead interviewed. We chose to compare toilet ownership to mobile ownership because the pit latrine toilets used in rural Zimbabwe are cheaper to build compared to the average cost of buying and running a mobile phone. Toilets use locally available and naturally occurring building materials.
materials (clay for bricks) other than cement and the Ministry of Health has run programs teaching people how to build toilets. In our study, toilets were cheaper to build (costing on average 20 USD) compared to the average cost of buying and running a mobile phone (average 5 USD charging costs). Protected wells are also cheap to build as they require only labour and families tend to build their own protected wells. Boreholes are more expensive to build with costs varying extensively between households.

**Parasitology**

We diagnosed infection with the helminth parasites, *Schistosoma haematobium* and *S. mansoni*, in the community’s children through enumerating parasite eggs excreted in urine and stool was used as per routine protocol. Briefly, one stool and three urine samples were collected on three consecutive days. Samples were collected between 10:00h and 14:00h and processed within 2 hours of collection. Urine samples were examined microscopically for *S. haematobium* infection following the standard urine filtration method [19] and the number of eggs were reported per 10 ml of urine. Stool samples collected were processed using the Kato-Katz method, using slides with the standard 41.7 mg templates for *S. mansoni*. Children were labelled as positive for the specific schistosome infection if one or more eggs were present in any of their urine or stool samples.

**Data analysis**

Descriptive analysis of the data was performed in SPSS v.24 and plotted using GraphPad Prism v.8.0. Descriptive statistics summarised the prevalence of toilet access, phone possession, pediatric schistosomiasis status, livestock ownership and access to water sources in rain and dry seasons. Frequency and crosstab tables were produced examining the associations between the following: toilet access and phone possession; toilet access and schistosomiasis status; livestock ownership and toilet access; cultural taboo, toilet discrimination and toilet access; schistosomiasis status and open defecation; and schistosomiasis status and children going to the river.

Chi-square tests were performed to examine any relationship between toilet access and phone possession; toilet access and schistosomiasis status; phone possession and schistosomiasis status; and access to toilets and livestock ownership.

The Population Attributable Fraction (PAF) was then calculated for schistosomiasis status and open defecation; and schistosomiasis status and children attending the river, using the PAF formula (Eq 1). The proportion of cases exposed was attained by dividing the number of schistosome infected children who attended the river by the total number of infected children. The attributable proportion in the exposed was attained by calculating the risk difference (expressed as RD) (Eq 2). From the RD calculation, the Attributable Proportion (expressed as AP) was then attained (Eq 3); the result of which was used as the attributable proportion in the exposed for Eq 1.

**Population Attributable Fraction (PAF)**

\[
\text{PAF} = \left( \frac{\text{number of cases exposed}}{\text{total number of cases}} \right) \times \left( \frac{\text{attributable proportion in the exposed}}{\text{cumulative incidence in the exposed}} \right)
\]  

Eq 1

**Risk Difference (RD)**

\[
\text{RD} = \text{CI}_e - \text{CI}_u
\]  

Eq 2

**Attributable Proportion**

\[
\text{AP} = \frac{\text{RD}}{\text{CI}_e} = \frac{\text{CI}_e - \text{CI}_u}{\text{CI}_e}
\]  

Eq 3

\( \text{CI}_e \) is the cumulative incidence among the exposed children (i.e., attended the river), and \( \text{CI}_u \) is the cumulative incidence among unexposed (i.e., did not attend the river) children.
was calculated by dividing the number of children infected with schistosomiasis who also went to the river by the total number of children who attended the river; with CIₜ attained by dividing the number of children infected with schistosomiasis who did not attend the river.

Results

Demographics

Of the 22 surveyed villages, 127 households participated in the household questionnaire survey. The number of people living in each household ranged between 1–21, with a mean and median of 6 and 5, respectively.

Of the total 471 young people (0–18 years), 125 children were tested for schistosomiasis and were pre-school aged children (1–6 years), with a mean age (SD) of 3.36 (1.24) years (Table 1). Of the children tested for schistosomiasis, there were more males, 76 (60.6%) than female, 49 (39.4%). The majority of adult interviewees reported having gone to secondary school (82%), and under half reported receiving health education or science education in secondary school (42%) (Table 1). Data pertaining to mobile phones was also collected; 95 (74.8%) participants reported owning a mobile phone, ranging from 0–6 phones per household, with a mean and median of 1.6 and 1, respectively (Table 1). The most frequently reported use of mobile phones was socialising and 20% of participants reported using their phone for access to the social media platforms; Facebook and WhatsApp.

