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REVIEW

A framework for designing hand hygiene educational interventions in schools

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Abstract

Objectives Hygiene education appears to be the commonest school-based intervention for preventing infectious diseases, especially in the developing world. Nevertheless, there remains a gap in literature regarding a school-specific theory-based framework for designing a hand hygiene educational intervention in schools. We sought to suggest a framework underpinned by psychosocial theories towards bridging this knowledge gap. Furthermore, we sought to propound a more comprehensive definition of hand hygiene which could guide the conceptualisation of hand hygiene interventions in varied settings.

Methods Literature search was guided by a standardized tool and literature was retrieved on the basis of a predetermined inclusion criteria. Databases consulted include PubMed, ERIC, and EBSCO host (Medline, CINAHL, PsycINFO, etc.). Evidence bordering on a theoretical framework to aid the design of school-based hand hygiene educational interventions is summarized narratively.

Results School-based hand hygiene educational interventions seeking to positively influence behavioural outcomes could consider enhancing psychosocial variables including behavioural capacity, attitudes and subjective norms (normative beliefs and motivation to comply).

Conclusions A framework underpinned by formalized psychosocial theories has relevance and could enhance the design of hand hygiene educational interventions, especially in schools.

Keywords Hand hygiene · Education · School · Theories · Framework

Introduction

Hand hygiene as a structured intervention to prevent the spread of infections began only some few decades ago. In the early 1960s, the Center for Disease Control (CDC) published a guideline instructing healthcare professionals to practice handwashing with soap (HWWS) for 1–2 min before and after patient contact. This position is, however, challenged by some authors who have suggested that hand hygiene practice and research in the clinical setting dates back to the 1840s, when it was discovered by Ignaz Semmelweis that puerperal fever could be prevented by adhering to hand hygiene disinfection; which eventually led to his introduction of handwashing standards in obstetric clinics (Kelcíkova et al. 2012; Potter 2001).

The threats posed by infectious diseases to the global public health deserve increased attention. Infectious diseases continue to claim thousands of lives, especially in developing countries, where relatively little investments are made by the governments to create an enabling environment which enhances the pursuit of hygiene (Cross and Coombes 2014). In Africa, for example, while cholera claimed 1583 lives in 2014, the Ebola virus disease killed a

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woeful number exceeding 11,000 people at the end of the first quarter of 2016 (WHO 2016). Cholera continues to be endemic in many developing nations around the world. For example, in Ghana, a total of 28,975 cases of cholera (CFR = 0.8%) resulting in 243 deaths were recorded between June 2014 and August 2015 (WHO 2015).

Among children, diarrhoea continues to claim lives which could have been preserved. Diarrhoea and respiratory illness account for about five million deaths in children every year, and are mentioned as the top two killers of children worldwide (Curtis et al. 2011). It is estimated that by the year 2030, approximately 24 million children could lose their lives as a result of diarrhoea, if global efforts are not intensified (UNICEF 2016). It is worth noting that about 60% of diarrhoeal mortality worldwide is attributable to poor water, sanitation and hygiene (Prüss-Ustün et al. 2014).

Though hygiene promotion has received relatively less attention from donors and governments, especially when compared to other health issues such as malaria and HIV, the evidence is clear that the contribution of hygiene-related diseases namely diarrhoea and pneumonia to child mortality is greater than the contribution of all the other child illnesses combined (UNICEF 2016). Interventions on hand hygiene have often targeted clinical settings and related ones with few targeting the school setting, despite the fact that school-based hygiene interventions are essential for fostering life-long learning (Snel and Shordt 2005; Adams et al. 2009). Also, school children can be good agents of health behaviour change in homes and the community, as they tend to be more receptive to new behaviours as compared to the adult population.

School-based hand hygiene interventions often seek to influence knowledge, attitudes, practices, illness or absenteeism due to illness. Some authors have underscored the importance of regular hygiene education in preventing the spread of infectious disease pathogens among children in the school setting (Jefferson et al. 2009). It is, therefore, not uncommon to find practitioners resort to hand hygiene education as an intervention for promoting safe hygiene practices in schools, especially in the developing world. Nevertheless, from our literature search, no school-specific theory-based framework was identified which could aid practitioners in the design of hand hygiene educational interventions in schools, though some guidelines and frameworks exist for other settings such as the clinics. In the absence of such a theory-driven framework, a school-based interventionist could resort to a trial and error in intervention design and evaluation (Melnyk and Morrison-Beedy 2012) and risk missing out on an opportunity to enhance construct validity (Stein et al. 2007).This paper attempts to contribute to bridging this gap, and consequently contribute to the enhancement of effectiveness in hand hygiene intervention delivery in schools. We begin with a contribution to the conceptualisation of hand hygiene. Subsequently, a critique of the notable hand hygiene approaches is presented. Also, we discuss the available evidence bordering on the existence of a school-specific theoretical framework for the design of a school-based hand hygiene educational intervention. On the basis of the identified gap in literature, the paper finally suggests a framework underpinned by multiple psychosocial theories for the design of a school-based hand hygiene educational intervention.

