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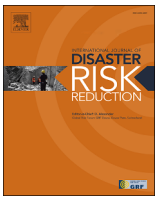

Infectious disease risk communication and engagement using puppetry and related approaches for improving handwashing with soap in an informal settlement of Nairobi

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ABSTRACT

Handwashing with soap (HWWS) has been estimated to have the potential to prevent 35% of the 704,880 deaths per year caused by diarrhoeal infectious diseases (UN Millennium Project, 2018), its wider risk reduction influence subsequently accentuated in times of COVID-19. However, this depends on place specific risk communication that leads to behaviour change, particularly amongst children in economically poor neighbourhoods. A study centred on five schools in the informal settlement of Kawangware, Nairobi found that puppetry, shadow shows and school model making produced effective risk communication and engagement spaces. Increased HWWS occurred when children designed, owned, and were able to apply risk communication.

1. Introduction

Risk communication for infectious disease reduction involving interventions such as handwashing with soap (HWWS) are well-recognised by humanitarian, disaster prevention and health development sectors [1,2]. However, the efficacy of risk reduction actions varies from one location to the next depending on how they are locally understood and communicated, perceptions, community engagement and municipality level monitoring [3,4]. Earlier work linked to the current paper going back 20 years found that combinations of environmental, social and economic influences, as evidenced in urban Mozambique, produced complex disease risk terrains [5,6]. Subsequent research in Bangladesh identified how self-care supported by social networks and education channels [7] reinforced health related coping and agentive capabilities [8]. A challenge in achieving full risk reduction impacts within these studies was found to be in communicating infectious disease risk interventions in a way that delivers sufficient engagement. Addressing this challenge through children's communication is both relevant to enabling behaviour change in public health emergencies, and to engaging risk reduction in multi-hazard environments.

Building on the earlier work, the study reported in this paper goes some way to illustrating innovative risk communication and engagement techniques, based on puppetry, in a poor neighbourhood of Nairobi. The findings are important in understanding infectious disease and other risk communication needs through locally grounded risk engagement spaces, particularly those of women and children [9–12]. Child-led approaches are becoming better accepted in disaster risk reduction [13], but are generally under-developed in terms of risk communication for managing infectious diseases and the multi-hazard exposure situations faced by children and all of society.

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No Strings International (NSI) and Northumbria University (NU) trialled an action-based project orientated to HWWS communication issues with local partners in Nairobi. Child centred approaches led to HWWS via participant communication of risk reduction enactments. In 2020, COVID-19 brought added impetus to promote handwashing here and elsewhere to lessen the spread of the virus. Although the science also argues the virus is transmitted through aerosolization and is less linked to transmission on surfaces, handwashing is still widely acknowledged as a reflection of improved hygiene behaviour in general. Further, success in bringing about behaviour change linked to HWWS would be exemplary of a whole host of similar types of risk reduction behaviours that could be supported through the approach developed. This rationale is accentuated by the reality that effective implementation of measures such as HWWS remained beyond the reach of billions of people [14], particularly children who are high-risk spreaders of infection [15]. This paper uses the 2017–2020 research findings in Nairobi to analyse how communicating risk through puppet facilitated engagement overcame barriers to handwashing among children in schools of poor neighbourhoods.

The specific objectives of the study were to:

i. Understand how puppetry, and its aspects of play and creativity, can increase positive behaviour change and HWWS,
ii. Explore best practices and understand barriers preventing behaviour change, finding resolutions and new effective systems,
iii. Develop a risk communication and engagement application that enables innovative hygiene promotion activities in resource poor neighbourhoods.

A working hypothesis was that puppetry evokes positive associations with HWWS and encourages risk reducing behaviour change amongst children in schools, which is influential on the wider locale within which the children reside. The study addresses questions about the impacts of puppetry as a risk communication tool amongst the children and their minders, whether the NSI programme led to other unintended outcomes, how widely the methodology can be applied and its efficacy in changing behaviour. Whilst this study is based on specific techniques, it also provides support for key principles informing risk communication more widely.

2. Literature review

The need to advance multiple routes to reduce infection rates is reflected in extensive reviews of Water Sanitation and Hygiene (WaSH) interventions for varying contexts [16] including for climate change adaptation in a time of increased climatic related risks [17,18]. Communication of WaSH related risks against a backdrop of varying perceptions is central to local efficacy of the interventions [4]. Studies highlight improved knowledge scores in at-risk locations for cholera though lacking prevention practices [19,20]. Nonetheless, handwashing has been identified as a prominent example of a locally owned and effective intervention, reducing diarrhoeal disease by 47% [21]. However, it has continued with low priority in many diarrhoeal disease prone environments of the world, often with water and soap being allocated for other uses [22]. The uptake amongst children is generally unknown and globally, the percentage of people who regularly wash their hands with soap and water after contact with excreta has been estimated to be only around 19% [22].

2.1. Engaging children's HWWS

Children under five years old are the most vulnerable to water-related diseases [23], with 11% of the 7.6 million child deaths per year having been caused by diarrhoeal disease (equivalent to 2200 children each day) [24]. WaSH practices could prevent at least 9.1% of the global disease burden and 6.3% of all deaths [25]. This achievement or better is however largely dependent on the psychological context of individuals [26], with children being influenced more easily than adults about hygiene habits [27]. As such, involving children in handwashing techniques and designing of handwashing facilities can spark change [23]. A previous UNICEF linked study in Kenya revealed that soap use made a significant difference, alongside resource availability, and that children could be agents of change for WaSH practices within families [28]. Further technologies, such as Oxfam buckets, The Tippy Tap, Hand Washing Bags and Communal Wash Stations, 'The LaBobo' [22] are also important, but HWWS is required as part of the WaSH processes these facilitate.

