



Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Effect of a school-based hand hygiene program for Malawian children: A cluster randomized controlled trial

Balwani Chingachifwe Mbakaya PhD^a, Paul Lee PhD^b, Regina Lai Tong Lee PhD, MScN, RN^{c,*}^a St John's College of Nursing & Midwifery, Mzuzu, Malawi, South Africa^b World Health Organization Collaborating Centre for Community Health Services, School of Nursing, The Hong Kong Polytechnic University, Hung Hom, Hong Kong^c Faculty of Health and Medicine, School of Nursing and Midwifery, University of Newcastle, Callaghan, NSW, Australia

Key Words:

Schoolchildren
Handwashing compliance rate
School absenteeism
Developing countries
Simplified handwashing procedure
Health policy

Background: Proper handwashing technique can reduce the mortality of a child. This study aimed to evaluate the impact of a school-based hand hygiene program on the handwashing compliance of children and school absenteeism in Southern Africa.

Methods: We conducted a 2-arm cluster randomized trial in which 6 private primary schools were allocated randomly to either intervention (3 schools) or control (3 schools) groups. The intervention group consisted of implementing a series of planned activities and measures of hand hygiene program over 9 months. Parameters of primary and secondary outcomes were estimated with generalized estimating equations.

Results: There were no significant between-group differences in demographic characteristics. The knowledge scores in the intervention group were significantly higher than the scores in the control group, and the technique scores in the intervention group were significantly higher than the scores in the control group after baseline. Further, after the third month, the cleanliness scores in the intervention group were significantly higher than the scores in the control group. In addition, the number of sick leave days decreased in the intervention group.

Conclusions: The impact of the school-based hand hygiene program was positive. It can be used in both the planning and development of a hand hygiene protocol to increase the handwashing compliance rate of schoolchildren and to reduce school absenteeism in developing countries.

© 2019 Published by Elsevier Inc. on behalf of Association for Professionals in Infection Control and Epidemiology, Inc.

Infectious diseases remain responsible for significant global morbidity and mortality. According to the World Health Organization (WHO), nearly 644,000 people died owing to diarrhea-related diseases in sub-Saharan Africa between 2000 and 2012, accounting for 67% of global deaths.¹ Diarrhea is the second most common cause of death among school-age children in sub-Saharan Africa.² School-age children are more vulnerable than adults to infectious diseases because of their immature immune systems and the school environment in which they spend most of their day, interacting with others, and, therefore, become exposed to many infections. This makes the school an important setting for disease transmission, prevention, and

control. Diarrhea and respiratory disorders caused 80% of childhood diseases and 272 million days of school absenteeism.³ Diarrhea has a negative impact on childhood growth and cognitive development, thereby affecting school performance through absenteeism and cognitive capability.⁴

Poor hand hygiene has increased childhood morbidity and mortality owing to infectious diseases, leading to the death of a child every minute.¹ However, effective hand hygiene can produce significant benefits in preventing gastrointestinal and respiratory infection.⁵

WHO has advocated for the use of a standardized 7-step technique for handwashing. This has been incorporated in formal training in developed and developing countries as part of health care training.⁶ In Malawi, health care workers and the people in the community were expected to wash their hands using the WHO 7-step technique as the standard. However, many studies have shown low compliance with the standardized 7-step handwashing technique among global health workers.^{7,8} The complexity of the standardized 7-step handwashing technique also contributed significantly to noncompliance, especially among young school-age children, who

* Address correspondence to Regina Lai Tong Lee, PhD, MScN, RN, Faculty of Health and Medicine, School of Nursing and Midwifery, University of Newcastle, University Dr, Callaghan, NSW 2308, Australia.

E-mail address: Regina.L.Lee@newcastle.edu.au (R.L.T. Lee).

Funding/support: This research was supported by funding from Research Higher Education at The Hong Kong Polytechnic University (RUU7), Hong Kong Special Administrative Region, China.

