Research Paper

Predictors of hand hygiene behaviours among primary and secondary school children in a rural district setting in Zimbabwe: a cross-sectional epidemiologic study

France Ncube, Artwell Kanda, Maude Chahwanda, Margaret Macherera and Bigboy Ngwenya

ABSTRACT

Hand hygiene is one of the most effective and efficient ways of controlling faecal–oral diseases. However, little is known about the predictors of hand hygiene behaviours among school children. A predesigned checklist guide was used to observe hygiene behaviours of 460 pupils from four rural schools in Shamva South district, Zimbabwe. A pretested questionnaire was administered to obtain demographic data of the observed school children. Membership of a Water, Sanitation and Hygiene (WASH) club, age, gender and the level of education were associated with hand hygiene practices ($p < 0.05$). The findings indicated that investing in hand hygiene behaviour change processes among school children using the promotion, formation, resuscitation and empowerment of WASH clubs in schools is important in disease prevention among communities in developing countries.

Key words | fingernails, handwashing, hygiene behaviour, hygienic hand drying, sanitation, school children

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HIGHLIGHTS

- School WASH clubs provide the required environment for inculcating the responsibility and practice of good hygiene behaviours among members.
- Government ministries responsible for health and education should promote the formation, resuscitation and empowerment of school WASH clubs.
- More pupils with clean teeth washed hands with soap and water in comparison to those with dirty teeth.
- Further research could include swabbing hands of school children post handwashing and post hand drying to assess the effectiveness of methods used.

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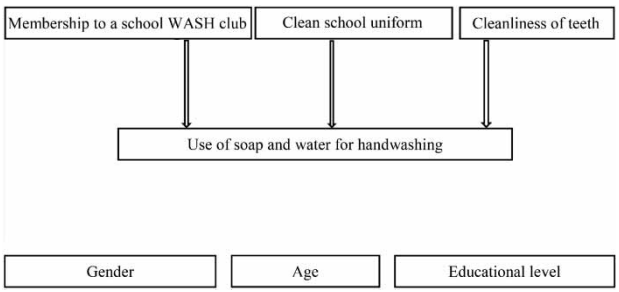
GRAPHICAL ABSTRACT



INTRODUCTION

The provision of Water, Sanitation and Hygiene (WASH) services is a universal human right and indeed a birth right for every individual (Uddin *et al.* 2016). Hygiene refers to the conditions and practices that are essential for the maintenance of health and prevention of the spread of diseases (WHO/UNICEF 2015). Despite the public health relevance of hygiene, the expired Millennium Development Goals did not address it (WHO/UNICEF 2017). In the last two decades, global attention narrowly focused on the provision of improved water and sanitation services without actively providing similar guidance on hygiene issues. The 2030 Sustainable Development Goals (SDGs) emphasise household, health facility and school hygiene issues (WHO/UNICEF 2015; Mara & Evans 2018). The inclusion of hygiene issues shows benefits associated with access to drinking water, and sanitation cannot be accomplished without good hygiene (WHO/UNICEF 2017). Target 6.2 of SDG 6 seeks to achieve universal access to adequate, equitable sanitation and hygiene, end open defecation, and address the special needs of girls, women and those in vulnerable situations (WHO/UNICEF 2017).

Studies have demonstrated that inadequate hand hygiene leads to contamination of hands with faecal coliforms (Hoque 2003; Greene *et al.* 2012) and coagulase-positive *staphylococci* (Soares *et al.* 2012). Handwashing has been associated with a significant reduction of microbial load on the hands (Toshima *et al.* 2001) and is recommended in preventing the spread of the COVID-19 virus (WHO/UNICEF 2020). Toshima *et al.* (2001) demonstrated that although handwashing with a placebo soap for a short time (lathering 3 s and rinsing 8 s) removed about 95% of the total coliforms transferred from hamburger patties, an antibacterial soap further reduced the coliform count significantly. Poor hand hygiene potentially spreads diarrhoeal illnesses (Nizame *et al.* 2013) and respiratory diseases such as COVID-19 (WHO/UNICEF 2020). The eyes, mouth and nose should not be touched with unwashed hands and hand hygiene is extremely important with regard to preventing the transmission of the COVID-19 virus (WHO/UNICEF 2020). Handwashing can reduce the prevalence of diarrhoea and acute respiratory infections thereby leading to large economic gains (Townsend *et al.* 2017). In two meta-analyses, handwashing interventions reduced the diarrhoea risk by 47% (Curtis & Cairncross 2003) and decreased the risk of respiratory infection by 16% (Rabie & Curtis 2006).