Regular challenges include unreliable access to water and soap, prioritisation of soap for uses other than handwashing, insufficient drainage around handwashing stations, damage to handwashing stations and the high cost of handwashing materials [22]. Whilst these infrastructural issues concern access to resources, transmission is reducible where those at risk are empowered to identify, communicate and consequently implement change. Dysfunctional handwashing spaces [29] reduce where there is community cohesion, school management and WaSH committees to identify maintenance issues [23]. Where financial investments remain absent for maintenance, non-water handwashing options (e.g. sand, soil and ash), making soap and social marketing persist [22]. Children are usually engaged as secondary recipients of these strategies.

2.2. Self-owned behaviour change aspects of infectious disease risk communication

The Theory of Planned Behaviour (TPB) model in this study is applied to understanding a person's behavioural intentions, motivations and attitudes towards the behaviour and its outcome. Shaped by social and subjective norms in their environment, a person perceives the behavioural control they have over performing the behaviour and the influences of impeding factors present. Extensive elaboration and reviews over decades of the model (e.g. Ref. [30] is beyond the scope of this paper and a suitable summary is presented by LaMorte [31]. The puppetry in this study acts as a tool to instigate positive attitudes and behavioural intentions to increase personal hygiene by HWWS including where social and subjective norms see it as less important and too difficult to perform.

This study's action orientated Theory of Change guided six activities and seven engagement pathways for self-sustaining HWWS and the likely consequence from that action of infectious disease reduction. Chambers [32] pointed out that behaviours can be easier

to change than attitudes, values and fixed beliefs and Curtis and Barra et al. [33] reminded that traditional classroom and public broadcasted educational approaches are insufficient to bring this about. Alternatives have included Behaviour Centred Design (BCD), which requires a surprise intervention to change something in the behaviour environment [34]; 438). The surprise element in the case of the current study was tried via the use of puppetry, to ignite behaviour change. SuperAmma is a further approach which uses emotional drivers of behaviour such as disgust, nurture, status, and affiliation as motivators. They are communicated through a variety of mediums such as animated films, skits, humour and public pledging ceremonies as used successfully for a handwashing campaign and post intervention HWWS in rural India [35,36]. In a group setting, hygiene is influenced by social learning and cultural values with higher sensitivities [33]; 389); creative puppetry could stimulate this process.

Further, 'nudging' of environmental cues engages the unconscious decision-making process prompting behaviour change. Successful nudges have been recorded such as when the infrastructure has improved through dedicated handwashing areas and reconnecting latrines to handwashing stations with painted footprints [37]. The RANAS (risk, attitudes, norms, ability, and self-regulation) approach has been used by Mosler [38] for risk perception, attitudes to behaviour, beliefs towards changing behaviour, resources and skills that underlie HWWS among school children. Other examples include Community Led Total Sanitation (CLTS), health clubs, handwashing champions, Global Handwashing Day and mass media campaigns [22].

2.3. Risk communication

The WHO refers to risk communication as 'the exchange of real-time information, advice and opinions between experts and people facing threats to their health, economic or social well-being … enabling people at risk to take informed decisions to protect themselves and their loved ones' [39]; p.1). The two-way action of risk communication where participants can voice their concerns and experts analyse the risks and feedback essential information is referenced in some contexts [40,41]. [42]:1) indicates it 'should inform about potential threats and empower people to adopt protective measures', albeit also routing communication into the socio-cultural context. Public judgement of risk is however complex involving psychological and cognitive processes, culture, beliefs, social relations, religion, politics and economics [43]. This was evidenced during diarrhoeal disease research actions in Mozambique [4] and the Ebola crisis in West Africa [44]. In these contexts, successful disease risk communication was achieved when the community's concerns were listened to first, and the local traditions, beliefs, religion and cultural practices were taken into account. Appropriate risk messaging is then developed and communicated in line with local level structures.

2.4. Techniques with puppetry

Puppets help elicit information from children and adult onlookers more effectively than traditional educational methods as the puppets aid the children to verbalise, express and clarify their feelings in a fun, relaxed and comfortable setting [45]. By having an image or physical object to present and discuss to others, it enables the user to communicate and connect more directly [46]; 4). The CHAST (Children's Hygiene and Sanitation Training) approach developed from PHAST (Participatory Hygiene and Sanitation Transformation), uses puppetry in open discussions and fun exercises to encourage the shy children to contribute [27]. Film also communicates risk, as adopted by Hicks [42] in their study of disaster resilient communities potentially increasing trust, improving relations, conveying difficult information, increasing risk perception, motivating behaviour change, developing personal preparedness efforts, and strengthening resilience. This was contingent on the messages in a film being designed and delivered in partnership with the local community. A similar rationale had proved successful with the use of radio [47] and radio projects that combine with theatre performances, as used for Covid-19 awareness in Nepal [48] and previously for HIV/AIDS and other risk interventions an author of this paper (Collins) had worked with World Vision International (WVI) in Mozambique.

However, the current study was to understand how puppets can elicit rich data, as a pedagogical instrument [45], and deliver impact such as by breaking down barriers, reducing fear or acting as a distraction from unpleasant realities [49]). The puppets may help to project feelings and thoughts onto others in a creative way [50] and bridge cultural, linguistic, religious, or racial barriers (Freidman, 2005 Cited in Pearce and Hardiman [51]. Puppets are known for connecting with all people at a childlike level, allowing both adults and children to benefit [52] cited in Ref. [51]. Puppets allow characters and communications to be created that can't be expressed easily in everyday life, giving freedom and expression, being comical, symbolic and acting purposefully and anonymously (Tova, Cited in Ref. [53]. The puppet would enable connection with others and a medium to express personal emotions and thoughts within self and peers, in this case addressing some of the barriers to HWWS. Participant identification with the puppet would encourage an emotional release that can build self-esteem [54] and increased ownership of new knowledge amongst participants [55].

