

Lentora Nursing Journal
e-ISSN 2776-1622
Volume 7 Issue 1, 2026, page 1-11
DOI: 10.33860/lnj.v7i1.4440
Website: https://jurnal.poltekkespalu.ac.id/index.php/LNJ
Publisher: Poltekkes Kemenkes Palu

Original Article

Handwashing Knowledge Following Storytelling-Based Education among Indonesian Primary Schoolchildren: A Single-Group Pretest–Posttest Study

Nurul Fitrah [1], Andi Fatmawati Syamsu[1], Fitria Masulili[1]
[1]Department of Nursing, Poltekkes Kemenkes Palu, Central Sulawesi, Indonesia

Corresponding author: fitrahnurul102@gmail.com

ARTICLE INFO

Article History:
Received: 2026-09-16
Accepted: 2026-10-22
Published: 2026-10-31

Keywords:

Storytelling;
Handwashing;
Health education;
Knowledge;
Schoolchildren

ABSTRACT

Background: Age-appropriate handwashing education is important for school hygiene promotion, but the immediate knowledge gains following brief storytelling-based programs require local evaluation. This study described immediate changes in handwashing knowledge among Indonesian primary schoolchildren following a two-session educational program.

Methods: A single-group pretest–posttest study included 49 third- and fourth-grade students at SD Negeri 8 Mamboro. Two 30-minute storytelling sessions with visual aids were delivered on consecutive days. Knowledge was assessed using the same 20-item questionnaire at baseline and after each session. A paired t-test estimated baseline-to-final mean change.

Results: Mean knowledge scores increased from 13.35 (SD 2.08) at baseline to 17.37 (SD 1.32) after day one and 19.53 (SD 0.74) after day two. The baseline-to-final mean increase was 6.18 points (95% CI 5.61–6.76; $t(48) = 21.68$, $p < 0.001$).

Conclusion: The educational program was followed by improved immediate handwashing knowledge. The uncontrolled design and short follow-up limit causal interpretation and conclusions about sustained behavior change.

©2026 by the authors. Submitted for possible open-access publication under the terms and conditions of the Creative Commons Attribution (CC BY SA) license (https://creativecommons.org/licenses/by-sa/4.0/)

INTRODUCTION

Hand hygiene education is an important component of school health promotion, but children's ability to apply what they learn depends on the environment in which that learning occurs. The 2024 World Health Organization and United Nations Children's Fund monitoring report estimated that 646 million children lacked basic hygiene services at school (World Health Organization & United Nations Children's Fund, 2024). School-based research in Mongolia and Ethiopia has identified limited access to soap, interruptions in water supply, and inadequate facilities or maintenance as barriers to handwashing (Enkhbat, Togoobaatar, Erdenee, & Katsumata, 2022; Melaku & Addis, 2023). These findings indicate that educational messages need to be considered alongside practical opportunities to wash hands.

Knowledge is one relevant educational outcome, although it should not be treated as equivalent to behavior. In an Ethiopian study, knowledge, attitudes, and hygiene-club membership were associated with handwashing practice (Engdaw, Alemu, Alemayehu, & Tesfaye, 2024). Conversely, research examining psychosocial determinants found that knowledge did not independently predict children's handwashing behavior, whereas attitudes, skills, and subjective norms were relevant (Appiah-Brempong & Appiah-Brempong, 2024). Together, these studies support assessing knowledge as one component of a broader process involving understanding, motivation, skills, and environmental support.

The distinction between educational and health outcomes is also apparent in intervention research. A school water, sanitation, and hygiene intervention in the Philippines increased observed handwashing in some intervention groups without improving overall health literacy (Sangalang et al., 2022). A large cluster-randomized trial in Ethiopia found a borderline reduction in respiratory illness but no effect on diarrhea or school absence (Bick et al., 2024). Another Ethiopian evaluation improved school hygiene conditions and students' knowledge, attitudes, and practices, while providing limited evidence of additional health benefits beyond existing deworming and school feeding programs (Tadesse et al., 2024). Thus, improvement in a questionnaire score cannot establish a reduction in infection.

Storytelling offers a way to present health messages through characters, events, and consequences that children can discuss. Indonesian studies have reported improvements in handwashing knowledge or attitudes after storytelling, including a study of school-age children and a comparison of storytelling with demonstration (Lestiawati, Hapsari, & Retnaningsih, 2025; Srinatania, Dahlia, & Perdani, 2022). Other investigations have combined storytelling with demonstration or audiovisual materials (Hidayati, Romadhonika, & Salfarina, 2023; Lestari & Putri, 2024). These findings provide a rationale for further evaluation, but differences in age, intervention components, measurement, and study design limit direct comparisons. In particular, uncontrolled pretest-posttest studies cannot isolate the contribution of storytelling from repeated testing or other influences.