In Zimbabwe, not all schools have adequate toilet facilities (UNICEF/WHO 2018). Efforts targeted at increasing the use of school toilets could provide a means of disease reduction. However, there is a health risk to school children if such efforts do not include (a) good hygiene behaviours, (b) the daily provision of soap and clean water and (c) the availability of anal cleansing materials (Greene *et al.* 2012). WHO/UNICEF (2020) defines hand hygiene as behaviours aimed to reduce transient microbial flora through handwashing with plain or antimicrobial soap and water, alcohol-based rub and proper hand drying. The available studies about hand hygiene among school children (Dube & January 2012; Greene *et al.* 2012; Zhang *et al.* 2013; Assefa & Kumie 2014; Monney *et al.* 2014; Seimetz *et al.* 2017) do not discuss the predictors of appropriate hand

drying and keeping fingernails clean. Recommended hand drying methods include the use of disposable paper towels and air drying (WHO/UNICEF 2020). Incorrect hand drying methods such as rubbing wet hands on the school uniform and sharing hand towels can re-contaminate hands.

In the Zimbabwean context, food is commonly prepared, served and eaten with bare hands, which justifies the need for optimum hand hygiene. Studies that elucidate the predictors of hand hygiene behaviour (handwashing, hand drying and nail hygiene) of school children may yield valuable findings to guide health officers to design and improve the implementation of school-focused WASH programmes. Literature shows that it is inappropriate to design WASH interventions without taking into account existing practices (Hoque 2003; Greene *et al.* 2012; Kefeni & Yallew 2018; Mara & Evans 2018).

Schools are important institutions for inculcating desirable health behaviours, such as hand hygiene among pupils (Dube & January 2012; Burke & Dworkin 2016). The foundations for lifelong responsibility for the practice of personal hygiene are laid down in childhood (Khatoon *et al.* 2017). The school provides an environment where children's behaviours can either influence or be influenced by those of their peers (Holloway & Valentine 2000; Wills *et al.* 2005). In addition, school children act as agents of behaviour change in their families and communities by spreading information learnt at school (Khatoon *et al.* 2017). The school also provides rich opportunities to intervene early and correct undesirable health habits of children before they become well established (Wills *et al.* 2005). Therefore, the objectives of the present study were to (a) identify positive and negative hand hygiene practices, (b) ascertain the determinants for the use of desirable hand hygiene practices and (c) suggest interventions for promoting hand hygiene among school children.