Conflicts of interest: None to report.

learned better with a validated, simplified 5-step handwashing technique.^{9,10}

Since children's cognitive and motor skills are not fully developed, their skills may be immature. It is very easy to get their long sleeves wet as they practice washing their hands and wrists using the standardized 7-step handwashing technique.^{9,10} Wet sleeves create an environment that is conducive to the production and multiplication of microorganisms, which are transferred thereafter through direct contact to the hand, then to the mouth or eyes, completing the epidemiological triad of the infectious disease transmission cycle (hand-to-mouth or hand-to-eye).

In addition, the incidence and prevalence of infections owing to poor hand hygiene practices are still on the increase, especially in developing countries. Further, little is known regarding the use of standardized handwashing techniques among schoolchildren in developing countries.¹¹

A simplified handwashing technique, with 5 instead of 7 steps, has been validated and studied, which aimed to reduce the spread of infectious diseases and school absenteeism.⁹ The simplified 5-step handwashing technique should be adopted to deliver hand hygiene education among school-age children in both developed and developing countries.¹¹

A cluster randomized controlled trial (RCT) was performed to examine the effects of a school-based hand hygiene program (SBHHP) on handwashing knowledge, skills, hand cleanliness, and absenteeism rate among primary school students in Malawi.

Handwashing knowledge, skill acquisition, hand cleanliness, and absenteeism rate improve after implementing an SBHHP using a simplified 5-step handwashing technique compared with usual handwashing practice using the WHO standardized 7-step handwashing technique in the control group.

METHODS

Sampling

The study was performed in 6 private primary schools in Malawi, South Africa; a total of 375 schoolchildren were recruited. The inclusion criteria for schools were: (1) schools that had a treated, clean, and safe running water source, and (2) they were private primary schools. Government-subsidized primary schools were excluded owing to limited resources. The inclusion criteria for schools at the cluster level were: (1) schools that had treated, clean, and safe running water sources in Mzuzu city, Malawi, and (2) they were private primary schools. The inclusion criteria for students were (1) schoolchildren enrolled in private primary school in Mzuzu city, Malawi, (2) schoolchildren without any visual, hearing, or intellectual problems; (3) schoolchildren in grades 1 or 6, and (4) schoolchildren able to write, understand, and speak Chichewa (Malawi's local language). The exclusion criteria for schools at the cluster level were: (1) schools that had no treated, clean, or safe running water sources in Mzuzu city, Malawi, and (2) they were government-subsidized primary schools. The exclusion criteria for the students were: (1) schoolchildren enrolled in government-subsidized primary school in Mzuzu city, Malawi; (2) visual, hearing or intellectual problems; (3) studying in grades 2 to 5, and (4) unable to write, understand and speak Chichewa (Malawi's local language).

Design

This study was conducted using a 2-arm cluster RCT. The 6 selected primary schools were randomized by undergoing an online randomization process. The intervention and control groups consisted of 3 primary schools each, and each participating school constituted 1 cluster. Allocation concealment was achieved by using

sequentially numbered sealed envelopes before intervention. One researcher and 5 nursing students were blinded and specifically trained to rate the handwashing skills of schoolchildren on videos and hand cleanliness of schoolchildren on photos at baseline (T0), midpoint (at the third month-T1), posttest (immediately after SBHHP-T2), and follow-up (3 months after implementing SBHHP-T3).

Intervention

The strategies to implement the multilevel SBHHP in the school setting included the following: (1) integration of hand hygiene protocol in school policy; (2) setting up proper handwashing facilities and building water pipes for fresh running water; (3) providing training of trainers for school teachers and parents; (4) enhancing knowledge of schoolchildren on how, why, and when to wash hands; (5) providing a supportive environment with available resources, such as soap and paper towels; (6) delivering hand hygiene promotion activities; and (7) developing reminders and posters for the simplified 5-step handwashing technique.