Table 1. Demographic, sample size and phone information.

| Demographics                                      | Sample size |
|---------------------------------------------------|-------------|
| Villages                                           | 22          |
| Wards                                             | 8           |
| Households                                        | 127         |
| People living in households (range per household) | 764 (1–21)  |
| Average number of people in household             | 6           |
| Median number of people in household              | 5           |
| Ages 0–3                                          | 111         |
| Ages 3–6                                          | 137         |
| Ages 7–18                                         | 223         |
| Ages 19–50                                        | 244         |
| Ages 50+                                          | 62          |
| Mean age of children across households            | 3.36        |
| Education                                         |             |
| Primary                                           | 11%         |
| Secondary                                         | 82%         |
| College                                           | 1%          |
| University                                        | 5%          |
| Other                                             | 1%          |
| Science at secondary/ health education             | 42%         |
| Mobile phone                                      |             |
| Owns a phone                                      | 95          |
| Average per household                             | 1.6         |
| Range                                             | 0–6         |
| Median                                            | 1           |
| Whatsapp/ Facebook                                | 20%         |
| Main use                                          | Socialising |
| Money spent on phone average (RTG$)               | 6           |
| Range (RTG$)                                      | 0–20        |
| Median (RTG$)                                     | 5           |

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Toilet and mobile phone descriptions

Photographs of the respondents’ toilets and mobile phones, if they had one, were taken on site. The respondents’ toilets were very varied (Fig 2). The toilet walls themselves were an assortment of straw, tin and brick walls. The favoured toilet design was a pit with a slab over it, with the ventilated pit Blair latrine and a pit without a slab in close second and third most common-place. The ventilated pit Blair latrines design of a latrine with a slab of concrete over the pit with two holes caste in, one for the squat hole and one for the screened vent pipe. The ventilated pit Blair latrines were the most sanitary due to the vastly improved air circulation and elimination of flies and bad smells through the ventilated design of the chimney that disperses the odours caused by human waste. Over the chimney there is a fly screen, preventing flies from entering the latrine; and due to the semi-darkness created by the roofed top, any flies inside are attracted to the light coming from and the smells exiting via ventilation pipe, and they too are trapped by the flyscreen. Due to the walls built around the latrine the individual

![Fig 2. Photographs of respondents' toilets. A) Toilet constructed with straw wall, with no roof, ventilation system or flyscreen. B) Toilet constructed with tin walls, with no roof, ventilation system or flyscreen. C) Toilet constructed with brick walls, with a covered roof and a ventilation system. D) Toilet consisting of a pit with no slab, constructed with 3 straw walls, with no roof, ventilation system or flyscreen. E) Toilet consisting of a pit with no slab, constructed with straw walls, no roof, ventilation system or flyscreen. F) A pit Blair latrine with concrete walls, with a tin roof, a ventilation system and flyscreen.](https://doi.org/10.1371/journal.pwat.0000038.g002)
will also have privacy. Toilets with walls made of straw or tin, are much less sanitary. As they have no carefully constricted ventilation system or proper method of waste disposal, foul odours gather flies quickly and the improperly disposed waste increases the spread of disease and infection.

Photographs of the respondents’ phone where also captured (Fig 3). Some individuals had better, likely more expensive smartphones that could access social media (e.g., Facebook and WhatsApp). Whereas others had older model mobile phones, which would not be able to access social media sites and would be for phoning or texting only.
Data on ownership and utilisation of toilets and boreholes was collected. We also collected data on mobile phone ownership and the results are summarized in Table 2 below. It is notable that while 60.6% had access to a functioning toilet and 38% owned a borehole, more households (74.8%) owned a mobile phone but no toilet. A further notable 16% practiced open defecation despite having a functioning toilet at the homestead.

Of those with access to a functioning toilet, 27 (21%) reported receiving health education, and 51 (40%) received no health education. Among those with no access to a functioning toilet, 23 (18%) received no health education, whereas 26 (20%) did receive health education (Fig 4).

### WASH knowledge, attitudes, practices and behaviours

WASH KAPB data were collected in order to identify factors leading to people’s prioritisation of toilet construction and causes and determinants of toilet usage. Interviews identified the most likeable and dislikeable qualities of toilets as reasons why they would be more or less likely to use toilets. The most frequently reported likeable qualities of toilets were cleanliness (22%), proximity to the main house (10%) and presence of a toilet seat (6%) (Fig 5A). The most frequently reported dislikes of toilets were that they felt unsafe (21%), no roof (14%) and lack of cleanliness (e.g., bad smells, and pit full) (7%) (Fig 5B).