By bringing creativity into a situation needing learning and embodied knowledge [56], it could help risk communication by giving people 'the opportunity to reflect, to make their thoughts, feelings or experiences manifest and tangible' [46]; 4). Further, Sennett [57] proposed 'The Craftsman' ingredient whereby use of the hands is central to thinking, supporting exploration and problem solving. Wills [58] indicated that the creativity brings critical thinking, long-term memory, evaluation of emotions and transfer of knowledge. Resonant with infectious disease risk communication challenges, participants would express themselves whilst interpreting risk related objects in their own way, encouraging engagement.

2.5. Risk reduction engagement

Through engagement in a creative action, participants actively listen to key messages and enhance their learning capacities leading to a greater level of behaviour change. Whilst Bowen and Salerno et al. [59] suggested that engaged learners complement and interpret what they learn from others with direct knowledge based on personal experience, interacting with others extends personal views, beliefs and perspectives [60]. NSI group discussions encourage this way of thinking for engagement, enhancing academic achievement, promoting retention of messages, and the ability to apply knowledge successfully [61]. Habit formation theory de-

scribes an outcome of using engagement as a tool potentially changing people's mind and heart [62]. According to Ref. [63]: 484), habits are 'automatic behavioural responses to environmental cues, thought to develop through repetition of behaviour in consistent contexts', capable of breaking fixed habits if a trigger is established. In this paper it is proposed that the use of a puppet can act as the trigger amongst the children and others who participate in the exercises. Previous studies suggested that the more novel the stimuli, the more likely the messages are to be adopted by the listener [64,65] as cited in Ref. [66]. The project chose puppetry to communicate infectious disease risk reduction through handwashing, building also on well-established ideas on participation and pedagogic empowerment [67,68], learning from one another and or problem solving.

3. Methodology

The study applied the technique of puppetry, whereby children, and their teachers used self-derived narratives to recreate the lived experiences of water related infectious disease risks. NSI applies the technique during training and dissemination of key messages about direct links between personal hygiene and good health to health clubs. Through this method the messages then also pass on to families and peer groups through indirect peer inclusion in activities [27,69]. The technique was applied as part of NSI work with school children living in the informal settlement of Kawangware, Nairobi, Kenya.

The health patrons (the teachers who lead the health club) took part in a puppetry course and learnt the techniques to use in school each being given a puppet that they named Jesse to use with the health club alongside a puppetry film on WaSH. Jesse is a 'big mouth hand puppet' who is controlled with one hand inside to move his mouth and the other hand holding sticks attached to his hands. He was given to the participants after watching the WaSH film to encourage them to talk about the issues they have seen and help them to express emotions and feelings, this also being backed up by a comprehensive puppetry manual complete with patterns and guides. The teachers then taught the children the puppetry techniques so they could spread messages to their peers. Five schools and an initial estimate of 250 children engaged these hygiene promotion activities. School health patrons, healthcare professionals and government representatives were interviewed, with further information being obtained from observational and focus group work.

The first set of data was collected in March 2018, followed by three more data collection sets up until October 2019. A third set of data collection intended for 2020 was interrupted by COVID-19 disruption but the accumulation of recognisable impacts of the actions led to the results outlined in this paper. The first two sets of data were based on the five primary school locations, with a final two sets based on just one school in which a second phase of the intervention was carried out, known as the Phase 2 Follow up study (or Phase 2).

3.1. Field location

Between 60 and 70% of the residents living in Kenya's capital city Nairobi, live in informal settlements (formally known as slums) and these are characterised as areas subjected to poverty, overcrowding, limited access to clean water and exposure to diseases. This study was implemented within Nairobi's second largest informal settlement by population, Kawangware, which is in the Dagoretti County. From the 2009 Census, the Kawangware settlement had a population of 133,286, 65% of whom were children and youth [70]. More recent figures cannot be found. Kawangware settlement spans across 3 km with scarcity of safe drinking water and high cases of water-borne diseases. Records from the Public Health ministry reported 22,574 diarrhoea cases in the Dagoretti County in 2017. Meanwhile for Nairobi County diarrhoeal diseases are reported as the second highest cause of morbidity in the under-five age group after respiratory infections and third highest for the over five age group after respiratory and skin infections [71]. Limited access to education leaves many of the children working informally to support family members. Following the five schools in Kawangware district in the first phase, the Phase 2 study worked in Riruta HGM Primary School. The Department of Health Nairobi County selected schools they considered the poorest in terms of WaSH facilities. The five schools serve circa 8000 pupils (from ages 4–14) ranging from 300 to 3400 pupils with classes of up to 125 students. Four of the five schools are public, government run schools (Kawangware Primary, Satellite Primary, Riruta HGM Primary and Ndurarua Primary) and the smallest school, Kabiru, is a community run school.

The study worked alongside health clubs that had been running weekly in the schools since 2015, with a recommended 40 pupils per school selected from the top three school years (years 6, 7 and 8). Some hard infrastructure had been installed, such as toilets and handwashing stations prior to NSI promotion of handwashing behaviour. Three teachers per school were asked to volunteer as health patrons. They were given training in WaSH issues and provided big picture books to base lessons around. The project applied an iterative process, Phase 2 study being co-designed with children based on responses during Phase 1 that highlighted a lack of handwashing practices due to a shortage of water points and handwashing systems. Research in Phase 2 focused on gathering quantitative data to assist in providing evidence of any change additional to the qualitative assessments of Phase 1. The Phase 2 study included a 'Challenge Day' whereby all children in the selected school would receive hygiene promotion through the NSI film and participatory puppetry methodology. Group discussions with the children led to new designs of classroom handwashing systems, and essential facilities (e.g. handwashing tanks, jerry cans, buckets, liquid soap). These were purchased by NSI to enable successful handwashing.

3.2. Data collection

For Phase 1, the 225 school children across five primary schools were aged between 8 and 13 years old, the 0–7 age group being excluded due to early primary school students being too young to respond to surveys. Health club respondents were 175 and non-health club (the control group) was 50. Other respondents included, 100 caregivers (parents/guardians), 15 health patrons, five head

teachers, one health care professional, one public health officer and two NGO representatives. Varying methods and spending extensive time with the children, overcame potential problems in engaging children in primary data collection.

