Handwashing Research Summary: What we learned about handwashing in the second half of 2016

Between July and December 2016, we identified 37 relevant peer-reviewed studies on handwashing. Observational studies were mostly cross-sectional studies. Experimental studies included community-based cluster randomized trials, randomized trials, and non-randomized / quasi-experimental studies.

Benefits of Handwashing

Big Idea: Handwashing is one of the most cost-effective investments in public health and the economic benefit from handwashing is not unique to the prevention of diarrhea and pneumonia, but also the majority of healthcare-associated infections, which are extremely costly to individuals, healthcare systems, and countries.

Overall Burden of Disease

The Global Burden of Disease Study reported the attributable burden of disease associated with risk factors exposure indicates that prevalence of no handwashing has steadily declined since the 1990s, and mortality and DALYs attributed to no handwashing has also been declining since 2000.[1]

Cost of poor handwashing

Researchers used DALYs estimates from the WHO to estimate the annual net cost due to diarrhea and acute respiratory infection (ARI) in India and China, as well as the cost and monetary benefits of handwashing. Annual net cost for diarrhea and ARIs was $23 billion USD per year for India. The estimated cost of national handwashing program for India would be $62 million, while the total saving to the Indian economy would be $5.64 billion, a 92-fold return on investment. Annual net cost for in China was $12 billion USD per year, whereas a national handwashing program would cost $77 million and bring $2.64 billion in saving to the Chinese economy, a 35-fold return on investment.[2]

Diarrhea and Acute Respiratory Infection

Home-based, multiple-component interventions reduced childhood diarrhea, but had no observable effect on acute lower-respiratory infection. A multiple-component randomized controlled trial in 51 rural communities in Peru compared incidence of diarrhea and acute respiratory infection among children under the age of 36 months, comparing the intervention group (who received a combined intervention, including hygiene promotion) with the control group (who received an early-child stimulation program). At the 12-month follow-up, the incidence of diarrhea in the intervention group was 2.8 episodes per child-year, compared to 3.1 episodes per child-year in the control arm.[3]

Bacterial Infection

Existing handwashing practice at home among primary caregivers in Zimbabwe was effective in reducing *E. coli* contamination of hands. Researchers obtained hand rinse samples from 173 primary caregivers in Harare and compared the *E. coli* counts before and after handwashing. The results showed that *E. coli* contamination on hands was significantly lower after cleaning under fingernails, scrubbing the fingertips, using soap, and drying hands through rubbing on clothes or a clean towel than before handwashing.[4]

Researchers found that use of communal handwashing bowls in preschools in Accra, Ghana, tends to reduce the effectiveness of eliminating microbes. Researchers collected water samples from communal handwashing bowls and hand swabs from children in 6 preschools and found bacterial isolates among samples from all the schools, with *Staphylococcus* bacteria being the most common microbe. Researchers also found *Cryptosporidium parvum* parasite and *Aspergillus niger* fungus, among others.[5]

Benefits of handwashing	Location
Overall cost and burden of disease	
The attributable burden of disease associated with risk factors exposure indicates that prevalence of no handwashing has steadily declined since the 1990s, and mortality and DALYs attributed to no handwashing has also been declining since 2000.[1]	Global
Annual net cost of diarrhea and ARI was $23 billion per year, while estimated cost of a national handwashing program would be $62 million and bring $5.64 billion in savings.[2]	India
Annual net cost diarrhea and ARI was $12 billion per year, while estimated cost of a national handwashing program would be $77 million and bring $2.64 billion in saving.[2]	China
Diarrhea and acute respiratory infection	
The incidence of diarrhea among children under the age of 36 months who received early-child stimulation combined with hygiene promotion was 2.8 episodes per child-year compared to 3.1 episodes per child-year who only received an early-child stimulation.[3]	Peru
Bacterial infections	
E. coli contamination on hands of primary caregivers was significantly lower after cleaning under fingernails, scrubbing the fingertips, using soap, and drying hands through rubbing on clothes or a clean towel than before handwashing.[4]	Zimbabwe
Use of communal handwashing bowls in preschools tends to reduce effectiveness of eliminating microbes. Samples detected *Staphylococcus* bacteria as the most common microbe found.[5]	Ghana

Handwashing Behavior Compliance

Big Idea: There is a gap between knowledge about handwashing with soap and optimal handwashing behavior.