In relation to basic WASH sanitary practices, such as handwashing; the survey revealed that 31 people (24%) washed their hands after urination, with 96 people (76%) reporting that they...
do not wash their hands (Fig 6A). When asked about handwashing after defecation, 52 people (40%) stated they did wash their hands and 75 people (60%) reported not washing their hands post-defecation (Fig 6A). Further, the participants’ explanations for choosing to wash or not wash their hands after defecation was ascertained; finding the most common reasons to be having no facilities for washing hands (37%) and believing handwashing to be of little importance (29%); followed by scarcity of water (11%) (Fig 6B). When asked about wiping materials used after defecation, the most prevalent answers were ‘other paper’ (e.g., newspaper) (72%), ‘leaves’ (28%) and ‘toilet paper’ (14%) (Fig 6C).

**WASH sanitation characteristics and access to water sources**

Of the 127 surveyed households, 77 (60.62%) reported having access to a functioning toilet. Other family members were the most likely to source resources and labour to build a toilet (45%) (Fig 7A), as the majority of households with access to a functioning toilet reported that it was financed through family income (74%) (Fig 7B). Forty-nine percent of respondents reported cleaning their toilet every day, with very few (6%) reporting not to clean it at all or only once a week (Fig 7C). Furthermore, the most frequently mentioned source of toilet design was the neighbour (22%), followed by the builder (20%) and other family members (20%) (Fig 7D). The most prevalent type of toilet surveyed was described as a pit with a slab over it (44%); followed by the Blair Pit Latrine (32%) and open pit without a slab over it (28%) (Fig 7E).

Boreholes were reported as the most common water source during both the dry and rain seasons, with 72% of respondents reporting to use. During the rainy seasons, the most
Fig 5. Likeable and dislikeable qualities of toilets as reported by respondents. A) Data indicates that most likeable qualities of having a toilet were the cleanliness, nearness to homestead and having a toilet seat. B) Data indicates that the most dislikeable qualities of toilets were that they felt unsafe, they were shared, the pit became full quickly and there was no roof.

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A

Percentage of individuals

Handwash After Urination  Handwash After Defaecation

B

Percentage of individuals

Reasons for not washing hands after urination and defaecation

C

Percentage of individuals

Wiping materials

Leaves  Other paper  Toilet paper  Maize cobs  Sticks  Nothing
common water source following boreholes (28%), was protected dugwells (24%), rainwater (21%) unprotected dugwell (11%), surface water (9%), protected spring (4%) and other unnamed sources (2%); with the time taken to get water for the majority between half an hour and an hour (85%). During the dry season, the most common source of water, following boreholes (44%), was protected dugwell (26%), unprotected dugwell (17%) and unprotected spring (13%) (Fig 8A); with the time taken to get water for the majority increasing to over half an hour to over an hour (91%) (Fig 8B).

Socio-economic factors and risk of schistosome infection

Socio-economic factors were examined to gain an understanding of how to propagate factors that would encourage adherence to WASH guidelines. Out of the total 125 children tested for schistosomiasis, 53 (42.4%) tested positive for either *S. haematobium* or *S. mansoni* (Table 3).

An understanding of such factors can be developed to guide the utilisation and management of WASH policies and practices. A significant association between phone possession and negative schistosomiasis status was observed ($\chi^2 (1) = 4.001, p<0.05$ (one-tailed)) (Fig 9A).

However, there was no statistically significant relationship between schistosomiasis status and...
Fig 8. Access to water sources. A) Water sources in rainy vs dry seasons; the most common water source in both rainy and dry season was reported to be a borehole. B) Data indicates that the time taken to fetch water is significantly longer in dry season compared to rainy season.