For Phase 2, the whole of the HGM Riruta Primary school population were observed, an additional 1230 children excluding the original health club and non-health club members from Phase 1. The protection of children's rights and privacy and minimizing potential risks was deemed crucial throughout [72], including through ethical procedures of NSI, the schools, Ministry of Health Kenya, ELRHA and Northumbria University. Children were told to give their own views and opinions on the subject and that there were no right or wrong answers. The right to withdraw or refuse to participate, anonymity and confidentiality were guaranteed.

Table 1 lists the dates and timings of data collection events for the study together with a note on the rationale to timing. All interviews and discussions were recorded using a dictaphone, with one research team member taking notes or video recording. All recordings and notes were later transcribed, representing the participants' own words and the interviewer's descriptions and observations of the context, a 'thick description' approach [73]; 437). Transcriptions of all interview texts were inputted into the analysis software 'NVivo' and then coded guided by the interview questions on hygiene practices, behaviour change, puppetry, soft and hard infrastructure, constraining factors, NSI delivery and reduction in infectious disease.

The Phase 1 child one to one interviews of around 15 min allowed children to describe their own behaviours of handwashing and discuss knowledge on hygiene and risks through their interaction with the NSI puppetry technique. A total of 24 other key informant interviews of around 45–60 min were conducted, of which five were with head teachers, 15 with health patrons, two with CRS WaSH coordinators, one with a Public Health officer for the Nairobi County Office, and one with a healthcare professional in Kawangware.

Focus Group Discussions (FGD) with children were designed in a fun and creative manner to engage information with considerations to children's short attention spans, limited writing ability, and with props and puppets alongside a range of activities [74]. FGD were conducted for the Baseline and BM1 in all five schools with six students per group (equally mixed boys and girls) with five discussions in week one with health club members and five discussions in week two with the control group. The English language was used as the children speak this in schools. By using the FGD to share experiences, the capacity of the participants to know how to respond to potential poor hygiene situations could be strengthened. FGD served as good settings for children to be more relaxed with friends and not isolated with just an adult researcher [75,76]. Questions were semi-structured to resemble conversations rather than interviews per se. The discussions were carried out over a period of 1 h, with some extending to 1.5 h.

One hundred pre-set questionnaires were applied for the Baseline and BM1, these being distributed to health club children (20 from each school, 10 girls and 10 boys). One hundred more were used with the caregivers of those children and 15 to the health patrons. Response rates from the Baseline were 59% from caregivers, 59% from children and 46% from health patrons. BM1 response rates were 75% caregivers, 95% from children and 40% from health patrons. Data compilation was complimented by unobtrusive direct observation to monitor hand hygiene practices and behaviour change using a trained observer as considered a 'gold standard' method for evaluation [77]. Observations in the five primary schools took place over 1 h during lunchtimes. The researcher placed themselves in positions where the handwashing stations were visible, recording behaviours that included; water and soap usage, queue length, gender and age, time of handwashing in relation to eating and latrine use, dominant children, avoidance, handwashing systems, school environment and observed barriers. Observations for the Phase 2 study were used to monitor the impact of handwashing using a team of four enumerators from the Nairobi County Health Office. Data was tabulated and all results given to NSI and the researcher to be uploaded to Excel. After the Phase 2 study was completed, OBM3 was conducted with the same enumerators and observational process to ensure accurate monitoring for evidence of change.

4. Findings

4.1. Behaviour change through HWWS

Those schools where the intervention occurred experienced a change in risk communication and engagement by overcoming barriers and finding solutions. Health patrons indicated overall highly significant increases in pupil HWWS and soap usage amongst the target population following the NSI puppetry intervention ($t = 1.56373E\text{-}05$, $p < 0.0001$) (Table 2). The exception was for one response indicating there had already been 100% usage and three responses indicating no change.

Caregiver's responses during BM1 indicate that behaviour change also occurred at home (Table 3) including through increased handwashing before eating, after using the toilet and after playing. Seventy percent of the 59 caregiver respondents indicated personal increases in their HWWS behaviours. Anecdotes from the *caregiver's questionnaires* support these findings, suggesting this to be due to knowledge passed onto them from the children gained through puppetry and other NSI tools. One respondent commented, "I

Table 1
Timeline of data collection events throughout the study.

Data collection event	Date of data collection	Accompanying rationale
Baseline	26 Feb – March 9, 2018	NSI Intervention 1 was implemented 1–6 months prior to the Baseline depending on the school.
Baseline Monitoring 1 (BM1)	4–June 15, 2018	3 months after the Baseline
Observational Baseline Monitoring 2 (OBM2)	15–July 17, 2019	Before Phase 2 Follow up Study
Phase 2 Follow up Study	September 13, 2019	Challenge Event Day in HGM Riruta Primary School
Observational Baseline Monitoring 3 (OBM3)	3–October 14, 2019	3–4 weeks after Phase 2 Follow up Study and 3 months after OBM2.

Table 2
Health Patron Questionnaire response to the question: 'How many pupils always wash their hands with soap at critical times of the day before & after NSI came to the school?' (June 15, 2018).

Health Patrons Questionnaire BM1	Health Patron	More than 3 months ago (Before NSI) %	In the last 3 months (After NSI) %	% Difference	Average % Change
Nursery School	1	70	90	+20	**+12%**
	2	50	70	+20	
	3	100	100	0	
	4	70	70	0	
	5	40	60	+20	
Lower Primary	1	20	40	+20	**+15%**
	2	60	85	+25	
	3	60	70	+10	
	4	60	80	+20	
	5	70	70	0	
	6	40	55	+15	
Upper Primary	1	40	50	+10	**+15%**
	2	70	90	+20	
	3	70	80	+10	
	4	60	80	+20	
	5	70	70	0	
	6	40	70	+30	

Table 3
Care Giver Questionnaire responses.