METHODS

Study design and determination of sample size

A descriptive cross-sectional epidemiologic study was carried out at four rural schools (two primary and two secondary), between February and May 2019 in Shamva South district, Zimbabwe. This district has 18 primary and 11 secondary schools, with a total of 16,854 school children enrolled (Parliament Research Department of Zimbabwe 2016). Of these schools, the authors accessed and obtained permission to carry out the study in 11 schools. Other schools could not be reached due to logistical challenges. Four schools (36.4%) were purposively selected from the 11 accessed schools, on the basis that they had basic WASH services during the study period (WHO/UNICEF 2017). Basic school WASH services meant the provision of (a) handwashing facilities that have soap and water available, (b) improved sanitation (latrines) which are single sex and useable at the school and (c) drinking water from an improved source within the school (WHO/UNICEF 2017). Purposive sampling is a procedure commonly used in WASH studies to select study institutions (Nizame *et al.* 2013; Khatoon *et al.* 2017; Melariri *et al.* 2019). In light of the current study's cross-sectional design and its large study population, the minimum sample size (n) was calculated using an appropriate formula described in the literature (Kasiulevičius *et al.* 2006; Charan & Biswas 2013), where $n = ((z^2)\ (p)\ (1-p))/d^2$, yielding 362 study participants. Z represented the critical values at the level of 95% confidence intervals (CI) = 1.96, $p = 62\%$ (proportion of students who practised good hygiene behaviours), and d denoted the margin of error = 5%. Hygiene studies conducted among school children have reported a practice level $\leq$62% for good hygiene behaviours (Dube & January 2012; Assefa & Kumie 2014). Consequently, we assumed 62% practice level for hygienic behaviours (p). Further, assuming a 10% (36 participants) non-response rate, the final minimum sample required was 398 school children. The pupils were recruited through the school administration and their teachers. In total 460 pupils participated in this study, of whom 37% (170) were in grades 6 and 7 (primary level of education) and 63% (290) in forms 3 and 4 (secondary level education). In Zimbabwe, forms 3 and 4 refer to the third and fourth years of secondary education, respectively. To be eligible, pupils had to be at a level of education above grade 5. The rationale behind this criterion was that school WASH clubs (a key issue assessed in this study) were dominated by senior pupils (grades 6 and 7 in primary schools and forms 3 and 4 in secondary schools). The four studied schools had a total of 23 classes that were eligible for

participation in this study. Fourteen of these classes comprised pupils in grades 6 and 7, and the remaining 9 classes comprised pupils in forms 3 and 4. In each of these 23 eligible classes, the objectives and procedures of the study were explained and the pupils were invited to voluntarily participate. Prior to data collection, consent was obtained from the parents and guardians of the pupils. The study protocol and instruments were ethically reviewed and approved by the institutional review board of the authors' university and the school authorities in the four studied schools.

Questionnaire and observation

A structured age-appropriate questionnaire was administered in English to school children between the ages of 11 and 17 years (mean ± SD: 14.61 ± 1.8 years), in a face-to-face 5–10-min interview. Four expert teachers in primary and secondary education reviewed the questionnaire to determine and improve its appropriateness to the age of the school children.

Measurement of study variables

The questionnaire and observation guide were developed based on the stated study objectives and contained hygiene-related issues assessed in previous studies (Hoque 2003; Assefa & Kumie 2014; Khatoon *et al.* 2017). The questionnaire gathered information about the participants' socio-demographic characteristics (gender, age and educational level), sources of hygiene information and membership to a WASH club. Observation of handwashing material represented a more reliable proxy for handwashing behaviour than asking individuals whether they washed their hands (WHO/UNICEF 2017). In line with this recommendation, a checklist guide was developed and used by trained research assistants to observe the school children's hand hygiene behaviours (handwashing procedure used after using the toilet, hand drying methods used and cleanliness of fingernails) and other personal hygiene practices (cleanliness of uniform, teeth and hair). Fingernails, uniforms, teeth and hair were coded as dirty if any form of dirt were seen and as clean if none were visible. In addition, teeth were coded as dirty when pupils engaged in the unhygienic practice of biting fingernails (Khatoon *et al.* 2017). Observations were carried out for two consecutive weeks per each school from mid-morning (10 am) and each session lasted about 2–4 h.

Data quality control

Several data quality control measures were employed in this study. Trained research assistants who were Environmental Health Practitioners took detailed notes using a checklist guide to record the hygiene behaviours. The data collection tools (questionnaire and observation checklist) were piloted on a sample size that was 5% of the study sample, improved and then peer-reviewed by two independent certified WASH experts. Kappa values (k) ranged from 0.73 to 0.93, which demonstrated a good measure of interrater reliability. A one-day training of research assistants was facilitated by the first author, who is a registered Environmental Health Officer with over 15 years of work experience in water, sanitation and hygiene promotion. The training covered the study's objectives, interview techniques and observation procedures. Field-based data quality checks in the form of spot checks during data collection, support visits and interviews with research assistants were carried out. At the end of each data collection day, all completed questionnaires and observation record forms were submitted to the principal investigators (two) and rechecked for completeness and inconsistencies to improve on the quality of collected data.