Methods

Hygiene promotion literature tends to be scattered across many databases, potentially due to the multiple disciplines which make contribution to hygiene promotion. Databases and search engines which were consulted to guide the literature search of this study included PubMed, ERIC, Cochrane Library, EBSCO host (Medline, CINAHL, Academic search complete, PsycINFO, PsycARTICLE, PsycLIT), Hinari and googlescholar. Only literature published in English were retrieved, and there was no limit to a particular time frame of published literature.

A search strategy, developed with guidance from a tool developed by the Humbolt State University (2008) guided the free literature search. Key search terms used included '*hand hygiene*', '*handwashing*', *'handwash', 'hand sanitation'*. Others were *'education', 'promotion', 'intervention', 'behaviour change', 'project', and 'programme'*. In addition, *'school', 'school age', 'grade', 'level', 'primary', 'children' and 'adolescents'* were used. Boolean operators were used to combine search terms, and words were truncated where necessary to ensure a more comprehensive search. Data from the recruited studies were extracted using a template developed by authors. In an attempt to report the existence or otherwise of a school-specific theoretical framework for hand hygiene education, articles were included if they met the following criteria: (1) study was on hand hygiene (2) intervention study (3) implemented in a school setting (4) evaluates hand hygiene education (5) published in English language.

Results

Towards a definition of hand hygiene

A review of the body of literature suggests a few attempts at defining the term *hand hygiene*, though the term *hygiene* has received varied conceptualisations. According to the US Center for Disease Control and prevention, hand

hygiene "includes handwashing (washing hands with non-antimicrobial soap), antiseptic handwash (washing hands with water and soap or another detergent containing an antiseptic agent), antiseptic hand rub (rubbing hands with an antiseptic hand rub) and surgical hand antisepsis (pre-operative antiseptic handwash or hand rub performed by surgical personnel)" (CDC 2015). As comprehensive as the above definition may appear, it is limited in the following ways:

- The use of local cleansing agents as alternative to soap is not conspicuous in the definition.
- The purpose of engaging in the act of handwashing or hand rubbing is not reflected.
- The definition appears to be skewed towards hand hygiene pertaining to the hospital setting and may not be applicable to other settings such as the school.

On the basis of the above discussion, we suggest the following definition of hand hygiene. The proposed definition seeks to address the aforementioned limitations, and this implies that it is potentially relevant for the conceptualisation of hand hygiene in varied settings:

> *"An activity involving the use of soap or other effective local agents in which running water is provided, or the use of a hand-rub containing the right proportion of alcohol or related substance, which cleanses the hands of micro-organisms of disease causing potential".*

Common approaches to hand hygiene

There are different approaches existing for hand hygiene. These approaches are often tied to the setting within which hand hygiene occurs. For example, within the clinical setting, gloves may be used as a hand hygiene strategy complementing handwashing with soap. In a school or community setting, the commonest approach for hand hygiene is observed to be handwashing with soap or ash/soil in the absence of soap. Also, the use of hand sanitizers or rubs tends to be common in clinical settings and many other workplaces.

The use of hand sanitizers

Earlier guidelines for hand hygiene placed more emphasis on the use of water and soap, than the use of a waterless hand sanitizer in the clinical settings (Hospital Infection Control Practices Advisory Committee 1995). Recent guidelines for clinical settings, however, appear to place emphasis on hand sanitizers, especially in instances where the hand is not visibly dirty (WHO 2009). A typical hand sanitizer consists of ethanol, isopropanol, and n-propanol. The antimicrobial activity of the aforementioned alcohols is tied to the ability to denature proteins (Jumaa 2005). An alcohol concentration of 60–95% is considered as most effective (Jumaa 2005; Centers for Disease Control and Prevention 2002). When applied to the skin, alcohols are known to have the most rapid bactericidal effect when compared to other disinfectants (*ibid*). A quantity of 3 mL of hand sanitizer, lasting for 20–30 s on the hands has been recommended (Hand Hygiene Australia 2016; Widmer 2000).

The use of hand sanitizers is not without criticism. Hand sanitizers can be criticized for not being able to rid the hands of debris and some oils which may serve as hiding places for some micro-organisms on the hands (Filion et al. 2011). Also, there are concerns about the possible hand irritations and even skin damage as a result of the use of hand sanitizers (Larson et al. 2006).