Hand hygiene in Healthcare Facilities

In Taiwan, researchers recruited 93 health-profession students to covertly observe 25,379 hand cleansing events among healthcare workers (85% doctors, 12% nurses, 3% caregivers and other professionals) at hospitals using a novel shorthand notation method based on the World Health Organization's (WHO) "Five moments for hand hygiene". Overall hand hygiene compliance was 32%, with the highest compliance occurring after touching a patient (42%) and the lowest compliance after touching the patient's surroundings (22%).[6] Similarly, researchers used covert observations also based on the "Five moments for hand hygiene" at a teaching hospital in Kingston, Jamaica and found overall compliance to be 39%; the highest level of compliance occurring after patient contact (54%) and the lowest before performing aseptic procedure (18%).[7]

In Kosovo, observation of hand hygiene among 67 nurses at a hospital in Pristina showed that overall compliance was 51.3%. Handwashing was highest after body fluid exposure risk (93%) and lowest before touching a patient (18.5%).[8] In Colombia, healthcare workers at obstetric units indicated that they were aware of hand hygiene checklists and had relatively positive attitudes towards them. However, actual compliance of safe behaviors, including handwashing, was relatively low.[9] In Iran, glove wearing/removal was significantly associated with hand hygiene compliance among nurses. Direct observation showed that before putting on gloves, hand hygiene compliance was 14.8%, while after removing gloves, compliance was 56.6%.[10] A study among medical students in Qatar showed 85.5% of students had sufficient knowledge about hand hygiene and reported practicing hand hygiene routinely, but only 33.87% were aware of the minimal time needed.[11]

Handwashing in Schools

A study at schools in Chennai, India, found discrepancy between knowledge and practice of handwashing, with 85.6% of students having knowledge about the need to wash hands at critical times (before eating and after

using the toilet), but only 24.9% actually practicing proper handwashing.[12] In Nigeria, the extent of handwashing practice among secondary school students was assessed using a self-reported 3-point scale to determine the extent of handwashing. The study showed handwashing was seldom practiced, with handwashing occurring more frequently after touching genitals than before eating meals or after using toilets.[13]

Handwashing among caregivers of children age under 5 years

In India, a community-based cross-sectional study of caregivers of children under 5 years of age found differences between urban and rural areas with regards to self-reported handwashing with soap after using the toilet (94% and 54%, respectively), before preparing food (74% and 13%), before feeding a child (79% and 27%), and after contact with a child's feces (98% and. 85%).[14]

Handwashing behavior	Method	Location
Handwashing in healthcare facilities		
Hand hygiene compliance among healthcare workers was 32% and ranged from 22% (after touching patient's surrounding) to 42% (after touching a patient).[6]	Direct Observation	Taiwan
Hand hygiene compliance at a teaching hospital was 39%, with the highest level of compliance after patient contact (54%) and lowest before performing aseptic procedure (18%).[7]	Direct Observation	Jamaica
Overall compliance among nurses was highest after body fluid exposure risk (93%) and lowest before touching a patient (18.5%).[8]	Direct observation	Kosovo
Compliance with safe behaviors, including handwashing, was relatively low at obstetric units despite awareness of the benefits of handwashing.[9]	Self-reporting	Colombia
Glove wearing/removal was significantly associated with hand hygiene compliance among nurses, with 14.8% before putting on gloves and 56.6% after removal.[10]	Direct observation	Iran
85.5% of medical students had knowledge about hand hygiene and reported practicing routinely, but only 33.87% were aware of the minimal time needed.[11]	Self-reporting	Qatar
Handwashing in schools		
85.6% of students had knowledge of the need to wash hands at critical times but only 24.9% actually practicing proper handwashing.[12]	N/A	India
The extent of handwashing practice among secondary school students was low, with handwashing occurring more frequently after touching genitals than before eating meals and after using toilets.[13]	Self-reporting	Nigeria
Handwashing among caregivers of children age under 5 years		
In rural areas, 54% of caregivers washed their hands after using the toilet, 13% before preparing food, 27% before feeding a child, 85% after contact with a child's feces.[14]	Self-reporting	India
In urban areas, 94% of caregivers washed their hands after using the toilet, 74% before preparing food, 79% before feeding a child, 98% after contact with a child's feces.[14]	Self-reporting	