Care Givers Questionnaire: Baseline Monitoring 1, March 9, 2018	Yes %
Q7. Has there been an increase in handwashing with soap at home in the last three months?	64
Q8. Has your child positively changed their handwashing behaviours in the last three months?	84
Q9. Have you changed your handwashing behaviours in the last three months to handwashing with soap?	70
Q.13. Did the puppet teach you how to wash your hands?	32

have made a bucket and a bar of soap and placed it at the door where they wash hands" whist another confirmed the knowledge had a positive impact on the whole family's hygiene practices. Another respondent declared "because of my son, I am now keen on washing my hands".

Responses from the children's questionnaire recorded 80% witnessed an increase in children regularly HWWS. Overall, the health patrons stated that 90% of children had not been washing hands effectively previously, but this improved post-intervention, explaining that "the children are now late to class more frequently due to handwashing". Comments during interviews with children suggested before the intervention that minimal to no HWWS occurred due to lack of knowledge about its effectiveness for disease mitigation. An interview with Participant 7 indicated; "there has been an increase in hygiene practices since puppets have been used in the school". Further health patron interviews confirmed an increase in HWWS among the school children since the intervention as suggested in the following extract:

> "There has been a big change since NSI came, our children are trying a lot to change their ways of cleaning and washing their hands. Even the other kids in the class are copying them. Since NSI, there has been an impact on handwashing with soap in the school."

A non-health club member indicated that out of all their friends, only a few would wash their hands before eating, whilst another referred to how the NSI practical puppeteering methodology had reduced misunderstandings and increased their knowledge and awareness.

> "Most of the time, we [teachers] assumed handwashing is you just dip your hands and you are clean. This time [with NSI] it came out practically, even the knowledge that soap is very important, an aspect we did not consider important".

A different health patron recounted the following;

> "As a teacher I never used to wash hands, I am sorry to say. But when I became a health patron, I now can't fail to wash my hands after the toilet. When NSI came in, I saw the sense."

FGD in each of the five schools suggested children who HWWS ranged between 25 and 75% across different schools and that this was sparked by the establishment of the school health clubs, and that handwashing continued to increase since the intervention.

> "Quite a number now wash their hands there [in school] as they think you are coming. They think if the visitors come and visit us, we will wash our hands. You have made washing hands more interesting for them." (Focus Group Discussion, Satelitte School. Health Club Member. 7 March 2018).

The head teacher from Kabiru School stated that; "the handwashing culture is growing, children wash of their own volition." However, results from BM1 observations also suggested contexts within which minimal HWWS was happening due to children rushing to get food, forgetting to wash hands or a lack of soap and water present for handwashing. These barriers were discussed at length in the FGDs with all participants and led to a greater communication about the reality and efforts for successful handwashing to take place in the schools.

4.2. Soap use and availability

Respondents to the *children's questionnaires* illustrated an increase in using soap for handwashing over the baseline period, from 55 to 82%. The health patrons and students explained that not using soap was largely due to not believing it is important, forgetting or where soap is unavailable. Health patrons disclosed soap use among most of the teachers in the school was infrequent, and that this impacted the children's decisions to use soap.

Many of the case examples were indicative of the mixed practices, perceptions and barriers to HWWS in these contexts, and the context within which the use of improved risk communication via the puppetry was having an impact.

Findings from the Phase 2 study (Table 4) show a very significant increase of 52% in children HWWS between those observed from OBM2 in July 2019 and OBM3 in October 2019 ($p < 0.0001$). There was also a very significant 19% decrease ($p < 0.0001$) in those children observed handwashing using only water, and this was indicated as being due to this intervention.

Further data indicated differences in handwashing behaviours dependent on age and gender, there being higher rates among girls than boys both among the under eight years old and over eight-year-old groups.

The Phase 2 study with children and teachers revealed all except one class was using the newly introduced systems including two queues and a soap/tap master and washing hands with soap, as well as drinking the treated water provided, with significant reductions to just 10–15 min to complete the handwashing process for the group. Further unanticipated impacts included added handwashing at other times of day, teachers being very happy that children's books they must handle were much cleaner and enjoying being able to wash their own hands with soap in classrooms and hence feeling safer around their pupils. By January 2020, during further monitoring a health patron at HGM school indicated that handwashing systems were still operational. The school principal indicated that:

> "In one classroom, a child brought liquid soap for their class's use immediately after the start of term to allow HWWS to take place ahead of the school soap-making programme. The child's parents make liquid soap using the same method as the school to sell locally. They donated the soap. They had not donated any soap prior to the intervention".

There were many more items of feedback indicating communication and engagement with associated health risks including health club children active in monitoring the correct HWWS procedures in the schools, feeling a specific role in the changed systems and taking the puppets with them to support these roles. This result extended to other health issues such as Sexually Transmitted Diseases.

4.3. Attitudes towards hygiene and health

Health patron and caregiver interviewees stated that "there is a positive change, a positive attitude with the children" and that "the children's attitude has improved towards hygiene, mostly the girls". Respondents to the caregiver questionnaire confirmed the positive changes towards hygiene practices had also been observed at home, shaping both the child's behaviour and their families. Comments included "No Strings International have impacted positively as now [my] children are aware of their health" and "It has brought a positive impact and good hygiene to our families". A health club student commented that the teachers seem much more interested in hygiene since the introduction of the puppets.

Both children and health patrons commented on an increase in the confidence of children who attend the health club and have been exposed to the methodology and tools. For example, a health club member indicated their confidence had grown since the puppetry and that they feel self-assured and able to speak in class, a finding backed up by health patron's who added it had also helped build more confidence and sense of achievement in their teaching skills.