Handwashing with soap (HWWS)

Handwashing with soap has been described as simple yet a complex practice. Though there is no single guideline for this practice, it is common to find many guidelines (CDC 2015; WHO 2009) outline steps including the following:

- Turn on clean running water.
- Get hands wet.
- Apply soap to hands to cover all the hand surfaces.
- Rub palms together, with fingers interlaced.
- Rub one palm over the back of another hand and vice versa, with fingers interlaced.
- Rub thumb with the other palm, and vice versa.
- Wash the tip of fingers and clean under finger nails (especially when hands are visibly dirty).
- Wash both wrists with palm.
- Rinse hands and wrists thoroughly with running water.
- Dry hands with a single use towel or air dry.

Regarding the duration for handwashing, WHO estimates a duration of 40–60 s for the entire handwashing procedure, beginning with the wetting of hands to the drying of hands (WHO 2009). The Center for Disease Control and Prevention has recommended a minimum duration of 20 s for the rubbing together of hands with soap (CDC 2015). This recommendation is in consonance with that published by Hand Hygiene Australia (2016). It is, however, worth mentioning that the duration for handwashing with soap has implications on the compliance to handwashing practice. A study by Kelcíkova et al. has shown that reasons for non-compliance to handwashing guidelines included the time required for handwashing with soap (Kelcíkova et al. 2012).

Critiques of HWWS borders largely on the reactive effects of cleansing agents. The notable agents being either

an antiseptic soap or a plain soap may come in the form of bars, liquid or leaflets. Some concerns have been expressed about HWWS from different but related perspectives. Larson has reported that HWWS could lead to damaged skin, which may be more heavily colonised by micro-organisms with pathogenic potential (Larson 1999). According to Nicolle, the use of soap for handwashing may result in skin irritation for some people (Nicolle 2007).

A suggested framework for hand hygiene educational intervention in schools

The literature search towards reporting on the existence or otherwise of a school-specific theoretical framework for hand hygiene educational intervention yielded an initial number of 1787 abstracts. When subjected to the study's inclusion criteria, 1697 were excluded, as they were not on hand hygiene but other fields of hygiene. The remaining 90 were further subjected to the inclusion criteria, where 30 were excluded as they were not intervention studies. When the remaining 60 were further subjected to the inclusion criteria, 47 were excluded as they failed to evaluate hand hygiene education. Two other studies failed to provide adequate information to make a determination and hence were excluded. Out of the remaining 11 studies, 6 were excluded as they were not school-based. The remaining 5 studies were used for the narrative synthesis. A flowchart of the search in presented in Fig. 1 below.

The available evidence

Studies identified and subsequently examined to determine the existence of a school-specific theoretical framework for the design of school-based hand hygiene educational interventions were conducted in different countries. Two were conducted in the United States, the remaining three studies were conducted in Egypt, Ghana and Ethiopia. Studies assessed varied endpoints including hand hygiene knowledge, behavioural intention, practices, as well as absenteeism. Characteristics of the studies are summarized in Table 1.

Guinan et al. (2002) delivered a comprehensive handwashing programme which included a 1-h hygiene education and reported that the intervention reduced absenteeism in five elementary schools in Pennsylvania. In another study by Snow et al. (2008), a teacher's cue to action in combination with a hand hygiene educational intervention was delivered in a public elementary school in Utah. The authors reported that the intervention was effective in terms of improving the application of hand hygiene products.

In Egypt, Moussa et al. reported that the handwashing practice of elementary school children was improved following a health educational programme (Moussa et al. 2015). Lang (2012) in a qualitative study conducted among elementary school children in Ghana reported that hand hygiene knowledge and practice improved post intervention. Graves et al. conducted a study in Kenya, which implemented a handwashing educational intervention employing a poster design competition among primary school children, and evaluated its effect on handwashing practice (Graves et al. 2012). Authors reported that the intervention failed to achieve a significant difference between the intervention and control arms, regarding the frequency of handwashing.

Theoretical considerations

Though a greater number of the aforementioned studies reported a positive intervention outcome, a key question which remains is, what are the pathways through which the interventions yielded the reported outcomes? And within which school-specific theoretical framework did the interventions operate? These questions are crucial, as they provide an opportunity for the enhancement of the replicability of interventions which work, through an understanding of the interplay between formalized constructs or variables involved in an intervention delivery. None of the studies reviewed above makes reference to a school-specific framework underpinned by relevant theories which could be used for guiding the conceptualisation or design of school-based hand hygiene educational interventions.

In the light of the above gap in literature, we suggest a school-specific framework underpinned by multiple psychosocial theories to guide the future design of hand hygiene educational interventions in schools, while not discounting the utility of the framework for related settings. The framework is based on pertinent constructs which facilitate a thorough understanding of health behaviour and the change in children, and the logical relationships existing between the constructs. Key theories/models guiding the development of the framework are: the health belief model (HBM) by Rosenstock et al. (1988), social cognitive theory (SCT) by Bandura (1986), and the theory of planned behaviour (TPB) by Ajzen (1988). Figure 2 presents the proposed framework.