In the intervention group, the simplified 5-step handwashing technique was taught to the schoolchildren. Our research team developed a validated 5-step handwashing technique by removing 2 steps from WHO's 7-step handwashing technique.⁹ The simplified 5-step handwashing technique consists of the following: (1) between fingers, (2) backs of hands, (3) backs of fingers, (4) finger tips, and (5) thumbs.⁹ Intensive training of the investigator and interventionist included a skills assessment test, with demonstrations based on the validation of the simplified 5-step handwashing protocol prior to the commencement of the intervention. Monitoring and assessing adherence and competence at the point of intervention delivery were carried out to ensure procedural fidelity. Parents were reached through a briefing session with a take-home handwashing package, which consisted of a simplified 5-step handwashing poster, leaflets and/or pamphlets, and a commitment letter. Handwashing resources were provided throughout the period of study. In addition, handwashing sinks were constructed in all of the 6 primary schools for children to access fresh water to practice handwashing technique.

The SBHHP was implemented in the intervention group for a period of 9 months, whereas the routine handwashing practice continued in the control group. In the control group, schoolchildren were encouraged to continue with their usual handwashing practice at primary schools. The control group continued with its school handwashing routine practice, and school teachers were advised to continue encouraging schoolchildren with the conventional WHO's 7-step handwashing method.

Assessments

Sociodemographic characteristics, proper handwashing knowledge, skill acquisition, cleanliness of hands, and school absenteeism data were measured at each of 4 time points. The investigator, 2 trained research assistants, and 4 helpers collected the data.

A self-administered questionnaire was used to collect demographic data, including class, age, and gender. Primary outcome measures included knowledge of proper handwashing procedure, proper handwashing technique, and hand cleanliness. The secondary outcome measure was the school absenteeism, with the report of sick leave days for the schoolchildren over the 3 school terms.

Knowledge gains on "why" and "when" to wash hands were assessed using a quiz, which was adapted from the Centers for Disease Prevention and Control.¹² One mark was awarded for each correct response to a question.

Acquisition of handwashing skills was assessed using a checklist, the content of which covered "how" to wash hands. The following 4 practices were included to achieve a quality handwashing

technique: (1) the use of soap, (2) the technique of rubbing areas of the hand, (3) duration, and (4) hand drying method. Scoring of handwashing technique in this study was as follows, with a possible 1 mark for each of the following actions: use of soap, duration of handwashing (>20 seconds), and proper hand air drying after washing. A half-mark was given to each of the following steps for each hand, according to the simplified 5-step handwashing method: rubbing between fingers, back of the hand, back of fingers, fingertips on palm, and thumb. The total score per assessment was 8.

On each assessment day, identification was given to each subject and the handwashing procedure of each student videotaped. The handwashing was rated against the simplified 5-step handwashing technique observational checklist by trained researchers.

The cleanliness of the hands was measured by assessing the amount of fluorescent stain on both hands. A validated 4-point scale (0, 1, 2, and 3) showing the amount of fluorescent stain on each hand was adopted and used to allocate a proper handwashing score. To validate the fluorescent stain test scores, 5 blinded assessors rated pictures on a scale of 0–3, with a higher rating indicating a cleaner hand. Interrater reliability was measured using the intraclass correlation coefficient. Results showed an excellent agreement among raters for both left (0.997) and right hands (0.996).¹³

Schoolchildren had the palm and dorsum of both hands photographed twice at each measurement point (at baseline and at the third, sixth, and ninth months), therefore, before and after handwashing with soap, water, and paper towel. Trained researchers administered the rating of the fluorescent stain test. This was done by looking at the visibility of the glow gel on pictures of both hands, photographed using a digital camera under a standardized photographing environment using ultraviolet light.

Statistical analysis

Data analyses were performed using the SPSS program (software version 23.0; IBM Corp, Armonk, NY), and intention to treat was applied to handle the missing data. Categorical demographic characteristics, such as gender and school grade, were compared between groups using the X^2 test, and age was compared using the Student *t* test.

For the primary outcomes, knowledge, skill assessment, and cleanliness score data were modeled with a generalized linear-mixed model, with a random intercept of schools for parameter estimation. The fixed effects were group, time, group by time interaction, school grade, and school grade by time interaction. The covariance type was first-order autoregressive. A robust estimator was used.