Statistical analyses

Data analysis was performed using the statistical package, SPSS version 25 (IBM Inc, Chicago 2017). A χ^2-test was carried out to determine whether the hand behaviours differed with the pupils' age, gender, level of education and other factors such as membership to a WASH club, sources of hygiene information and cleanliness of the school uniform and teeth. Although other modelling approaches are available, logistic regression has been reported to be one of the most popular methodologies that uses odds ratios (OR) to express the associations between independent and dependant variables (Kleinbaum & Klein 2002). It is widely used in cross-sectional epidemiological studies (Assefa & Kumie 2014; Jain *et al.* 2018; Kefeni & Yallew 2018; Abuzerr *et al.*

2020). In line with the objectives of the current study, binary logistic regression analyses were conducted to determine OR of factors that may influence the hand hygiene behaviour (dependent variables). The hand hygiene behaviours were handwashing with soap and water (no = 0, yes = 1), hygienic hand drying (no = 0, yes = 1) and clean fingernails (no = 0, yes = 1). Hygienic hand drying referred to the use of methods that posed less risk of transmission of microbiological hand contaminants from one child to another. Such methods included shaking and waving hands (commonly referred to as the shaking dry method), use of disposable paper towels and air drier. On the other hand, unhygienic hand drying entailed shared drying cloths and rubbing hands on the uniform. There were nine independent factors: (a) gender (0 = female, 1 = male), (b) age (0 for ≤14 years, 1 for >14), (c) education (0 = primary, 1 = secondary), (d) hygiene education in the last 6 months (0 = not received, 1 = received), (e) hygiene information source (0 = other sources, 1 = health worker), (f) uniform (0 = dirty, 1 = clean), (g) teeth (0 = dirty, 1 = clean), (h) hair (0 = not combed, 1 = combed) and (i) membership of the school WASH club (0 = not a member, 1 = member). Model fit was tested by the Hosmer and Lemeshow goodness-of-fit test. In all cases, over 70% of the variation was explained by the models using the Nagelkerke pseudo R Square. ORs and their CIs were calculated while factors were tested for significance at 95% level of confidence ($p < 0.05$). Significant factors in the binary logistic regression model were further assessed for specific categories using a multinomial logistic regression. A backward stepwise elimination of non-significant variables ($p > 0.05$ eliminated) was applied. ORs and CIs were used to compare the relative effects of the reference category to the dependent variables of interest.

RESULTS

Characteristics and hand hygiene practices of school children

Table 1 shows the relationship between socio-demographic characteristics and hand hygiene behaviours of 460 pupils selected from four rural schools in Shamva South district, Zimbabwe. There were no differences in handwashing practice (use of soap and water) based on the gender, age and educational level of the pupils ($p > 0.05$). In addition, no differences were found in the cleanliness of fingernails based on the demographic factors ($p > 0.05$). Hygienic hand drying was practised more by males, older children (>14 years) at secondary school ($p < 0.05$). Having clean teeth (brushed) and combed hair was significantly associated with use of soap and water for handwashing purposes ($p < 0.05$). A substantial proportion of pupils with dirty teeth and uncombed hair did not use soap and water for handwashing purposes. Being a member of the school WASH club was significantly associated with use of soap and water for handwashing and use of a hygienic hand drying method ($p < 0.05$). Pupils who had received hygiene education from health workers in the last 6 months showed good hand hygiene behaviours than those who did not. Out of a total of 460 pupils, 39.6% (182) did not wash their hands with soap and water. About 35% (159) of them did not dry hands using approved methods and 9% (42) had dirty fingernails.

Predictors of hand hygiene behaviours

This study investigated the predictors of three hand hygiene behaviours: handwashing with soap and water, hygienic hand drying and keeping of fingernails clean. The association of each type of hand hygiene behaviour with the investigated independent risk factors is presented in Table 2.