From Fig. 2, a school-based hand hygiene educational intervention should primarily target the individual-level variables namely behavioural capacity (i.e., knowledge and skill), perceived susceptibility, perceived seriousness, attitude and subjective norms (i.e., normative beliefs and motivation to comply). Nevertheless, the creation of an enabling school environment must form the basis for attempting to influence individual-level variables. In the light of this, practitioners should work together with relevant stakeholders to ensure that there are supportive handwashing facilities in the school, as well as a supportive

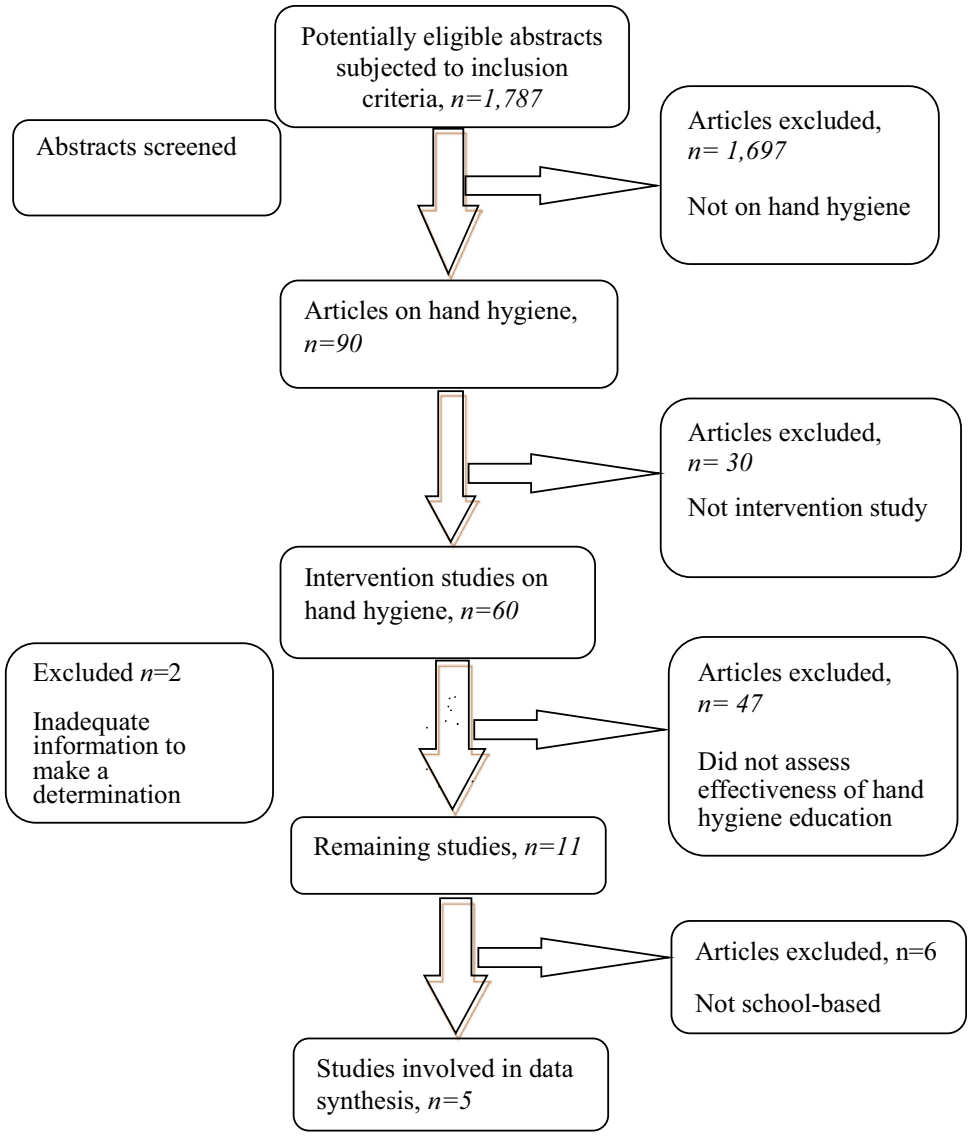

Fig. 1 A flow chart of the study selection process

school policy environment. The social cognitive theory (SCT) posits that the combined effect of knowledge and skill (behavioural capacity) can trigger the adoption of a behaviour (Bandura 1986). In a school-based hand hygiene education, practitioners ought to give substantial attention to the enhancement of the skill of target participants, and not merely the enhancement of knowledge. Rosenstock et al. have described perceived susceptibility as an individual's evaluation of his/her vulnerability to a given health condition (Rosenstock et al. 1988). In line with this description, a student will likely consider whether the failure to wash hands with soap could result in him/her contracting diarrhoea. In the event that a student concludes that he/she is prone to diarrhoea, then a further evaluation emerges which assesses the seriousness or otherwise of the consequences of diarrhoea, which when considered by the individual to be devastating to his/her aspirations could trigger an intention to adopt a healthful behaviour. This has been termed as perceived seriousness (Rosenstock et al. 1988).