4.4. Active risk communication in behaviour change

In relation to combinations of new knowledge and interaction a health patron indicated:

> "It sticks so much more in the children's heads, and they understand; they forget when they read but practically they remember … the children are now more engaged with the puppets. They learn more when they are doing, they are bored in the books".

Table 4
Children observed handwashing with water and/or soap at handwashing points.

Handwashing Points	Total students included in observation	Hand washed with only water	Hand washed with soap and water
Observational Baseline Monitoring 2 (OBM2) (Handwashing Stations 1&2)	1100	303 (28%)	57 (5%)
Observational Baseline Monitoring 3 (OBM3) (Classrooms)	1087	73 (7%)	615 (57%)

Note: Significant changes between OBM2 and OBM3 are in excess of the 99.9% confidence level using chi-square analysis on pairs of proportions.

Another health patron confirmed the old method of using books to communicate risks can be boring for the children, however with the puppets they enjoy them and participate, being more involved in the class. They explained that through puppetry, students have communicated their own stories and explored risk messages in more depth than before; "they enjoy touching and manipulating with the puppets; they are learning more when they are touching them and they go deeper into it". Students believed that when the puppets were used, more information was given and absorbed due to their enjoyment and heightened interest. This was reiterated by students not in the health club when they watched a shadow puppetry performance by the health club members on hygiene, commenting that they had learnt new information about handwashing from watching the show.

A teacher indicated the following about the participants:

> "They share ideas, you can see they're having fun when they are doing the work, it's really collaborative … they now refer to real examples back at home to what they have learnt. Since NSI have come in, they are motivated, and their awareness levels are higher."

Another teacher indicated that due to the NSI risk communication tools, including the puppets and the films, external students became much more interested in the risk messages addressed through the health club than before due to its clear explanation and its local contextual setting recognisable to the students. There were many personalised responses referring to individual puppets.

A teacher also discussed how the NSI methodology and training taught them a new approach to their own teaching. When interviewed this respondent explained that; "personally I learnt about the practical approach of things and various ways of how to reach the larger community." Students also commented in interviews on the influence puppetry has had on the health patrons teaching approach and attitude, such as for example:

> "The puppetry has made them feel active. Before they were angry, not interested in anything. But these days, because of the puppets, you can see they are happy every time. They enjoy using them."

With 59% of children taking the puppets home these were found to be used as aids to help them to communicate new hygiene risks to both adults and children in a fun and informative method. Caregivers confirmed in questionnaire responses that they gained new knowledge from the children and the demonstrations with puppets, with 21% stating this was the reason for their own increased handwashing and 32% that the puppetry helped to teach them (Table 3).

4.5. Further related health risk engagement impacts

Further risk engagement impacts relating to poor health and hygiene practices in the schools included:

> A greater retention of risk messages: FGD found that message retention could also be attributed to another tool used by NSI, singing, aided by a film with a song called 'Time to Wash' sung by the puppets and then learnt by the students.

Increased popularity of the health clubs: Since NSI introduced puppetry, the popularity of this form of social organisation increased as confirmed in interviews with the students and health patrons. This engagement has also been through making friends in the health club, creating a sense of belonging and a new motivation to attend sessions.

Reduction in diarrhoeal disease: The number of children suffering from diarrhoeal infectious diseases is reported by the schools to have decreased since the NSI intervention, which is strongly consistent with the identified increase in children HWWS more frequently. Examples of comments from three respondents included:

- "now my children are not becoming sick as often because they wash their hands before eating, after visiting the toilet, after changing babies' diapers and after playing",
- "before [washing hands] they complained of stomach-ache but now that is all gone", and
- "waterborne diseases have reduced drastically. Children are now growing healthy and strong".

Children made responses such as "washing hands with soap has made us not get sick … before [the puppets] I was sick every week, with diarrhoea and vomiting". An indicator of disease reduction is the increase in children's school attendance, observed by the children themselves with their friends and class size increasing and where the registers also illustrated a higher daily attendance of students. Health patrons from another school confirmed more children are in attendance now than before the intervention; a change from around ten students absent to only one or two per day (Ndurarua health patrons).

A teacher also recounted the impact on their own health as follows:

> "I used to have really bad skin problems on my hands and arms, but since NSI and the children have started HWWS, their books are cleaner and so when I mark their work, I am no longer touching the dirt. Now my skin problems have disappeared". (Teacher, HGM School)

4.6. Barriers and solutions to achieving HWWS in schools

Nine FGD with students across all five primary school locations revealed several existing barriers preventing a vast majority of children washing hands with soap at critical times of the day. The students debated and explored their own solutions to the barriers, contributing over thirty different ideas to the problems. The results are presented in Table 5. The barriers that appeared in all FGD included: ignorance, hunger, insufficient handwashing facilities, lack of knowledge, lack of soap, long queues and washing hands as a waste of time.

Table 5
Barriers and Solutions to HWWS in schools
Source: Students in FGD with five schools.