Handwashing with soap and water

The strongest associations were observed between being a member of a school WASH club and the use of soap and water for handwashing (OR = 4.56, 95% CI [2.95–7.04], $p = 0.001$). Having clean teeth was significantly associated with the use of soap and water for handwashing (OR = 1.97, 95 CI [1.32–2.92], $p = 0.001$). A weaker association was observed between the cleanliness of a child's uniform and use of soap and water for handwashing (OR = 1.06, 95% CI [1.04, 1.14], $p = 0.078$). This means that pupils with clean uniforms were more likely to wash hands with water and soap than those with dirty uniforms. No

Table 1 | Study participants' characteristics and hand hygiene practices ($n = 460$ school children)

Characteristic (n)	Handwashing with soap			Hygienic hand drying			Clean fingernails		
	Yes n (%)	No n (%)	p	Yes n (%)	No n (%)	p	Yes n (%)	No n (%)	p
Gender									
Female (231)	134 (58)	97 (42)	0.285	136 (59)	95 (41)	0.003**	203 (88)	28 (12)	0.578
Male (229)	144 (63)	85 (37)		165 (72)	64 (28)		205 (90)	24 (11)	
Age (Mean ± SD: 14.61 ± 1.8 years)									
≤14 (171)	106 (62)	65 (38)	0.600	94 (55)	77 (45)	0.001***	146 (85)	25 (15)	0.084*
>14 (289)	172 (60)	117 (40)		207 (72)	82 (28)		262 (91)	27 (9)	
Education (Mean ± SD: 9.97 ± 1.9 years of education)									
Primary (170)	105 (62)	65 (38)	0.655	93 (55)	77 (45)	0.001***	145 (85)	25 (15)	0.078*
Secondary (290)	173 (60)	117 (40)		208 (72)	82 (28)		263 (91)	27 (9)	
Pupil's uniform									
Clean (418)	263 (63)	155 (37)	0.001***	279 (67)	139 (33)	0.062*	374 (90)	44 (10)	0.096*
Dirty (42)	15 (36)	27 (64)		22 (52)	20 (48)		34 (81)	8 (19)	
Pupil's teeth									
Clean (418)	126 (70)	54 (30)	0.001***	111 (62)	69 (38)	0.173	157 (87)	23 (13)	0.424
Dirty (280)	152 (54)	128 (46)		190 (68)	90 (32)		251 (90)	29 (10)	
Pupil's hair (short)									
Combed (408)	247 (61)	161 (39)	0.898	271 (66)	137 (34)	0.213	360 (88)	48 (12)	0.382
Not combed (52)	31 (60)	21 (40)		30 (58)	22 (42)		48 (92)	4 (8)	
Hygiene information source in the previous 6 months									
Health worker (242)	150 (62)	92 (38)	0.474	163 (67)	79 (33)	0.361	224 (93)	18 (7)	0.006**
Other sources (218)	128 (59)	90 (41)		138 (63)	80 (37)		184 (84)	34 (16)	
WASH club membership									
Yes (332)	234 (70)	98 (30)	0.001***	238 (72)	94 (28)	0.001***	298 (90)	34 (10)	0.246
No (128)	44 (34)	84 (66)		63 (49)	65 (51)		110 (86)	18 (14)	

*$p < 0.1$; **$p < 0.05$; ***$p < 0.001$; handwashing with soap: yes used soap while no did not wash hands or washed with water only; hygienic hand drying: yes used the shaking dry method, disposable paper towels and/or air drier; unhygienic hand drying means shared drying cloths and/or rubbing hands on uniform.

association was found between handwashing with soap and water and other factors ($p > 0.05$).

Hygienic hand drying

Gender, age, level of education, cleanliness of uniform and WASH membership were independently associated with the use of a hygienic hand drying method ($p < 0.05$). The study found significant differences with regard to hand drying by males and females. More male than female school children dried hands using a hygienic hand drying method (OR = 1.80, 95% CI [1.22–2.66], $p = 0.003$). Children older than 14 years tended to use the recommended hand drying methods than those ≤14 years (OR = 2.07, 95% CI [1.39–3.07], $p = 0.001$). The use of hygienic hand drying methods appeared to increase with pupils' level of education (OR = 2.10, 95% CI [1.41–3.12], $p = 0.001$) and to decrease with lower hygiene standards of pupils' uniform (OR = 1.83, 95% CI [0.96–3.46], $p = 0.065$). A substantial number of children who belonged to a school WASH club (in comparison to non-members) used hygienic hand drying methods (OR = 2.61, 95% CI [1.72–3.98], $p = 0.001$).