Another individual-level variable which has been suggested to influence behavioural intention is subjective norms. Bennet and Murphy posited that subjective norms are determined by normative beliefs and the motivation to comply (Bennet and Murphy 1997). Normative beliefs have been described as the belief which an individual has about the approval or otherwise of a given behaviour by people considered to be significant others (Huesmann and Guerra 1997). In a school setting, such significant others could be teachers and respectable peers. Many studies have underscored the crucial role of teachers in influencing the handwashing behaviour of school children, even though few have assessed teachers' handwashing behaviour (Setyautami et al. 2012). In the home, significant others

Table 1 Characteristics of studies assessing school-based hand hygiene educational interventions

Study (location of study)	Type of intervention	Methodological approach	Study design	Setting	Method of analysis	Total participants	Key outcome(s) variables assessed	Reported results
Guinan et al. (2002) (Pennsylvania-USA)	Education and use of a hand sanitizer	Quantitative	Not reported	Elementary schools	Binomial distribution with parameters	290	Absenteeism	E
Snow et al. (2008) (Utah-USA)	Teacher cue to action and Hand hygiene education	Quantitative	Not reported	Public elementary school	A two sample test of proportion using STATA 8.0	492	Application of hand hygiene products	E
Moussa et al. (2015) (Egypt)	Health educational programme	Quantitative	Quasi-experiment	Primary schools	Descriptive stats using IBM SPSS 20.0. Qualitative analysis	450	Knowledge about HW HW Practices	E
Graves et al. (2012) (Kenya)	Provision of *HW facilities and education using a poster contest	Quantitative	Cluster-randomized trial	Primary schools	Two sample paired *t* test, Wilcoxon rank-sum non-parametric test	Not reported	HW practice	IE
Lang (2012) (Ghana)	Hand hygiene intervention	Qualitative	Not reported	Elementary schools	Not reported	1739	Hand hygiene Knowledge Hand hygiene practice	E

E effective, *IE* ineffective, *POs* primary outcomes, *HW* handwashing, *HH* hand hygiene