#	Barriers to handwashing with soap in school listed in order magnitude	Solutions to the barriers
1	**Ignorance** (having the knowledge, but it being ignored or forgotten)	Punishment for not washing hands. Design a handwashing system & area that makes it easier to wash hands, so it is harder to ignore or forget. Have handwashing monitors. Children wash hands next to own class with buckets/jerry cans. Teacher reminds children to wash hands at critical times. Rules are set and enforced e.g. not allowed back into class for lunch until handwashing is complete. Maintain water and soap in the classrooms for handwashing.
2	**Lack of knowledge:** Students and parents don't understand why handwashing and soap use is important. Students believe using spoons when eating means you don't need to wash hands. Handwashing is not practiced at home with parents. Children think handwashing is boring or they are lazy. Children are not allowed to leave the classroom to wash hands when there are visitors in the school.	Teach the importance of hygiene to students in lessons, after school and in assemblies. Create a 'health club day' where all must clean the school. Educate the teachers about hygiene through the head teacher. Continuous monitoring of knowledge and refresher sessions. Health club members tell true stories to the students, using puppetry and songs. Educate parents on handwashing importance at home.
3	**Lack of time for handwashing:** Teachers don't allow time to wash hands after using the latrine during lessons. Teachers punish if there is lateness to class, even if washing hands, so there is rushing. Children want to play for the whole of breaktime, rather than wash hands. They also play games, such as races (first to lunch). Children believe handwashing takes too long.	Communicate with the teachers about importance of handwashing to allow extra time for it before lessons. Schedule time for handwashing at the end of break and before lunchtime, instructed by the teachers. No-one is served food at lunch until all handwashing is complete.
4	**Insufficient handwashing stations:** Creates overcrowding, long queues. Long distances from classroom and kitchen.	To avoid the overcrowding and long queues: Stagger each class at the handwashing stations (rotas). Have different stations for older and younger children. Have handwashing supervisors. Apply handwashing in the classrooms with jerry cans. Add more handwashing stations.
5	**Water shortage & value:** No water system in Satelitte school. Unreliable water supply in most schools. Children play with the water which is wasteful. Children fear the water. Water is prioritised for washing the classroom floors, not handwashing. It is also prioritised for drinking over handwashing.	Employ a water watchman. Fix the borehole and water supply in all the schools, especially Satelitte school, so it is reliable. Each student brings own water in from home, for both drinking and washing hands. Head teacher communicates with parents about this. Sustainable use of treated rainwater. Harvest water from rainy season to ensure sufficiency in the dry season. Contribution towards water from students and staff. Educate about the value and use of water.
6	**Lack of soap in schools:** Those who can afford soap do not share it. Soap is expensive for most to buy. Soap is stolen. Soap is not provided by the school.	Each class contributes a set amount of money towards buying soap, or it is provided by the school. Students bring leftover soap from home. School asks parents to contribute soap with explanation of why it is important. School makes their own soap. Soap is monitored by the school prefects. Soap is locked away. Government tax can be used for soap in schools. Punishment if soap is stolen.
7	**Handwashing taps are stolen:**	Replace or repair missing/broken taps. Increase school security to prevent taps being stolen (this has been done by government subsequently). Supervise handwashing to prevent damage.
8	**Peer pressure/bullying at handwashing stations:** Students believe handwashing is childish and it gets laughed at when doing it. Older children push younger children away from handwashing stations.	Senior school pupils speak to the teachers about those who are bullying. More public awareness with posters. Information sessions led by the health patrons.
9	**Children are hungry:** There is a rush for food without handwashing.	Friends buy snacks in the morning for those who cannot afford lunch. School provides breakfast.

Physical barriers included no running water as the borehole was broken, unreliable water connections, with shortages up to 50% of the time, a handwashing station being at the bottom of a hill with difficult access due to thick mud, and handwashing taps stolen by the surrounding community as there was no perimeter fence. The barriers, identified by children through puppetry, were then incorporated into an intervention through which health club members designed handwashing systems.

5. Discussion

The outcomes of this research are informative in several ways and have added resonance during the COVID-19 period. Impact was reliant on self-selecting actions that then became managed HWWS, such that combinations of individual behaviour and school commitment to reduce health risk are consistently reported at the schools to have reduced infection rates. There is a high level of evidence of behaviour change having significantly occurred, though it is not possible to fully prove cause and effect links between numbers of cases of illness and a fixed amount of behaviour change. Indeed, the complexity of infectious disease risk, as already evidenced in the earlier work outlined in this paper, provided the understanding that significant behaviour change with children is possible; this is consistent with, and a part of what is needed to reduce infectious disease risk.

In extending the importance of this work to COVID-19 risk reduction, evidence of the efficacy of communication with children in risk engagement spaces remains highly relevant, for preparedness and response to this and other pandemic emergencies in resource poor environments. A difference however relates to the contrasting protracted 'normalised' diarrhoeal disease burdens of multi-hazard prone urban slums, and emergency management shocked into action on new viral hazards. Further research would need to examine pathways to societal resilience through co-produced lessons from COVID-19 response alongside children's engagement with longstanding health burdens.

The puppets were designed to be relevant to the participant's lives, needs and interests, making the learning process more meaningful and encouraging active engagement in creating, understanding and connecting to the knowledge [61]. The high influence of peers on engagement and shaping children's attitudes could be due to the amount of time spent with each other [78]. Peers can have a more direct influence on children's engagement than parents or teachers, highlighting the significance of creating positive peer relations, enhanced by the process of implementing puppetry.

Longer-lasting impacts for participants were supported through self-directed changes to promote intrinsic interest [79]. Once established, habits were measured through automaticity, frequency and identity, which it was noted could take a long period to form [80]; suggested an average 66 days to do so. Further explanations lie in linking behaviour control over handwashing to different kinds of psychological influences [81]; automatic or habitual responses, motivated goal-driven behaviour to satisfy needs, and cognitive causes which reflect conscious concerns.

It is proposed that critical learning in risk communication includes characteristics of good and poor listening that impact on the information being absorbed by the listener. The listeners expectations for the messages can be shaped by their background, experience, roles and mental and physical states influencing listener expectations for the messages [66]. To be an effective listener and fully engaged, the listener must be perceived as actively listening by the others in the group [82], a process enhanced by the puppetry. However, younger listeners can absorb and comprehend what they have heard less due to not applying productive metacognitive strategies whilst listening [83].

By using puppetry as a tool, learners were engaging their senses and involvement with the information, a preferred method of learning compared to solely listening [51]. This stimulated engagement amongst those who might not have absorbed the messages if presented in another form [52]. It was therefore upheld that puppets are an effective tool for allowing participants to interact and explore a range of ideas and opportunities, using only their imagination. For example, the results of this work were consistent with making decisions, exploring experiences, interaction with others, learning from role-play, self-discovery and handling. Creatively emphasising the importance of using soap with water increased understanding and awareness of the intended beneficiaries who gained an interest in using it and possessing it. School grades also increased due to higher concentration, variability of skills, application of new skills to learning, being happier, having more confidence in oneself and being inspired to learn.