For the secondary outcome, school absenteeism was calculated as a proportion of days on which schoolchildren were absent from school owing to illness. The total number of expected school attendance days during the entire academic year, in which the SBHHP was implemented, was 180 days, with 60 school days per term (each academic year has 3 terms). The generalized estimating equation was used to analyze school absenteeism (sick leave days). The working correlation was first-order autoregressive. The empirical estimator was used.

There was no violation of statistical assumptions under residual diagnostics based on plots of residuals, such as box plots, scatter plots, and normal Q-Q plots. With respect to missing value analysis, the result of Little's MCAR test was insignificant, which indicated the data were missing completely at random. No imputation was done.

Ethics and reporting protocol

Ethical approval was obtained from the Ethical Committee at The Hong Kong Polytechnic University and the National Health Sciences Research Committee in Malawi, South Africa. Written informed

consent was obtained before enrollment. Parents were also given details of the program through an information sheet, which was given to each parent of a participating child before they consented for their child to participate.

The reporting protocol complied with the Consolidated Standards of Reporting Trials guidelines.¹⁴ The trial was registered in the Clinical Trials Register (Clinicaltrials.gov NCT02968251).

RESULTS

Table 1 shows the demographic characteristics of the study sample. Six private primary schools were recruited, with a total of 375 schoolchildren; 48.8% (n = 183) and 51.2% (n = 192) in the intervention and control groups, respectively. There were 195 (52%) men and 180 (48%) women in the study. The mean age of schoolchildren in the intervention group was mean = 8.14, SD = 2.77, and the control group was mean = 8.08, SD = 2.4. There were no significant differences in age, gender, and school grade between groups.

Table 2 demonstrates there were significant increases in knowledge score within both the intervention group and the control group. However, the scores in the intervention group were significantly higher than the scores in control group.

Table 3 shows there were significant increases in handwashing technique score in the third, sixth, and ninth month within the intervention group.

Table 4 demonstrates there were significant increases in cleanliness score within intervention group after the third month. However, there was significant increase in the score in control group at the sixth month but then dropped. After the third month, the scores in intervention group were significantly higher than the scores in the control group.

There were neither significant within-group nor between-group differences in sick leave days as shown in Table 5. However, the descriptive statistics show that the number of days decreased in the intervention group.

DISCUSSION

Handwashing knowledge, handwashing skill acquisition, hand cleanliness, and absenteeism rate improve under the simplified 5-step

Table 1
Demographic characteristics of schoolchildren (N = 375)

	Intervention N = 183		Control N = 192		X^2	df	P value
	n	%	n	%			
Gender							
Male	88	48.1	97	50.5	.14	1	.71
Female	95	51.9	95	49.5	—	—	—
Grade 1	93	50.8	95	49.5	.02	1	.88
Grade 6	90	49.2	97	50.5	—	—	—
	Mean	SD	Mean	SD	t	df	P
Age	8.14	2.77	8.08	2.40	.22	359.95	.83

Table 2
Estimated means of handwashing knowledge score

	Intervention			Control			
	Mean	SE	p_w	Mean	SE	p_w	p_b
Baseline	3.55	0.13	—	2.83	0.08	—	<.01
Third month	3.97	0.12	<.01	2.95	0.07	>.05	<.01
Sixth month	4.65	0.11	<.01	3.42	0.11	<.01	<.01
Ninth month	5.6	0.09	<.01	3.69	0.1	<.01	<.01

p_w , P value within group. p_b , P value between group.

Table 3
Estimated means of handwashing technique score

	Intervention			Control			
	Mean	SE	p_w	Mean	SE	p_w	p_b
Baseline	1.88	0.07	—	1.79	0.07	—	>.05
Third month	5.05	0.15	<.01	3.26	0.09	<.01	<.01
Sixth month	7.06	0.11	<.01	1.75	0.09	>.05	<.01
Ninth month	7.1	0.08	<.01	2.04	0.08	>.05	<.01

p_b , P value between group; p_w , P value within group.