Table 2 | Binomial logistic analyses of factors influencing hand hygiene behaviour

	Handwashing with soap			Hygienic hand drying			Nails short and clean		
Factor	**OR**	**95% CI**	***p***	**OR**	**95% CI**	***p***	**OR**	**95% CI**	***p***
Gender									
Female	1.00	–	0.285	1.00	–	0.003	1.00	–	0.579
Male	1.23	0.84–1.78		1.80	1.22–2.66		1.18	0.66–2.10	
Age									
≤14	1.00	–	0.600	1.00	–	0.001	1.00	–	0.086
>14	1.11	0.75–1.64		2.07	1.39–3.07		1.66	0.93–2.97	
Education									
Primary	1.00	–	0.655	1.00	–	0.001	1.00	–	0.080
Secondary	1.09	0.74–1.61		2.10	1.41–3.12		1.68	0.94–3.00	
Hygiene information source									
Other sources	1.00	–	0.474	1.00	–	0.362	1.00	–	0.007
Health workers	1.15	0.79–1.67		1.20	0.81–1.76		2.30	1.26–4.21	
Status of uniform									
Dirty	1.00	–	0.078	1.00	–	0.065	1.00	–	0.102
Clean	1.77	0.94–3.35		1.83	0.96–3.46		2.00	0.87–4.59	
Pupil's teeth									
Dirty	1.00	–	0.001	1.00	–	0.173	1.00	–	0.424
Clean	1.97	1.32–2.92		1.31	0.89–1.94		1.27	0.71–2.27	
Pupil's hair (short)									
Not combed	1.00	–	0.898	1.00	0.81–2.61	0.214	1.00	–	0.386
Combed	1.04	0.58–1.87		1.45			1.60	0.52–4.64	
WASH club membership									
No	1.00	–	0.001	1.00	–	0.001	1.00	–	0.248
Yes	4.56	2.95–7.04		2.61	1.72–3.98		1.43	0.78–2.64	

Clean fingernails

The hand hygiene practice of keeping fingernails clean increased with the pupils' age and educational level. Pupils aged >14 years were more likely to keep their fingernails clean (OR = 1.66, 95% CI [0.93–2.97], $p = 0.086$) than were pupils ≤14 years. More secondary school children (in comparison to primary school children) had clean fingernails (OR = 1.68, 95% CI [0.94–3.00], $p = 0.080$). In addition, the practice of keeping fingernails clean was significantly higher in pupils who received hygiene information from health workers in the previous 6 months compared to those who received it from other sources (OR = 2.30, 95% CI [1.26–4.21], $p = 0.007$). More children who belonged to a WASH club had clean fingernails than those who did not but this difference in nails' cleanliness was not statistically significant (OR = 1.43, 95% CI [0.78–2.64], $p = 0.248$). In general, school children with uncombed hair had dirty fingernails while those with combed hair tended to keep fingernails clean. In addition, more school children with clean teeth had clean fingernails. However, these differences were not statistically significant (OR = 1.27, 95% CI [0.71–2.27], $p = 0.424$).

Multinomial logistic regression analyses

Results of the multinomial logistic regression analyses are shown in Table 3. Membership to a WASH club was found to be a significant predictor for the use of soap and water for handwashing (OR = 5.08, 95% CI [3.24–7.98], $p = 0.001$) and for the use of a hygienic hand drying method

Table 3 | Multinomial logistic analyses of factors influencing hand hygiene behaviour

Hand hygiene behaviour	Factor	OR	95% CI	*p*
Handwashing with soap	WASH membership: yes (referent no)	5.08	3.24–7.98	0.001**
	Pupil's teeth: clean (referent dirty)	2.35	1.53–3.62	0.001*
Hygienic hand drying	WASH membership: yes (referent no)	2.59	1.69–3.98	0.001**
	School: secondary (referent primary)	2..02	1.35–3.00	0.001*
	Age: >14 (referent ≤14 years)	2.05	1.37–3.07	0.001*
	Gender: male (referent female)	1.71	1.15–2.54	0.008*
Clean fingernails	Source of hygiene information in the last 6 months: health workers (referent other sources)	2.30	1.26–4.21	0.007*

*$p < 0.05$, **$p < 0.001$; OR, Odds ratio; CI, confidence interval.