Availability of Soap

In Bangladesh, researchers found that handwashing among cholera patients and their family members was very infrequent. Researchers made spot-checks for presence of soap at bathroom areas in a hospital in Dhaka and conducted 3-hour structured observations among 148 cholera patients and their visiting family members. Soap was observed at 7% of handwashing places during spot-checks. Just 3% of pathogen transmission events among patients and 5% of such events among family members involved handwashing with soap.[15]

Also in Bangladesh, in a nation-wide cross-sectional study, researchers observed hand hygiene infrastructure and behavior at 875 inpatient healthcare facilities. Researchers found that healthcare workers had better access to soap, better hand hygiene behavior, and performed more hand hygiene than patients and their families; but adherence level was still low. Soap was available at 78% to 92% of handwashing locations for doctors and nurses, but only 4% to 30% of handwashing locations designated for patients and their family members had soap. Healthcare workers washed their hands with soap during 7% of the opportunities (67/919), compared to 3% among family caregivers (93/2751) and 1% among patients (14/1006).[16]

Availability of soap in households	Method	Location
Soap was present in only 7% of handwashing places available to cholera patients and their families during spot-checks at hospitals.[15]	Direct observation	Bangladesh
78% - 92% of handwashing locations for doctors and nurses had soap. 4% - 30% of handwashing locations for patients and family members had soap.[16]	Cross-sectional study	

Behavior Change

Big Idea: Social norms are created and governed by the community, so people are more likely to wash their hands when others observe them.

Multiple Behavior Change Interventions

In Zambia, a community-based cluster randomized trial compared the effect of multiple behavior change interventions (e.g., radio messaging, clinic events, and community events) against control (e.g., standard care) on observed use of soap during handwashing. At the end of the study period, the intervention communities had higher prevalence of self-reported handwashing with soap after risk of contact with feces than the control communities (32% and 28%, respectively).[17]

In Healthcare Facilities

At a 160-bed, non-referral hospital in Rwanda, the introduction of alcohol-based hand rub combined with educating healthcare workers on proper hand hygiene practice and posting hand hygiene reminders throughout the workplace was associated with an increase in hand hygiene compliance from 34.1% at the baseline to 68.9% post intervention. There were significant increases in hand hygiene compliance before touching a patient, before a clean/aseptic procedure, after touching a patient, and after touching a patient's surroundings. However, hand hygiene compliance after body fluid exposure risk did not significantly change.[18]

Among New Mothers

In Bangladesh, researchers assessed whether pregnant women were more receptive to teachings about hand hygiene compliance than new mothers. Researchers provided one group of pregnant women with an intensive handwashing intervention during the perinatal period, while another group received the same intervention after the end of the perinatal period. Researchers found that the probability of handwashing at home 1-14 months later was not significantly different between the intervention and control groups.[19]

Children as Agents of Behavior Change

In Zambia, researchers used qualitative research methods to assess the extent that children disseminate information about WASH at home after learning about handwashing in school. The study found that pupils were generally enthusiastic about engaging with their parents and were successful at constructing handwashing stations at home. Mothers also reported trust in the messages that their children brought home from school. In other words, students were able to communicate knowledge to family members, thus, enacting small changes.[20]

In Public Health Campaigns

In Thailand, oral cholera vaccine (OCV) campaigns were associated with an increase in reported handwashing practice. Residents of the Maela refugee camp received two doses of OCV combined with vaccination campaign-associated messaging (e.g., information about OCV, handwashing, other cholera prevention practices) and other WASH educational activities. Reported use of soap to wash hands was 66% at the baseline, 77% at the first follow-up, and 85% at the second follow-up. Observed availability of soap at the handwashing station was 84% at the baseline, 90% at the first follow-up, and 95% at the second follow-up.[21]