Table 4
Estimated means of hand cleanliness score

	Intervention			Control			
	Mean	SE	p_w	Mean	SE	p_w	p_b
Baseline	0.24	0.05	—	0.28	0.05	—	>.05
Third month	0.17	0.03	>.05	0.17	0.04	0.03	>.05
Sixth month	1.82	0.09	<.01	0.59	0.06	<.01	<.01
Ninth month	1.33	0.08	<.01	0.34	0.06	>.05	<.01

p_b , P value between group; p_w , P value within group.

Table 5
Estimated means of sick leave days

School term	Intervention		Control	
	Mean	SE	Mean	SE
1	16.09	4.38	3.72	1.35
2	8.05	2.15	5.61	2.1
3	4.18	2	6.45	2.44

handwashing technique after the multilevel school-based hand hygiene program compared with the standardized WHO 7-step handwashing practice without intervention.

Although the knowledge score in the intervention group was significantly higher than the score in the control group at baseline, the increase in the score was 2.1 within the intervention group but only 0.9 within the control group. Therefore, hypothesis (1), handwashing knowledge, might be supported.

There were significant increases in the technique score and in the cleanliness score in the intervention group until the ninth month, however, there was no increase in the control group. Moreover, the scores in the intervention group were significantly higher than the scores in control group after the third month. Therefore, hypotheses (2) and (3), handwashing skill acquisition and hand cleanliness, are supported.

Although there were no significant within-group nor between-group differences in sick leave days, the number of sick leave days decreased in the intervention group across time. Therefore, hypothesis (4), decrease in absenteeism, might not be supported.

The findings of this trial suggest that the adoption of simplified 5-step handwashing techniques for the SBHHP in the school and home settings is sustainable and effective. With the available hand hygiene resources in the school setting, the intervention can increase the knowledge, attitude, and compliance of schoolchildren to practice proper handwashing technique. In this cluster RCT, the SBHHP was associated with a short-term increase in handwashing compliance (handwashing knowledge, skills, and cleanliness scores) and a reduction in sick leave days in the intervention group.

Knowledge

Our study found that the overall difference in knowledge mean scores were better in the intervention group compared with the

control group across time. The higher scores observed in the intervention group could be ascribed to the intensive weekly education delivered to the intervention schools. The findings of our SBHHP agree with those of a study conducted in 42 Kenyan schools, in which school-based hygiene and water treatment programs increased student knowledge, improved hygiene, and decreased absenteeism.¹⁵ Education increases knowledge, influences attitude, and triggers self-efficacy. Therefore, it is a critical success factor of an individual's internal control and motivation to improve hand hygiene practices.^{16,17}

Technique

This study indicates significant improvement in the technique score of the simplified 5-step handwashing technique among the intervention group compared with the control group. Although the observed difference would be ascribed to our intervention (SBHHP), the context of the school set-up might have reinforced our intervention because schoolchildren were able to learn from each other, mostly through observation as stipulated in Bandura's social learning theory.¹⁷ These results agree with the study conducted in Thailand that the scores of the 7-step handwashing technique significantly improved postintervention among schoolchildren in Thailand. This study adopted a simplified 5-step handwashing technique, which was easy and simple for the schoolchildren to follow because it saved water and time during handwashing practice.^{9,13}

Cleanliness

In this study, the overall scores for hand cleanliness improved more in the intervention group than in the control group. Therefore, the simplified 5-step handwashing technique may be cleaner, with fewer steps, than handwashing under usual practice.