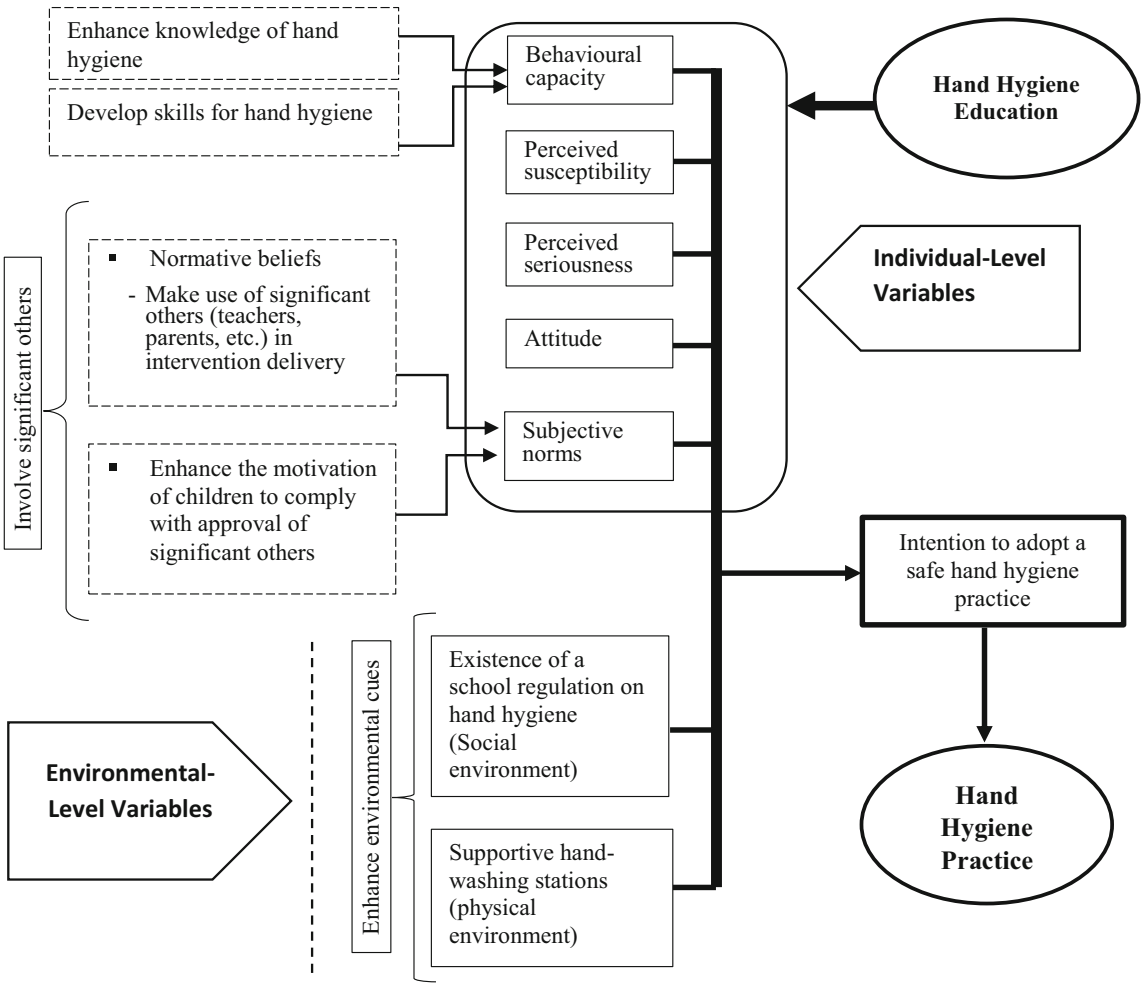

Fig. 2 A framework for designing hand hygiene educational intervention in schools

could be parents or older relatives. Apart from the school, children spend the rest of the day in the home. This brings to light the potential influence of parents or guardians on a child's handwashing behaviour even at school.

Within the context of handwashing with soap for example, the existence of an enabling physical environment is essential for encouraging the practice. The existence of functional facilities for engaging in the practice, such as running water, and soap are crucial to the adoption and maintenance of the behaviour. The importance of a functional handwashing facility for enhancing children's handwashing behaviour has been greatly established (UNICEF 2008; Adams et al. 2009). In addition, the social environment plays a critical role in the adoption and maintenance of hand hygiene behaviour in the school setting. An important variable pertaining to the school environment worth considering is school regulations or prohibitions pertaining to hand hygiene. This holds a potential for influencing students' handwashing behaviour.

Behavioural intention according to the theory of planned behaviour is the closest determinant of behaviour (Ajzen 1988; Lavin and Groarke 2005). It often presents itself as a moderator variable through which a behaviour is adopted or rejected.

Discussion

The studies evaluating a hand hygiene educational intervention in schools appear to be characterised by some design limitations. Several of such studies failed to demonstrate an intervention's theory of change or framework (Guinan et al. 2002; Snow et al. 2008; Moussa et al. 2015; Graves et al. 2012; Lang 2012), which is apparently required to explain the pathways to the intervention effect. The benefits of a theory-based intervention include the avoidance of a trial and error in intervention design and evaluation (Melnyk and Morrison-Beedy 2012), enhancement of construct validity and subsequently intervention

fidelity (Stein et al. 2007). The framework presented in this paper could play a useful role in this regard.

It is essential for frameworks of interventions to be based on formalized theories of behaviour change (Bandura 2004). The suggested framework thrives on constructs and variables emanating from formalized psychosocial theories, and these constructs have been applied empirically in several fields, many of which are hand hygiene related (e.g., Walker and Jackson 2015; Liao et al. 2011; Clayton and Griffith 2008), and also examined in a number of systematic reviews (e.g., Dreibelbis et al. 2013; Hardeman et al. 2002).

A crucial variable namely behavioural intention which is presented by the proposed framework has been described as the closest determinant of behaviour. However, over the years, there has been an increased understanding of the fact that intention does not necessarily predict behaviour. This phenomenon has been referred to as the "intention-behaviour gap" (Sniehotta et al. 2005; Godin et al. 2005). For example, a lack of self-efficacy could inhibit a progression from intention to behaviour (Sniehotta et al. 2005). A key lesson for practitioners seeking to bridge the intention–behaviour gap in a school setting could be to target variables including self-efficacy, and the enhancement of cues to action. A strategy to enhance self-efficacy among students could be the use of peer-led educational campaigns. Regarding cues to action, posters or stickers on hand hygiene at vantage points can potentially trigger safe hand hygiene practices among students.

The proposed framework is limited to a hand hygiene behaviour as an outcome variable, but in practice, some interventions seek to assess disease conditions associated with hand hygiene behaviour. From the body of literature, many studies can be identified which resorted to behaviour as an outcome variable (Moussa et al. 2015; Setyautami et al. 2012; Schmidt et al. 2009). A decision on an outcome variable is contingent on several factors including the intervention objectives, and the availability of resources in terms of time, funds and expertise.