Behavior Change	Method	Location
Handwashing behavior change in healthcare facilities		
Communities that receive multiple behavior change interventions (e.g., radio messaging, clinic events, and community events) had higher prevalence of handwashing with soap at key times or after risk of contact with feces than communities receiving only standard care (32% vs. 28%).[17]	Direct observation	Zambia
Hygiene compliance increased from 34.1% to 68.9% when alcohol-based hand rub was combined with education on hand hygiene practice and the use of reminders throughout the workplace.[18]	N/A	Rwanda
Handwashing behavior change among new mothers		
Probability of handwashing at home was not significantly different between new mothers who received intensive handwashing interventions during the perinatal period and new mothers who received the intervention after the perinatal period.[19]	N/A	Bangladesh
Handwashing behavior change among children as agents of change		
School children are likely to disseminate information about WASH at home after learning about handwashing in school and were successful at constructing handwashing stations. Mothers also reported trust in the messages that their children brought home from school.[20]	N/A	Zambia
Handwashing behavior change in public health campaigns		
Reported use of soap to wash hands increased from 66% - 85% when key handwashing information, cholera prevention practices, and other WASH educational activities were shared during oral cholera vaccination campaigns.[21]	Self-reporting	Thailand
Availability of soap at handwashing stations increased from 84% - 95% when key handwashing information, cholera prevention practices, and other WASH educational activities were shared during oral cholera vaccination campaigns.[21]	Direct observation	

Determinants of Handwashing

Big Idea: To wash their hands properly people must have access to the necessary materials, including a functional handwashing station with soap in a convenient location. When handwashing stations are visible and accessible they can serve as environmental cues to remind people to wash their hands.

In the Household & Community

A number of studies have looked at determinants of handwashing in the household and the community. A study of more than 1,000 households in 12 countries showed that handwashing frequency is associated with routine (i.e., how automatically it is performed), whether someone is busy or tired, and being concerned with good manners.[22] Similarly, results of a UNICEF cross-sectional study of 1,700 households in three provinces in Indonesia showed that handwashing with soap was significantly associated with the

desire to smell nice, interpersonal influences, presence of handwashing places within 10 paces of the kitchen and the toilet, and key handwashing moments (i.e., after eating and after cleaning child's stools).[23]

A community-based study in urban areas in India showed that determinants of not washing hands among mothers with children under 5 years of age included absence of soap and water at handwashing stations and lack of awareness of the importance of handwashing.[24] A qualitative study in Nepal suggested that hand hygiene habit formation was supported by ease of access to hardware and reinforcement of key hygiene behaviors, and that there were four key emotional drivers of hygiene behavior change: perceived threat, disgust, comfort, and shame/stigma.[25]

In Schools

A cross-sectional study in Indonesia showed that handwashing practice was associated with subjective norms, but not with perceived barriers, availability of handwashing facilities, and sex.[26] A study in urban and rural schools in Karnataka, India, showed that handwashing was correlated with knowledge of hand hygiene and non-availability of handwashing spaces and soap.[27] A study in primary schools in Mumbai, India, showed that handwashing among students was infrequent and the primary reasons for not washing hands were forgetfulness and laziness.[28]

In Healthcare Facilities

A number of studies have reported factors associated with handwashing in healthcare setting. A study on handwashing among 259 healthcare workers in rural India stated that barriers to hand hygiene included high workload, lack of resources, lack of scientific information, and perception that priority is not given to hand hygiene. Meanwhile, previous training is associated with self-reported hand hygiene practice.[29] However, in a study on hand hygiene knowledge, attitude, and practice among nursing students in Saudi Arabia, good attitude towards hand hygiene, being male, awareness of the benefits of hand hygiene, attending hand hygiene trainings and seminars, and being in the early years of the program were associated with better hand hygiene practice.[30]

Work experience is positively associated with hand hygiene compliance among healthcare workers. In Cyprus, staff nurses (who had more experience) had significantly higher hand hygiene compliance and aware ness of the importance of infection control than nursing students (who had less experience).[31] A study on reported hand hygiene among medical students in Dominica showed that no handwashing was highest (30%) after cadaver work due to lack of time (41% of respondents who reported never washing their hands), lack of perceived necessity (31%), and unavailability of hygiene materials (28%).[32]

Data collected from 233 dentists in Pakistan showed that common barriers to hand hygiene included lack of educational program, time constraint, inconvenient location of handwashing place, false sense of security against infection, lack of supplies, and lack of guidance.[33]

Determinants of handwashing	Location
Determinants of handwashing in household and community	
Frequency of handwashing with soap is associated with routine (i.e., how automatically it is performed), whether someone is busy or tired, and being concerned with good manners.[22]	Global
Handwashing with soap was significantly associated with the desire to smell nice, interpersonal influences, presence of handwashing places within 10 paces of the kitchen and the toilet, and key handwashing moments.[23]	Indonesia