Behavioral change

Developmental milestones may influence the behavioral change process.¹⁸ A study conducted in Hong Kong found that schoolchildren in grades 5–9 performed handwashing better than those in grades 1–4.¹³ These results imply a remarkable direction to pursue regarding prevention of influenza and diarrheal outbreak in school settings in Malawi and in neighboring countries. The effects of the multilevel SBHHP were upheld in the intervention group at the 9-month follow-up assessment. This suggests that the SBHHP might have had prolonged effects on hand hygiene practice and handwashing behavior of schoolchildren. This is a significant indicator of behavioral change among schoolchildren regarding hand hygiene practice.¹⁹

Absenteeism

It had also been found that there was a significant reduction in overall school sick leave days between the intervention groups. These study findings reached an agreement with those of previous studies that there was a positive link between proper hand hygiene practice of schoolchildren and reduced school absenteeism after participation in a structured hand hygiene program.^{13,19,20}

Limitations

Government-subsidized primary schools were not recruited because application to the government for building handwashing facilities for the study involved a much more complicated and longer process than private schools. The study was conducted in private schools only, which could be different from government-subsidized

public schools in terms of educational background, available resources, the environmental set-up of the school, and the school culture. Therefore, the results of this study may not be able to be generalized to government-subsidized schools.

However, only grade 1 and grade 6 students were recruited because these primary school students had more time available for activities in their first and last school years. The schools recruited the study sample for the research team and arranged a time for them to participate in the study. Regarding the intervention procedure, the Hawthorne effect may have resulted in increased proper handwashing because participants knew they were being observed through photographic and video capturing. For the assessment, recall bias may exist across time, especially for the handwashing knowledge quiz scores.

Significance

Based on a recent review, very few randomized trials have assessed the handwashing technique of schoolchildren and its compliance in the school communities in Malawi.¹⁰ To our knowledge, this is the first cluster RCT to be conducted in Malawi or anywhere in sub-Saharan Africa to evaluate the efficacy of a SBHHP using a simplified 5-step handwashing technique.

CONCLUSIONS

The handwashing knowledge, handwashing technique acquisition, and hand cleanliness of schoolchildren have improved after participating in the simplified 5-step handwashing procedure in a multilevel school-based hand hygiene program compared with children's usual handwashing practice without intervention. The findings confirm that an SBHHP using the simplified 5-step handwashing technique improved proper handwashing knowledge, skills, and practice among schoolchildren. The simplified 5-step technique may provide an alternative solution to conventional handwashing practice. Health policy and programming need to pay greater attention to the interplay of the structural, social, and individual dimensions of unique contextual environments that influence habitual behaviors.

The intervention will provide an impetus for health promotion campaigns using a simplified 5-step handwashing technique to improve handwashing skills and knowledge among vulnerable groups and increase handwashing practice. Our findings provide additional evidence to the public health agenda to develop a school curriculum on hand hygiene to reinforce proper handwashing technique, especially for schoolchildren in developing countries. It is important for Malawi and other developing countries to standardize a simple handwashing technique by incorporating it into a curriculum that schoolchildren can easily follow.

Our study offers supplementary authentication to underpin a global effort to expand hand hygiene interventions in school settings, especially in developing countries. There is a need to expand the SBHHP to the government-subsidized schools in Malawi and other sub-Saharan Africa countries. This could improve hand hygiene practice and reduce diarrhea and respiratory infections, especially in developing countries.

ACKNOWLEDGMENTS

The authors would like to thank the research assistants for their help in collecting the data and conducting the training sessions on

hand hygiene in the intervention schools. We would also like to thank Mr Stephen Kwok Wai Hang for his critical review and help with the statistical analysis. Last, we would like to thank the schoolchildren and school personnel staff of the 6 participating primary schools, as well as the parents and/or guardians of the participating schoolchildren.