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lack of access to toilets ($\chi^2 (1) = 0.376, p = 0.54$ (one-tailed)) (Fig 9B); nor between access to toilets and phone possession ($\chi^2 (1) = 2.161, p = 0.71$ (one-tailed)) (Fig 9C). Furthermore, no statistically significant $\chi^2$ tests were observed when examining the relationship between access to toilets and livestock ownership ($\chi^2 (1) = 2.061, p < 0.076$ (one-tailed)) (Fig 9D). However,

Table 3. Schistosomiasis data table.

| Sample size | 125 |
|-------------|-----|
| **Mean Egg Count Overall (SE of the Mean)** | 6.41 (1.65) |
| **Children positive for schistosomiasis (53 (42.5%))** | **Children negative for schistosomiasis (72 (57.5%))** |
| **Cumulative incidence (CI)** |
| **Children practice open defecation** | 34 | 39 | 0.47 (CIe) |
| **Children do not practice open defecation** | 19 | 33 | 0.37 (CIu) |
| **Children in contact with river water** | 34 | 44 | 0.44 (CIe) |
| **Children not in contact with river water** | 4 | 9 | 0.31 (CIu) |

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Fig 9. Socio-economic factors, phone possession, toilet access and risk of schistosome infection. A) Association between phone possession and schistosomiasis status found to be statistically significant (Sample size 125). B) No statistically significant association between toilet access and paediatric schistosomiasis status (Sample size 125). C) No statistically significant association between toilet access and phone possession (Sample size 127). D) No statistically significant association between owning livestock and access to toilets (Sample size 127). Significance levels as displayed on graphs are abbreviated; abbreviations are as follows: 'ns' for not significant; for $P$ levels ($^* P < 0.05$).
this may have been due to the low sample size in the group that does not own livestock (n = 8). Further, as seen in Table 3, it can be observed that the majority of households owning livestock also have access to a toilet; with 75 (59%) owning livestock and with access to a toilet, whereas 44 (34%) own livestock but do not have access to a toilet.

**Fraction of schistosomiasis attributed to different potential risks for infection**

The fraction of schistosomiasis attributable to different potential risk factors was determined. The percentage of children and adults who practice open defecation was found (Fig 10). The data submits that the fraction of schistosomiasis attributable to open defecation was 21%. In order to ascertain the fraction of schistosomiasis attributable to the exposure for the entire study population, the PAF (Eq 1) was utilized; finding that 13% of schistosomiasis of the total population is attributable to open defecation.

The fraction of schistosomiasis attributable to contact with river water was 30%. In order to ascertain the fraction of schistosomiasis attributable to the exposure for the entire study population, the PAF (Eq 1) was utilized; finding that 27% of schistosomiasis of the total population is attributable to attending the river (Fig 11).

**Values and symbolic attachment that communities consider on home toilets**

To ascertain the values and symbolic attachment considered by communities on home toilets, the rates of toilet discrimination and cultural taboos were examined and reported.

Toilet discrimination was reported among participants (63%), with the most prevalently reported toilet discrimination category being grandparents and parents (13%). When asked about cultural taboos surrounding toilets, more participants reported no cultural taboos surrounding toilets (39%) than those reporting cultural taboo (22%), with the remaining 39%
respondents not specifying whether cultural taboos around toilets were present in their home. The main cultural taboo discouraging the use of toilets was embarrassment with 33% of respondents finding it culturally degrading to go to the bathroom in front of other family members (Fig 12).

**Discussion**

Whilst there has been a considerable amount of empirical work dedicated to KAPB surrounding WASH policies, and by extension, control of infectious diseases such as schistosomiasis, there is still a deficiency in work on the social, psychological, cultural and behavioural aspects that constrain toilet and borehole adoption and use in rural Africa. This study shows that the adoption and use of toilets and boreholes is not prioritised to the extent it needs to be, which poses a significant risk to public health.

The majority of individuals had access to a toilet and under half had access to a borehole. However, over a third of the household possessed a mobile phone but no toilet and just over 40% possessed a mobile phone but no borehole, indicating that not having a toilet or a borehole was not a simple matter of not being to afford one. This is due to the fact that pit latrine toilets used in this area are cheaper to build compared to the average cost of buying and upkeep of a mobile phone. The cost of maintaining a mobile phone is more expensive in the long run compared to the upkeep and maintenance of a latrine, not to mention the many health benefits of using a latrine as opposed to open defaecation [19]. The ventilated Blair-pit latrines are inexpensive to build [20] with it being found to be durable and resilient to climate change over time [21]. Protected wells are also cheap to build as the family tends to build their own protected wells, whereas boreholes are more expensive to build with costs varying between households. Another symbol of wealth, livestock ownership, also confirmed that WASH infrastructure was a matter of prioritization and not simply affordability.

![Chart](https://doi.org/10.1371/journal.pwat.0000038.g011)

**Fig 11.** Schistosomiasis status and river usage in children. Data shown indicates the percentage of children who go to the river (to play/bathe) and those who don’t; with the percentage of children testing positive or negative for schistosomiasis.