In urban settings, factors of no handwashing among mothers with children under 5 years of age included absence of soap and water at handwashing stations and lack of awareness of the importance of handwashing.[24]	India
Ease of access to hardware and reinforcement of key hygiene behaviors when four key emotional drivers of hygiene behavior change (perceived threat, disgust, comfort, and shame/stigma) are present reinforced a handwashing habit.[25]	Nepal
Determinants of handwashing in schools	
Handwashing practice is associated with subjective norms, but not with perceived barriers, availability of handwashing facilities, and sex.[26]	Indonesia
Handwashing is correlated with knowledge of hand hygiene and non-availability of handwashing spaces and soap.[27]	India
Primary reasons reported for not washing hands were forgetfulness and laziness.[28]	
Determinants of handwashing in HCFs	
Barriers to hand hygiene among healthcare workers include high workload, lack of resources, lack of scientific information, and perception that priority is not given to hand hygiene, while previous training is associated with self-reported hand hygiene practice.[29]	India
Better hand hygiene practice, hand hygiene knowledge, attitude, and practice among nursing students were associated with good attitude towards hand hygiene, being male, awareness of the benefits of hand hygiene, attending hand hygiene trainings and seminars, and being in the early years of the nursing program.[30]	Saudi Arabia
Nurses with more healthcare experience have significantly higher hand hygiene compliance and awareness of the importance of infection control.[31]	Cyprus
Reported hand hygiene compliance among medical students was lowest (70%) after cadaver work due to lack of time (41% of respondents who reported never washing their hands), lack of perceived necessity (31%), and unavailability of hygiene materials (28%).[32]	Dominica
Common barriers to hand hygiene practice among dentists include lack of educational program, time constraint, inconvenient location of handwashing place, false sense of security against infection, lack of supplies, and lack of guidance.[33]	Pakistan

Efficacy of hand cleansing materials

A non-randomized trial in Bangladesh compared the uptake of soapy water in 4 study arms: 1) promotion of soapy water; 2) promotion of soapy water and handwashing stations (tap-fitted bucket and soapy water bottle); 3) soapy water promotion and handwashing stations and detergent refill; and 4) control arm (no intervention). At four months after delivery of intervention, soap or soapy water was found in 18% of households in the promotion-only arm, 60% in the promotion + handwashing station arm, 71% in promotion + station + detergent refill arm, and 6% in the control arm. Use of soapy water was associated with having a shared courtyard, perceived value of handwashing, ease of use, and convenience of soapy water.[34]

A state of the science review of experimental studies comparing the benefits of hand hygiene products with antimicrobial agents, compared to the benefits of handwashing with plain soap, found no evidence that antimicrobial products had a superior effect compared to soap. A review of evidence of laboratory studies showed that antimicrobial products were superior to handwashing with soap only when the frequency, duration, and product concentrations were higher than a level that could be expected in low-income settings.[35] Similarly, a study comparing plain foaming and liquid soap with regard to microbial removal showed that both types had no statistically significant difference in microbial removal efficacy. However, foaming soap removed significantly fewer MS2 bacteriophage virus compared to *E. coli*.[36]

Povidone-iodine scrub significantly reduces the number of colony-forming units of bacteria after application on bare hands, according to a study to estimate the effectiveness of five handwashing agents among clinical and paraclinical personnel in India. The agents included 1) plain water, 2) non-medicated soap, 3) alcohol-based hand sanitizer, 4) chlorhexidine-based cleaning agent, and 5) povidone iodine based antiseptic.[37]

Hand cleansing materials	Location
A non-randomized trial compared the uptake of soapy water in 4 study arms showed that 4 months after delivery of intervention, soap or soapy water was found in 18% of households with only promotion; 60% of households with promotion and handwashing station; 71% in households with promotion, station, and detergent refill; 6% in houses with no intervention.[34]	Bangladesh
No evidence that antimicrobial products had a superior effect compared to soap against handwashing with plain soap, except only when the frequency, duration, and product concentrations were higher than a level that could be expected in low-income settings.[35]	N/A
There is no significant difference between plain foaming and liquid soap with regard to microbial removal. However, foaming soap removed significantly fewer MS2 bacteriophage virus compared to *E. coli*.[36]	N/A
Povidone-iodine scrub significantly reduced the number of colony-forming units of bacteria after application on bare hands among clinical and paraclinical personnel.[37]	India