Implications for research and practice

For researchers, the framework suggested in this paper is expected to spur more empirical studies seeking to establish the logical relationships existing among the variables and constructs and how these play out in a school-based hand hygiene educational intervention. Although the variables and constructs used for this framework emanate from well-established models and theories, it is expedient to strengthen the evidence base on how these variables and constructs interplay, and the possible moderator variables involved. Thus, more robust correlational studies may be helpful in this regard. For practitioners working in school health, the suggested framework could facilitate the conceptualisation, design and replicability of educational interventions. The obvious implications of this include the maximization of intervention effectiveness as well as efficiency.

Conclusion

A framework underpinned by multiple psychosocial theories could enhance the design of hand hygiene educational interventions in schools. The importance of drawing from multiple theories is varied and includes the avoidance of trial and error in intervention delivery, and an enhancement of construct validity and the strengthening of external validity of intervention results. We have contributed to the conceptualisation of hand hygiene, summarized the evidence bordering on the existence of a theoretical framework to facilitate the design of hand hygiene educational interventions in schools. In the light of the existing gap in literature, a school-specific framework underpinned by multiple psychosocial theories has been suggested, and could enhance the efforts of practitioners and researchers in the design of hand hygiene educational intervention in schools, while not discounting the utility of the framework for similar settings.

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Compliance with ethical standards

Conflict of interest The authors declare that there is no conflict of interest.

Ethical consideration No human participants or animals were involved in the study.

References

Adams J, Bartram J, Sims J, Chartier Y (2009) Water sanitation and hygiene standards for schools in low-cost settings. WHO/UNICEF, Geneva

Ajzen I (1988) Attitudes, personality and behavior. Open University, Milton Keynes

Bandura A (1986) Social foundations of thought and action: a social cognitive theory. Englewood Cliffs, NJ

Bandura A (2004) Health promotion by social cognitive means. Health Educ Behav 31(2):143–164

Bennet P, Murphy S (1997) Psychology and health promotion. Open University Press, Buckingham

Centers for Disease Control and Prevention (2002) Hand hygiene in health-care settings: recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA hand hygiene task force. MMWR, 51(No. RR-16):1–48. Atlanta

Centers for Disease Control and Prevention (2015) Handwashing: clean hands saves life [internet]. http://www.cdc.gov/handwashing/when-how-handwashing.html. Accessed 31 August 2016

Clayton DA, Griffith CJ (2008) Efficacy of an extended theory of planned behaviour model for predicting caterers' hand hygiene practices. Int J Environ Health Res 18(2):83–98

Cross P, Coombes Y (2014) Sanitation and hygiene in Africa: where do we stand?. IWA Publishing, London

Curtis V, Schmidt W, Luby S, Florez R, Touré O, Biran A (2011) Hygiene: new hopes, new horizons. Lancet Infect Dis 11(4):312–321

Dreibelbis R, Winch PJ, Leontsini E, Hulland KRS, Ram PK, Unicomb L, Luby SP (2013) The integrated behavioural model for water, sanitation, and hygiene: a systematic review of behavioural models and a framework for designing and evaluating behaviour change interventions in infrastructure-restricted settings. BMC Public Health 13(1):1

Filion K, KuKanich KS, Chapman B, Hardigree MK, Powell DA (2011) Observation-based evaluation of hand hygiene practices and the effects of an intervention at a public hospital cafeteria. Am J Infec Control 39(6):464–470

Godin G, Conner M, Sheeran P (2005) Bridging the intention-behaviour 'gap': the role of moral norm. Br J Soc Psychol 44:497–512

Graves JM, Daniell WE, Harris JR, Obure AFXO, Quick R (2012) Enhancing a safe water intervention with student-created visual aids to promote handwashing behavior in Kenyan primary schools. Int Q Community Health Educ 32(4):307–323

Guinan M, McGuckin M, Ali Y (2002) The effect of a comprehensive handwashing program on absenteeism in elementary schools. Am J Infec Control 30(4):217–220

Hand Hygiene Australia (2016) Clean hands all hands: information for caregivers of children [internet]. http://www.hha.org.au/. Accessed 10 September 2016

Hardeman W, Johnston M, Johnston D, Bonetti D, Wareham N, Kinmonth AL (2002) Application of the theory of planned behaviour in behaviour change interventions: a systematic review. Psychol Health 17(2):123–158

Hospital Infection Control Practices Advisory Committee (1995) Recommendations for preventing the spread of vancomycin resistance. Infect Control Hosp Epidemiol 16:105–113

Huesmann LR, Guerra NG (1997) Children's normative beliefs about aggression and aggressive behavior. J Pers Soc Psychol 72(2):408–419