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Fig 12. Values and symbolic attachment that communities consider on home toilets. A) Data displays percentage of respondents with access to toilets, the percentage who experience toilet discrimination and any cultural taboos surrounding using toilets. B) Percentage of toilet discrimination reported in different groups of households (e.g., parents, children, daughters in law). C) Respondents’ descriptions of cultural taboos.
Factors driving mobile phone prioritisation were variable. In this community, mobile phones provided the dual role of communication and mobile money transfer. Other studies have shown that mobile phones are an important lifeline for ensuring timely notifications food aid distribution, or when a family member in the city or abroad has sent a parcel or money over phone transfer [22]. Thus, for families in such a position, investing in a mobile phone is considered higher priority than building a toilet. There is a need for a systemic approach where a community’s livelihood is linked to hygiene and health. Various ministries, including social welfare, are needed to work synergistically to help solve the socio-economic issues of families prioritising mobile phone access through necessity rather than an active choice. If policymakers and ministers were to work directly with these communities, a first-hand perspective would be gained to glean an insight into the root of the issues, with effective, co-developed solutions coming to fruition.

We also demonstrated that 44% of adults and 58% of children practiced open defecation. This included people without access to toilets. The most recurrent dislike reported was that the toilet was not safe or did not feel safe to use. Young children in particular, feared falling into the opening of the pit latrines. Open defecation has been shown to lead to higher infection and disease status in children [2, 22, 23]. Cultural reasons were also used to explain non-adherence. For example, participants stated they felt embarrassment if they had to use a toilet in front of family members.

Other reported reasons for non-adherence to toilet-use have been reported from other studies [24], including bad odours, uncleanliness, a shared toilet and a full latrine pit. These together with falling or collapsing toilets are design flaws which the original ventilated pit latrine developed in Zimbabwe, was designed to prevent. As was shown in the photographs, in order to cut costs, villagers have constructed unsafe and unhygienic versions of the original pit latrine.

Conversely, the majority of participants with access to a functioning toilet also reported cleaning it daily, with the most frequently reported likeable quality of toilets to be that they were clean and easier to keep clean. During the study we observed that design issues were linked to cost and affordability. Houses with ventilated Blair-pit toilets showed signs of relative affluence through livestock ownership and physical infrastructure, with better houses in terms of size and construction material, e.g., bricks and corrugated iron roofing, with plastered flooring in the toilet, some of which with polished floors. In contrast, less affluent households by such symbols had less desirable toilets. Previous work has shown that increased awareness and action on sanitation policies has increased access to, adoption and usage of toilets in Sub-Saharan African (SSA) [22, 25], providing evidence that with increased knowledge and awareness, attitudes, practices and behaviours do evolve accordingly.

In addition to socio-economic drivers, the practice of open defecation needs to be understood in the wider socio-cultural context. In this study, focus group discussions with a representative group of women showed that they valued the time going to the bush or river as this provided safe spaces for female discourse leading to a preference for open defecation in the bush or using the river for domestic chores. The women valued the role the safe spaces had for their social and psychological well-being. This demonstrates that when confronted with WASH challenges, it is essential to do in the wider social context to encourage adherence. We have covered these cultural drives of non-WASH adherence in a hybrid film [26].

Our study confirmed the link between lack of toilets and use of river water with rate of schistosome infection in children, with 20% of infections attributable. This is keeping with other studies showing that the absence of toilets is a risk factor in schistosomiasis as shown by higher transmission rates among children who do not use a toilet and practice open defecation [27–29]. Proximity to the toilet is an important consideration, for example, despite children
having a toilet in their homestead, they reported that when away from the homestead toilet they practiced open defecation at nearby rivers [28], indicating that simply the presence of toilets is not enough to increase use and reduce disease.

In this study over 40% of participants reported having received health or science education with more people who had received health education also having a toilet compared to people who had not received health education. Previous work has found that lower levels of knowledge on schistosomiasis and other NTDs is often accompanied by more misconceptions about such diseases that lead to prevention practices [30–32]. There is need to have health education and awareness programs that target different age groups and genders, e.g. community-based vs. school-based programs. Community-based health education has been shown to promote behavioural changes, such as avoiding contaminated water sources and using toilets [33, 34].

While schools are an important centre of health education for children, the latter tends to discuss any health issues with their mothers, who are, usually, the children’s main contact with medical care. Women receiving health education through their children are more likely to be instigators in household and community based protective behaviours against disease [29].

Going forward, the use of social media platforms (Facebook and WhatsApp) by the community gives potential to use these platforms in an engaging and creative way for health messaging and health education.