(OR = 2.59, 95% CI [1.69–3.98], $p = 0.001$). The status of a school child's teeth was noted to be a key determinant of the use of soap and water for handwashing. More pupils with clean teeth washed hands with soap and water in comparison to those with dirty teeth (OR = 2.35, 95% CI [1.53–3.62], $p = 0.001$). Analyses clearly showed that age (OR = 2.05, 95% CI [1.37–3.07], $p = 0.001$) and level of education (OR = 2.02, 95% CI [1.35–3.00], $p = 0.001$) influenced hand drying behaviours of the pupils. Pupils >14 years and at the secondary level of education practised more hygienic hand drying than those at primary school (≤14 years). The study showed that students who gained hygiene information in the previous 6 months kept their fingernails clean. In particular, more pupils whose hygiene information was health workers kept fingernails clean compared to other pupils (OR = 2.30, 95% CI [1.26–4.21], $p = 0.007$).

DISCUSSION

A substantial proportion (39.6%) of school children in this study, and adults in other studies (Hoque 2003; Nizame *et al.* 2013; Hsan *et al.* 2019), did not wash their hands with soap and water after using the toilet. Hands were commonly washed with just water or were not washed at all. It has been reported that handwashing with water alone is the least effective hand cleaning option. In addition, soap and water or alcohol-based hand rubs are the most ideal and effective handwashing materials (WHO/UNICEF 2020). From a public health perspective, handwashing with soap and water has been reported to reduce bacterial hand contamination (Toshima *et al.* 2001) and incidence of diarrhoeal diseases (Greene *et al.* 2012). In the current study, some pupils (including some who washed hands with soap and water) did not use hygienic hand drying methods (shaking dry, air drying or disposable tissue). Hands were commonly dried by rubbing them on the school uniform, which promotes recontamination with pathogens. The study findings regarding non-use of soap and water for handwashing and the use of unhygienic hand drying methods indicate that access to basic school hygiene services does not translate to their use by school children. In addition, the findings underline the need for hygiene education programmes to promote the use of recommended handwashing and hand drying procedures by pupils in areas with fewer resources. School-based hygiene education was reported as an essential tool for reducing the transmission of infectious diseases (Khatoon *et al.* 2017).

Evidence from both primary and secondary school children in this study indicated that membership to a WASH club was a key predictor of use of soap and water for handwashing and the use of a hygienic hand drying method. In comparison to pupils who belonged to a WASH club, fewer pupils who were not WASH members practised the hand hygiene behaviours (use of soap and water for handwashing and hygienic hand drying). This may indicate that school WASH clubs are an essential component of hand hygiene behaviour change programmes among pupils. The study findings show that in the school WASH clubs, members engaged in various educational sessions, debates, discussions, games and other activities that enhanced acquisition, understanding and use of good practices with regard

to water quality, sanitation and general hygiene. Evidently, school WASH clubs enhance health literacy by offering opportunities for pupils to learn good hygiene practices from their peers as role models. One study carried out among school children showed that membership to a WASH club increased desirable water handling practices (Assefa & Kumie 2014). Therefore, efforts to inculcate good hand hygiene behaviours in school children must promote the formation, resuscitation and empowerment of school WASH clubs. Empowerment has been reported to be cause and outcome of successful gender-sensitive WASH programmes (Dery *et al.* 2020).

In this study, no inconsistencies in handwashing practice and cleanliness of fingernails were noted based on the age, gender and educational level of the school children ($p > 0.05$). However, handwashing with soap and water was significantly higher in pupils with clean teeth and uniforms than in pupils with dirty teeth and uniforms. This observation demonstrates that poor hand hygiene behaviour is common among pupils who generally lack personal hygiene. This highlights the need for comprehensive hygiene education programmes that target correcting poor practices with regard to hand and clothing hygiene, and cleansing of teeth. To yield desirable behavioural changes, hygiene education programmes should be planned, implemented, evaluated and included in the school's health and hygiene curriculum (Ncube *et al.* 2020).