References

1. Forouzanfar MH, Afshin A, Alexander LT, Anderson HR, Bhutta ZA, Biryukov S, Brauer M, Burnett R, Cercy K, Charlson FJ, Cohen AJ, Dandona L, Estep K, Ferrari AJ, Frostad JJ, Fullman N, Gething PW, Godwin WW, Griswold M, Hay SI, Kinfu Y, Kyu HH, Larson HJ, Liang X, Lim SS, Liu PY, Lopez AD, Lozano R, Marczak L, Mensah GA, Mokdad AH, Moradi-Lakeh M, Naghavi M, Neal B, Reitsma MB, Roth GA, Salomon JA, Sur PJ, Vos T, Wagner JA, Wang H, Zhao Y, Zhou M, Aasvang GM, Abajobir AA, Abate KH, Abbafati C, Abbas KM, Abd-Allah F, Abdulle AM, Abera SF, Abraham B, Abu-Raddad LJ, Abyu GY, Adebiyi AO, Adedeji IA, Ademi Z, Adou AK, Adsuar JC, Agardh EE, Agarwal A, Agrawal A, Kiadaliri AA, Ajala ON, Akinyemiju TF, Al-Aly Z, Alam K, Alam NKM, Aldhahri SF, Aldridge RW, Alemu ZA, Ali R, Alkerwi A 'a, Alla F, Allebeck P, Alsharif U, Altirkawi KA, Martin EA, Alvis-Guzman N, Amare AT, Amberbir A, Amegah AK, Amini H, Ammar W, Amrock SM, Andersen HH, Anderson BO, Antonio CAT, Anwari P, Ärnlöv J, Artaman A, Asayesh H, Asghar RJ, Assadi R, Atique S, Avokpaho EFGA, Awasthi A, Quintanilla BPA, et al. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*. 8;388(10053):1659-1724. doi:10.1016/S0140-6736(16)31679-8
2. Townsend J, Greenland K, Curtis V. Costs of diarrhoea and acute respiratory infection attributable to not handwashing: the cases of India and China. *Trop Med Int Health*. 2017;22(1):74-81. doi:10.1111/tmi.12808.
3. Hartinger S, Lanata C, Hattendorf J, Verastegui H, Gil A, Wolf J, Mäusezahl D. Improving household air, drinking water and hygiene in rural Peru: a community-randomized–controlled trial of an integrated environmental home-based intervention package to improve child health. *Int J Epidemiol*. November 2016. doi:10.1093/ije/dyw242.
4. Friedrich MND, Julian TR, Kappler A, Nhiwatiwa T, Mosler H-J. Handwashing, but how? Microbial effectiveness of existing handwashing practices in high-density suburbs of Harare, Zimbabwe. *Am J Infect Control*. doi:10.1016/j.ajic.2016.06.035.
5. Tetteh-Quarcoo PB, Anim-Baidoo I, Attah SK, Abdul-Latif Baako B, Opintan JA, Minamor AA, Abdul-Rahman M, Ayeh-Kumi PF. Microbial Content of "Bowl Water" Used for Communal Handwashing in Preschools within Accra Metropolis, Ghana. *Int J Microbiol*. 2016;2016:8