The intended effect of health education is essential to change KAPB and the theory of planned behaviour (TPB) tells us that this requires a succession of steps before being aware of doing so. Intention exists as the most important predictor of behaviour, with over ¾ of behavioural variance being explained by intent [35, 36]. For instance, adoption and use of a toilet involves the following steps in order for this intention and behaviour to be met: deciding what type of toilet they are going to use, get the means to finance the toilet, sourcing someone to build it, where to put the toilet (i.e., how far from homestead), who will use it, how often to clean it etc. Consequently, prediction of the behaviour located at the end of this continuum (e.g., getting and using a toilet) may be too distant to secure an accurate prediction of the behaviour being carried out. This also suggests that for health-related behaviours, perceived and actual control differ.

In addition to the traditional pillars of TPB such as behavioural intent, attitude, subjective norms and perceived behavioural control; the crucial roles of habit and emotions are considered in the theory of interpersonal behaviour (TIB) [37]. The construct of habit is key in the formation of a behaviour. For instance, adopting and using a toilet, if not had one previously, breaks a long-term habit and subsequently forms a new one. Empirical work has indicated that habits may be performed most reliably in circumstances where it is habitual [30, 38–40] as automatic behaviours have a much higher chance of being executed [40]. In order to encourage observance to WASH polices and to change KAPB, facilitating the formation of new and necessary habits (such as using a toilet, washing hands, avoidance of contaminated water sources) is a critical component.

There is, however, an issue of transferability between cultures when using Western social and psychological theories to explain behaviour in non-Western countries. Is it important that Western practitioners are mindful of the origins of psychological theory and practices [41, 42]. Western psychology and interventions have been successful in non-Western countries when they have been adapted to be culturally relevant within the culture it was delivered with an increase in acceptance and effectiveness [43, 44]. Therefore, working with the communities that the policies and interventions are aimed for is essential. Awareness of ways to improve the physical, socio-economic and psychological livelihoods of such communities and bolster health education programs need to be guided by this and be contextually relevant.
In terms of other WASH related behaviours, we observed that over 75% of participants reported that they did not wash their hands after urination or defecation, with the most frequently reported reasons being a lack of facilities to do so and not viewing the practice with any importance. As hand hygiene is regarded as the most effective means of reducing healthcare associated with infections, including those involving antimicrobial resistant organisms [45], it is of pivotal importance that adequate sanitation amenities are provided and such behaviours encouraged as habitual to avoid re-infecting the same community with the same pathogens repeatedly [46, 47]. There is a need to have more context relevant interventions for hygiene. The advent of the SARS-CoV-2 pandemic has forced people to rethink hand hygiene and for policymakers to come up with more practical guidelines for people facing WASH challenges. For example, the WHO has put together guidance for those who do not have access to running water and soap. This includes, for example, drained rice or vegetable water and coffee grounds, ash, sand and salt as alternatives to soap [48]. The momentum gained from this must be leveraged to improve WASH in rural Africa.

Given that schistosomiasis is a result of many factors including knowledge and attitudes, several risk factors and behavioural risk factors, socio-economic and cultural factors (65) as well as a level of environmental contamination, a future, more comprehensive study capturing all these factors, such as the Ranas [49] approach would be even more informative.

**Conclusion**

Our study demonstrates that the lack of WASH facilities as well as WASH adherence in this rural community is not just a matter of affordability. Rather it is a complex interaction of socio-economic and psychological factors, with some community members preferring to practice open defecation for safety, socio-cultural and psychological reasons. The need for safe spaces for women drove them to using the bush and river or unsafe water away from the homestead. The prioritisation of mobile phones which costs more than building toilets or protected wells indicates the need for a strategic drive to move WASH up the prioritization ladder. We demonstrated an association between schistosome infections in the community’s children and lack of toilets and exposure to river water. Taken together, our findings highlight the need for context relevant interventions developed with community input to ensure relevance, buy-in and uptake.

**Supporting information**

**S1 Data. Raw dataset of all data analysed.** The dataset contains all the raw data collected, before any analysis performed.
(XLSX)

**S2 Data. Demographic and summary dataset.** The dataset contains all demographic information and the summarised analytical data.
(XLSX)

**S1 Text. Questionnaire for the 2019 WASH survey.** The questionnaire distributed to the participants.
(DOCX)

**S2 Text. Inclusivity in global research.** This document outlines the steps taken to ensure ethics, equality, inclusivity, availability and equal authorship.
(DOCX)
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