Humbolt State University (2008) Creating a searching strategy. http://library.humboldt.edu/infoservices/sstrawrksht.htm. Accessed 13 August 2015

Jefferson T, del Mar C, Dooley L, Ferroni E, Al-Ansary LA, Bawazeer GA, van Driel ML, Nair S, Foxlee R, Rivetti A (2009) Physical interventions to interrupt or reduce the spread of respiratory viruses: a systematic review. BMJ [online first]. https://doi.org/10.1136/bmj.b3675.BMJ

Jumaa PA (2005) Hand hygiene: simple and complex. Int J Infect Dis 9(1):3–14

Kelcíkova S, Skodova Z, Straka S (2012) Effectiveness of hand hygiene education in a basic nursing school curricula. Public Health Nurs 29(2):152–159

Lang MC (2012) Implementation of an evidence-based hand hygiene program in elementary schools in Ghana, as part of a city-to-city partnership between Ottawa Public Health and KEEA health directorate. FCH 35(3):203–211

Larson E (1999) Skin hygiene and infection prevention: more of the same or different approaches? Clin Infect Dis 29(5): 1287–1294

Larson E, Girard R, Pessoa-Silva CL, Boyce J, Donaldson L, Pittet D (2006) Skin reactions related to hand hygiene and selection of hand hygiene products. Am J Infect Control 34(10):627–635

Lavin D, Groarke A (2005) Dental floss behaviour: a test of the predictive utility of the theory of planned behaviour and the effects of making implementation intentions. Psychol Health Med 10(3):243–252

Liao Q, Cowling BJ, Lam WWT, Fielding R (2011) The influence of social-cognitive factors on personal hygiene practices to protect against influenzas: using modelling to compare avian A/H5N1 and 2009 pandemic A/H1N1 influenzas in Hong Kong. Int J Behav Med 18(2):93–104

Melnyk B, Morrison-Beedy D (2012) Intervention research: design, conducting, analyzing, and funding. Springer Publishing Company, New York

Moussa M, Moussa M, Hassan N, Abdella A (2015) Effectiveness of a training program on improving the hand washing among children in primary schools. Int J Adv Nurs Stud 4(2):49–54

Nicolle L (2007) Public health hygiene: what and why? CMAJ 176(6):767–768

Potter P (2001) Ignaz Philipp Semmelweis (1818–65). Emerg Infect Dis 7(2):368

Prüss-Ustün A et al (2014) Burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: a retrospective analysis of data from 145 countries. Trop Med Int Health 19(8):894–905

Rosenstock IM, Strecher VJ, Becker MH (1988) Social learning theory and the health belief model. Health Educ Q 15(2):175–183

Schmidt WP, Aunger R, Coombes Y, Maina PM, Matiko CN, Biran A, Curtis V (2009) Determinants of handwashing practices in Kenya: the role of media exposure, poverty and infrastructure. Trop Med Int Health 14(12):1534–1541

Setyautami T, Sermsri S, Chompikul J (2012) Proper hand washing practices among elementary school students in Selat sub-district, Indonesia. J Public Health Dev 10(2):3–20

Snel M, Shordt K (2005) The evidence to support hygiene, sanitation and water in schools. Waterlines 23(3):2–8

Sniehotta FF, Scholz U, Schwarzer R (2005) Bridging the intention–behaviour gap: planning, self-efficacy, and action control in the adoption and maintenance of physical exercise. Psychol Health 20(2):143–160

Snow M, White GL, Kim HS (2008) Inexpensive and time-efficient hand hygiene interventions increase elementary school children's hand hygiene rates. J Sch Health 78(4):230–233

Stein KF, Sargent JT, Rafaels N (2007) Intervention research. Nurs Res 56(1):54–62

UNICEF (2008) More than soap and water: taking handwashing with soap to scale: UNICEF handwashing training module. http://globalhandwashing.org/wp-content/uploads/2015/03/HWWS-More-Than-Soap-and-Water_Training-Module.pdf. Accessed 8 July 2016

UNICEF (2016) One is too many: ending child deaths from pneumonia and diarrhoea. UNICEF Press, New York

Walker K, Jackson R (2015) The health belief model and determinants of oral hygiene practices and beliefs in preteen children: a pilot study. Pediatr Dent 37(1):40–45

WHO (2009) How to handwash. http://www.who.int/gpsc/5may/How_To_HandWash_Poster.pdf. Accessed 31 August 2016

WHO (2015) Situation report on cholera outbreak in Ghana as of 09 August 2015. WHO Country Office, Accra

WHO (2016) Hygiene. http://www.who.int/topics/hygiene/en/. Accessed 6 June 2016

Widmer AF (2000) Replace hand washing with use of a waterless alcohol hand rub? Clin Infect Dis 31(1):136–143