Field observations in this study showed that the hand hygiene practice of keeping fingernails clean increased with the pupils' age and educational level. Some plausible explanations for these findings were (a) older pupils (>14 years and mostly in secondary school) had possibly more hygiene learning opportunities during their primary and secondary levels of education than younger pupils (≤14 years and mostly in the primary level of education), (b) hygiene education messages and terminology may be easier to understand by secondary school children than by primary school children (as more comprehensive science content covered as the education level increases) and (c) a better understanding of risk of dying from poor hygiene by older pupils (generally, in African culture young children are not taught about death and its causes). Regardless of why the hand hygiene practice of keeping fingernails clean increased with the pupils' age and educational level, from a public health perspective, this finding suggests that younger pupils have a higher risk of hygiene-related diseases than older pupils. More hand hygiene behaviour change programmes with an emphasis on keeping fingernails clean may be undertaken among primary schools. When habits are well established in adolescence, they become long-lasting and difficult to change in adulthood (Wills *et al.* 2005). This demonstrates the importance and need for hygiene behaviour change programmes for school children. This cohort is vital to reach and help fulfil the crucial role of protecting their own health and that of their own future families (Byrd-Bredbenner *et al.* 2010).

Limitations of the study

This study's findings should be interpreted in the context of some limitations. The study was cross-sectional in design and the studied schools and sample of school children were not randomly selected. The study population comprised primary school children in grades 6 and 7, and secondary school children in forms 3 and 4, and the results may not be generalised to school children in other levels of education. Future studies may overcome these limitations by using longitudinal designs with larger and more representative samples (Hsan *et al.* 2019). With regard to the Hawthorn effect, the hand hygiene behaviour portrayed by the pupils under observation may not adequately represent their routine hand hygiene practices. To address this possible source of bias, the observation visits were not announced to the participants. This study focused on primary and secondary school children's hand hygiene behaviours but did not examine their teachers' practices, opinions and knowledge in this regard. This may have limited the study's capacity to determine institutional factors enhancing or constraining the hand hygiene behaviour of school children. Further research is needed in this regard.

CONCLUSION AND REMARKS FOR FURTHER STUDIES

Our findings showed that there is a lack of hand hygiene practices among school children who did not belong to a

WASH club and had dirty teeth. This finding indicates that functional school WASH clubs provide the required environment for inculcating the responsibility and practice of good hygiene behaviours among members. Therefore, investing in hand hygiene behaviours change processes among school children through the promotion, formation and or resuscitation of WASH clubs in schools is important in disease prevention among communities in developing countries. In this regard, government ministries responsible for health and education should promote the formation, resuscitation and empowerment of school WASH clubs because they play an important role in faecal–oral disease prevention. In addition, school-based WASH clubs are a low-cost public health intervention that can be readily implemented in low- and middle-income countries. The common practice of drying hands by rubbing them on the school uniform promotes recontamination with pathogens and points to the importance of providing hand drying materials such as disposable tissue or facilities such as air driers. In addition, the unhygienic practice could be a consequence of inadequate knowledge on recommended hand drying techniques and on diarrhoeal diseases associated with poor hand hygiene practices. Workshops for school WASH clubs and teachers may help address this knowledge gap. Future efforts may investigate whether the use of good hand hygiene behaviours at school is influenced by household level factors such as access to hygiene facilities at home and the community socio-economic status. Further research could include swabbing hands of school children post handwashing and post hand drying to assess the effectiveness of methods used and provide evidence-based recommendations on required improvements. Further studies should assess the role of water quality (source and point-of-use) for handwashing where the availability of soap is limited. Lastly, it may be helpful for future studies to consider analysing the WASH questionnaire through a model with hypotheses and constructs.

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CONFLICT OF INTEREST

Authors report no conflict of interest.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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