6. Wu K-S, Chen Y-S, Lin H-S, Hsieh E-L, Chen J-K, Tsai H-C, Chen Y-H, Lin C-Y, Hung C-T, Sy CL, Tseng Y-T, Lee SS-J. A nationwide covert observation study using a novel method for hand hygiene compliance in health care. *Am J Infect Control*. 2016. doi:10.1016/j.ajic.2016.10.010.
7. Nicholson AM, Tennant IA, Martin AC, Ehikhametalor K, Reynolds G, Thoms-Rodriguez C-A, Nagassar R, Hoilett T-K, Allen R, Redwood T, Crandon I. Hand hygiene compliance by health care workers at a teaching hospital, Kingston, Jamaica. *J Infect Dev Ctries*. 2016;10(10):1088-1092.
8. Sopjani I. Health Care Personnel's Attitude toward Hand Hygiene in Regard to the Prevention of Health-Care Associated Infections: A Cross Sectional Study at the University Hospital Pristine. *Open J Nurs*. 2016;6:841-852.
9. Amaya-Arias AC, Cortés ML, Franco D, Mojica JD, Hernández S, Eslava-Schmalbach J. Safe behaviours and acceptance of the use of checklists in urban obstetric units in Colombia. *Colomb J Anesthesiol*. 2017;45(1):22-30. doi:10.1016/j.rcae.2016.11.018.
10. Ghorbani A, Sadeghi L, Shahrokhi A, Mohammadpour A, Addo M, Khodadadi E. Hand hygiene compliance before and after wearing gloves among intensive care unit nurses in Iran. *Am J Infect Control*. 2016;44(11):e279-e281. doi:10.1016/j.ajic.2016.05.004.
11. Ibrahim AA, Elshafie SS. Knowledge, awareness, and attitude regarding infection prevention and control among medical students: a call for educational intervention. *Adv Med Educ Pract*. 2016;7:505-510. doi:10.2147/AMEP.S109830.
12. Tamilarasi R, Arunmozhi R, Karthick Raja V, Rajajeyakumar M. Study to assess the knowledge and practice of handwashing among school going adolescents in Chennai. *Int J Health Sci Res*. 2016;6(8):147-155.
13. Azuogu VC, Ilo CI, Nwimo IO, Azuogu BN, Onwunaka C. Extent of Hand Washing Practice among Secondary School Students in Ebonyi State, Nigeria. *Int J Educ Learn Dev*. 2016;4(7):11-22.
14. Khan S, Kumar V, Priya N, Yadav SS. Handwashing practices among the caregivers of under five children in rural and urban areas of Moradabad, India: a community based study. *Int J Med Sci Public Health*. 2017;6(1):133-138.
15. Zohura F, Bhuyian SI, Monira S, Begum F, Biswas SK, Parvin T, Sack D, Sack RB, Leontsini E, Saif-Ur-Rahman KM, Rashid M, Sharmin R, Zhang X, Alam M, George CM. Observed Handwashing with Soap Practices among Cholera Patients and Accompanying Household Members in a Hospital Setting (CHoBI7 Trial). *Am J Trop Med Hyg*. October 2016. doi:10.4269/ajtmh.16-0379.
16. Horng LM, Unicomb L, Alam M-U, Halder AK, Shoab AK, Ghosh PK, Opel A, Islam MK, Luby SP. Healthcare worker and family caregiver hand hygiene in Bangladeshi healthcare facilities: results from the Bangladesh National Hygiene Baseline Survey. *J Hosp Infect*. 2016;94(3):286-294. doi:10.1016/j.jhin.2016.08.016.
17. Greenland K, Chipungu J, Curtis V, Schmidt W-P, Siwale Z, Mudenda M, Chilekwa J, Lewis JJ, Chilengi R. Multiple behaviour change intervention for diarrhoea control in Lusaka, Zambia: a cluster randomised trial. *Lancet Glob Health*. 2016;4(12):e966-e977. doi:10.1016/S2214-109X(16)30262-5.
18. Holmen IC, Seneza C, Nyiranzayisaba B, Nyiringabo V, Bienfait M, Safdar N. Improving Hand Hygiene Practices in a Rural Hospital in Sub-Saharan Africa. *Infect Control Hosp Epidemiol*. 2016;37(7):834-839. doi:10.1017/ice.2016.71.
19. Kamm KB, Vujcic J, Nasreen S, Luby SP, Zaman K, El Arifeen S, Ram PK. Is pregnancy a teachable moment to promote handwashing with soap among primiparous women in rural Bangladesh? Follow-up of a randomised controlled trial. *Trop Med Int Health*. 2016;21(12):1562-1571. doi:10.1111/tmi.12782.
20. Bresee S, Caruso BA, Sales J, Lupele J, Freeman MC. "A child is also a teacher": exploring the potential for children as change agents in the context of a school-based WASH intervention in rural Eastern Zambia. *Health Educ Res*. 2016;31(4):521-534. doi:10.1093/her/cyw022.
21. Scobie HM, Phares CR, Wannemuehler KA, Nyangoma E, Taylor EM, Fulton A, Wongjindanon N, Aung NR, Travers P, Date K. Use of Oral Cholera Vaccine and Knowledge, Attitudes, and Practices Regarding Safe Water, Sanitation and Hygiene in a Long-Standing Refugee Camp, Thailand, 2012-2014. *PLoS Negl Trop Dis*. 2016;10(12):e0005210. doi:10.1371/journal.pntd.0005210.