References

1. World Health Organization. Health statistics and information systems. Cause-specific mortality estimates for 2000–2012. Available from: https://www.who.int/healthinfo/global_burden_disease/estimates/en/. Accessed July 6, 2019.
2. Rao C, Lopez AD, Hemed Y, et al. Causes of death. In: Jamison DT, Feachem RG, Makgoba MW, Bos ER, Baingana FK, Hofman KJ, editors. *Disease and mortality in Sub-Saharan Africa*, 2nd ed. Washington (DC): World Bank; 2006. p. 43–58.
3. World Vision International. Available from: <https://www.worldvision.com.au/global-issues/work-we-do/water-sanitation#XPlmFlwPzle6uXe5.9>. Accessed May 28, 2019.
4. Centers for Disease Control and Prevention. Handwashing: clean hands save lives. Available from: <http://www.cdc.gov/handwashing/when-how-handwashing.html>. Accessed May 28, 2019.
5. Bloomfield SF, Airillo AE, Cookson B, O'Boyle C, Larson EL. The effectiveness of hand hygiene procedures in reducing the risk of infections in homes and community settings including handwashing and alcohol-based hand sanitizers. Available from: [http://www.ajicjournal.org/article/S0196-6553\(07\)00595-0/abstract](http://www.ajicjournal.org/article/S0196-6553(07)00595-0/abstract). Accessed May 27, 2019.
6. World Health Organization. WHO Guidelines on hand hygiene in health care: first global patient safety challenge. Available from: www.who.int/gpsc/country_work/en/. Accessed May 27, 2019.
7. Kalata NL, Kamange L, Muula AS. Adherence to hand hygiene protocol by clinicians and medical students at Queen Elizabeth Central Hospital, Blantyre-Malawi. *Malawi Med J* 2013;25:50–2.
8. Dioso R, Samporna L, Eden VR, Sha MA. A clinical audit on the compliance on handwashing laboratory in a private university in Peninsular Malaysia. *IJRST* 2014;1:63–71.
9. Lee RL, Lee PH. To evaluate the effects of a simplified handwashing improvement programme in schoolchildren with mild intellectual disability: A pilot study. *Res Dev Disabil* 2014;35:3014–25.
10. Mbakaya BC, Lee PH, Lee RLT. Hand hygiene intervention strategies to reduce diarrhoea and respiratory infections among children in developing countries: A systematic review. *Int J Environ Res Public Health* 2017;14:371.
11. Grimason AM, Masangwi SJ, Morse TD, Jabu GJ, Beattie TK, Taulo SE, et al. Knowledge, awareness and practice of the importance of hand-washing amongst children attending state run primary schools in rural Malawi. *Int J Environ Heal R* 2014;24:31–43.
12. Centers for Disease Control and Prevention. Handwashing: Clean hands save lives. Available from: <http://www.cdc.gov/handwashing/when-how-handwashing.html>. Accessed January 10, 2019.
13. Lee RL, Leung C, Tong WK, Chen H, Lee PH. Comparative efficacy of a simplified hand washing program for improvement in hand hygiene and reduction of school absenteeism among children with intellectual disability. *Am J Infect Control* 2015;43:907–12.
14. Greene LE, Freeman MC, Akoko D, Saboori S, Moe C, Rheingans R. Impact of school-based hygiene promotion and sanitation intervention on pupil hand contamination in western Kenya: A cluster randomized control trial. *Am J Trop Med and Hyg* 2012;87:385–93.
15. Kaewchana S, Simmerman M, Somrongthong R, Suntarattiwong P, Lertmaharit S, Chotipitayasunondh T. Effect of intensive handwashing education on handwashing behaviours in Thai households with an influenza-positive child in urban Thailand. *Asia-Pac J Public Health* 2012;24:577–85.
16. World Health Organization. WHO guidelines on hand hygiene in health care: first global patient safety challenge. Available from: http://www.who.int/gpsc/country_work/en/. Accessed January 10, 2019.
17. Bandura A. Self-efficacy: towards a unifying theory of behaviour change. *Psychol Rev* 1977;84:191–215.
18. Rosen L, Manor O, Engelhard D, Brody D, Rosen B, Peleg H, et al. Can a handwashing intervention make a difference? Results from a randomized controlled trial in Jerusalem preschools. *Prev Med* 2006;42:27–32.
19. Talaat M, Afifi S, Dueger E, El-Ashry N, Marfin A, Kandeel A, et al. Effects of hand hygiene campaigns on incidence of laboratory-confirmed influenza and absenteeism in schoolchildren, Cairo, Egypt. *Emerg Infect Dis* 2011;17:619–25.
20. Campbell MK, Piaggio G, Elbourne DR, Altman DG. Consort 2010 statement: extension to cluster randomised trials. *BMJ* 2012;345:e5661.