Children's risk engagement through puppetry also included the following:

i) Children could take the role of the learner or the teacher. This method helped to concentrate the messages about infectious disease risk reduction and HWWS further. Teaching something is well known to help both the provider and the recipient of the information to instil the content of what is being communicated.
ii) Mapping out known risks. Using the school environment, and personalising own risks were most apparent in activities such as shadow shows whereby the risks and barriers to change were even more personalised.
iii) Memorising risks increased when using puppets, these being the most visual and active, therefore sticking in the minds of children when thinking about handwashing. Effectiveness was improved since children made their own puppets and making is connecting, in this case to handwashing behaviour.

Key pathways to infectious disease risk communication and engagement using the puppetry approach are explainable through the following processes:

- Creativity and participation that increases engagement: Learning a new skill involved more concentration and greater listening.
- Puppets that increased popularity of communal cooperation (e.g. the health club): Due to the novelty of puppets, children, parents and the teachers became more interested.
- Risk communication activities that reduced sickness: Since NSI were at the school, there is loose evidence that sickness levels decreased. Albeit not all of this would be directly to when NSI joined, a reduced rate of incidence was consistent with the risk communication activity reported here. The added benefits for infectious disease risk reduction were not just HWWS, but also through the other messages such as washing fruits before eating, cleaning utensils, cleaning lunch bowls, a cleaner environment and toilet facilities.
- Parents were reached by children taking puppets and their messages and songs home: The wider community was reached with health messages as the puppets 'came home to speak about HWWS'. The children are happy with the puppet; this makes the

parents happy and they positively want to listen to the child speaking about the incoming messages. Some parents already knew about hygiene practices, others did not and learnt from their children who acted here as the mediator, storyteller and message delivery medium. Further, the puppet acts as an aid for improved memory of the messages amongst the parents.

- New knowledge passed on through the puppets and child engagement technique: Puppets and other visual activities including film and models delivered new knowledge over the top of existing basic hygiene information that had already been established in the schools. This involved clarification of original messages by delivering them in a different way that can be understood by all. Some children learn visually or through participation.
- Barriers and solutions to HWWS were recognised and addressed: Behaviour change to HWWS is difficult due to the soft and hard infrastructure that stands in the way. Barriers that the children drew up were because of the school systems, culture and infrastructure which the children felt were beyond their control to change and manage. To be able to instil change, there needed to be the infrastructure in place as identified in Table 5. However, having the ideas come from the children made it more likely to be recognised and potentially addressed.

6. Conclusions

To be able to have successful HWWS there needs to be three elements; behaviour change, structurally embedded commitment via government and community infrastructure, and scientifically based knowledge with the means to disseminate it. Puppetry had an impact on all three of these aspects, through behaviour change that extended out to the teachers and government officials who formed part of the infrastructure.

The approach described in this paper complimented changes to the Kenyan school curriculum. The curriculum is very formal, and teachers focus on examinable subjects, with little space for practical elements or creative endeavours. This led to consideration of change towards a child-led approach with the opportunity for children's voices to be heard. The NSI methodology put children at the centre of the process of creating puppets and stories and delivering the messages themselves. Staff approved as they felt that children were able to resonate with the approach and because it blended practical elements with theory creating something novel for them that was fun and easy to grasp. However, the HWWS messages did not fully spread to the entirety of school populations and local communities outside the school, and as such full behaviour change did not take place. Addressing the significant barriers discussed in this paper makes the approach even more effective. If this action research orientated approach was to succeed in achieving greater impact, it would need to include some provision of facilities as part of its iterative process.

In addition to these results, there were promising reports on handwashing from HGM school in July 2020, which was closed for the most part of a year due to the Covid-19 pandemic. Teachers in the school documented since reopening to students, all handwashing stations as back in place and children being even more motivated to wash hands with soap due to the pandemic heightening their awareness and knowledge of the importance of hand hygiene. This research was working in tandem with a live intervention. As a result, NSI felt it was able to expand its child-led methodology from one where children lead hygiene promotion through puppetry and play, to one where children, as end users, also inform the design of handwashing facilities along with the adjustment of systems necessary for school-wide use, and in monitoring for sustainability.

This study concludes that there is grounded evidence that creative communication techniques, invoking engagement of children and their minders, in contexts of hygiene deprivation is an effective means to risk reduction. Specifically, it finds that the use of puppets collaboratively designed by their users, who are recipients of the information they convey, engage motivating emotions such as disgust, affiliation, and nurture. The sense of ownership of the risk reduction process is enhanced through this method. The implementation of this risk communication exercise using an action research approach was seen to be effective in changing attitudes and practices of handwashing in schools whilst spreading the knowledge of the barriers amongst key stakeholders interacting around the policy and practice space as highlighted by changing infectious disease risk. This experiential learning took place in the immediate run up to the COVID-19 outbreaks in Nairobi, bringing added additional significance and has had ongoing impact in that context to date. It demonstrates the power of well adapted and creative risk communication, that is owned by those it is intended to benefit, whilst exposing the need for a context for this to be impactful through both bottom up and institutional engagement in infectious disease risk reduction. Whilst understanding of risk communication and engagement is informed by this work with schools in Nairobi, it is replicable elsewhere. This provides reflection on how risk education and engagement can be more embedded and highlights hitherto unresolved structural and resourcing issues that need resourcing-based solutions. Given the ongoing demographic of many of the most at-risk regions, understanding child engagement and its effect on behaviours in risk contexts such as these is an avenue to reducing morbidity and mortality from old and new disease hazards. Well adapted risk reduction communication through child centred engagement will need to continue to energise action on sanitation and hygiene, though also in management of other types of hazards through comparative creative and accessible ways.

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