22. Aunger R, Greenland K, Ploubidis G, Schmidt W, Oxford J, Curtis V. The Determinants of Reported Personal and Household Hygiene Behaviour: A Multi-Country Study. *PLOS ONE*. 2016;11(8):e0159551. doi:10.1371/journal.pone.0159551.
23. Hirai M, Graham PJ, Mattson DK, Kelsey A, Mukherji S, Cronin AA. Exploring Determinants of Handwashing with Soap in Indonesia: A Quantitative Analysis. *Int J Environ Res Public Health*. 2016;13(9). doi:10.3390/ijerph13090868.
24. Begum RU, Bhavani K. Study of knowledge and practices of hand washing among mothers having children under 5 years of age in urban field practicing area of Kakatiya Medical College, Warangal, Telangana, India. *Int J Community Med Public Health*. 2016;3(8):2035-2039. doi:10.18203/2394-6040.ijcmph20162541.
25. McMichael C, Robinson P. Drivers of sustained hygiene behaviour change: A case study from mid-western Nepal. *Soc Sci Med*. 2016;163:28-36. doi:10.1016/j.socscimed.2016.06.051.
26. Nazliansyah, Wichaikull S, Wetasin K. Factors Affecting Hand Washing Practice among Elementary Schools Students in Indonesia. *Belitung Nurs J*. 2016;2(4):58-64.
27. Mane AB, Reddy NS, Reddy P, Chetana KV, Nair SS, Sriniwas T. Differences of Hand Hygiene and its Correlates among School going Children in Rural and Urban Area of Karnataka, India. *Arch Med*. 2016;8(5):1-5. doi:10.21767/1989-5216.1000163.
28. Gawai PP, Taware SA, Chatterjee AS, Thakur HP. A cross sectional descriptive study of hand washing knowledge and practices among primary school children in Mumbai, Maharashtra, India. *Int J Community Med Public Health*. 2016;3(10):2958-2966.
29. Diwan V, Gustafsson C, Rosales Klintz S, Joshi SC, Joshi R, Sharma M, Shah H, Pathak A, Tamhankar AJ, Stålsby Lundborg C. Understanding Healthcare Workers Self-Reported Practices, Knowledge and Attitude about Hand Hygiene in a Medical Setting in Rural India. *PLOS ONE*. 2016;11(10):e0163347. doi:10.1371/journal.pone.0163347.
30. Cruz JP, Bashtawi MA. Predictors of hand hygiene practice among Saudi nursing students: A cross-sectional self-reported study. *J Infect Public Health*. 2016;9(4):485-493. doi:10.1016/j.jiph.2015.11.010.
31. Karadag M, Pekin Iseri O, Yildirim N, Etikan I. Knowledge, Beliefs and Practices of Nurses and Nursing Students for Hand Hygiene. *Jundishapur J Health Sci*. 2016;8(4 SP e36469).
32. Afolabi OO, Adewumi EO, Medavarapu S, Ige TO, Alao J, Dada OE. Study to Ascertain the practice of Hand Hygiene among Medical Students in Commonwealth of Dominica. *Arch Med*. 2016;8(5):7. doi:10.21767/1989-5216.1000165.
33. Rana BK, Manazar Z. Evidence based Approaches towards Hand Hygiene. *Int Dent J Stud Res*. 2016;4(3):148-155.
24. Ashraf S, Nizame FA, Islam M, Dutta NC, Yeasmin D, Akhter S, Abedin J, Winch PJ, Ram PK, Unicomb L, Leontsini E, Luby SP. Nonrandomized Trial of Feasibility and Acceptability of Strategies for Promotion of Soapy Water as a Handwashing Agent in Rural Bangladesh. *Am J Trop Med Hyg*. December 2016. doi:10.4269/ajtmh.16-0304.
35. de Witt Huberts J, Greenland K, Schmidt W-P, Curtis V. Exploring the potential of antimicrobial hand hygiene products in reducing the infectious burden in low-income countries: An integrative review. *Am J Infect Control*. 2016;44(7):764-771. doi:10.1016/j.ajic.2016.01.045.
36. Conover DM, Gibson KE. Comparison of two plain soap types for removal of bacteria and viruses from hands with specific focus on food service environments. *Food Control*. 2016;69:141-146. doi:10.1016/j.foodcont.2016.04.047.
37. Kulkarni VV, Bhave PP, Shinde GT, Kartikeyan S. Comparative study of effectiveness of different germicidal hand washing agents in clinical and paraclinical health care personnel. *Int J Biomed Res*. 2016;7(11):807-810.