Evidence from other pediatric settings supports the educational potential of narrative approaches without establishing that all narratives have the same effect. An interactive reading session using a medically informed children's book improved third-grade students' knowledge about food allergy (Vollmer, Thompson, & Schimelpfenig, 2023). A randomized study of hospitalized children found that robot-assisted digital storytelling supported communication and engagement during education about intravenous injections (Chang, Hwang, Chou, Xu, & Jen, 2023). For hygiene education specifically, a low-cost intervention that made germs visible and a Japanese program using adenosine triphosphate testing illustrate approaches to making otherwise invisible contamination more understandable (Gupta & Anand, 2023; Oura et al., 2024). These studies inform the rationale for visual teaching but do not directly validate the story used in the present study.

Recent trials have evaluated cartoons, animated handwashing instructions, child-friendly educational resources, and video-assisted peer education (Graichen et al., 2024; McNicholl, Younie, Crosby, & Laird, 2024; Steinbauer et al., 2025; Zhang, Wen, Han, & Jiang, 2024). A large randomized study in rural Bangladesh also reported improvements after sustained skill-based education (Omura, Venkatesh, Khandaker, & Rahman, 2025). These longer or multicomponent programs do not establish the immediate response to a brief story in an Indonesian school.

School hygiene promotion requires age-appropriate handwashing education. Preliminary observations and interviews at SD Negeri 8 Mamboro identified one poorly maintained handwashing facility and more than 10 third- and fourth-grade students reporting limited knowledge of proper handwashing and inconsistent practice. These local concerns highlighted the need to evaluate storytelling-based education in this setting. This study assessed immediate changes in handwashing knowledge following two educational sessions among Indonesian primary schoolchildren.

METHODS

Study design and setting

A quantitative, single-group pretest–posttest study was conducted at SD Negeri 8 Mamboro, North Palu District, Palu City, Central Sulawesi, Indonesia, on February 11–12, 2025. There was no random allocation or concurrent control group. Knowledge was assessed at baseline, immediately after the first session, and immediately after the second session. The design measured within-group change over two days.

Participants and sampling

The target population comprised 49 students, including 20 in grade III and 29 in grade IV. Total population sampling was used, and parental permission was obtained for all participants. All 49 students participated in the baseline assessment, both storytelling sessions, and the immediate posttest after each session. Attendance was complete on both days, with no refusals, absences, or withdrawals. All participants completed the three assessments and were included in the analysis.

Storytelling intervention and assessment schedule

The researcher delivered two 30-minute health storytelling sessions entitled “Si Kuman & Si Bersih” (“The Germ and the Clean One”) on consecutive days, giving approximately 60 minutes of scheduled exposure. A structured health education session plan (Satuan Acara Penyuluhan; SAP) guided the activities and emphasized handwashing with soap and running water.

The SAP allocated five minutes to an introduction, 15 minutes to storytelling, five minutes to questions and discussion, and five minutes to closing activities. Discussion prompts asked when hands should be washed, how to describe the steps, and what might happen if hands were not washed properly. Closing activities reinforced the main messages and included planned rehearsal of handwashing movements through an activity such as singing. The SAP describes the planned educational package. The researcher delivered the health story “Si Kuman & Si Bersih” (“The Germ and the Clean One”) in Bahasa Indonesia, using visual representations of the story characters. The intervention was delivered in a classroom group format, with grade III and grade IV students taught separately.

The same questionnaire was administered before the first session and immediately after each session, with approximately 20 minutes allocated to questionnaire completion.

Knowledge instrument

Handwashing knowledge was assessed using 20 true/false statements covering soap and

running water, occasions for handwashing, handwashing movements, drying, contamination, and disease prevention. Correct responses received one point and incorrect responses zero points, giving a total score of 0–20. Higher scores indicated greater knowledge of the assessed topics. The same questionnaire was used at all three assessments. Study records attribute earlier instrument testing to Mutia Arini (2020), reporting item correlations above an r-table threshold of 0.344 and a Cronbach's alpha of 0.859.

Statistical analysis

Participant characteristics were summarized using frequencies and percentages, and knowledge scores using means, standard deviations, and ranges. The main reported comparison estimated baseline-to-final mean change using a two-sided paired t-test with a 95% confidence interval. Data were analyzed using a paired-samples t-test.

Ethical considerations

Ethical approval was issued by the Research Ethics Committee of Poltekkes Kemenkes Palu on February 4, 2025 (approval number: 000274/KEPK POLTEKKES KEMENKES PALU/2025). Study records describe school coordination, provision of study information and written parental or guardian consent forms, voluntary participation and withdrawal, and confidentiality of participant identities.

RESULTS

Participant characteristics

The sample included 49 students with a mean age of 9.02 years (SD 0.90; range 8–11). Girls accounted for 61.2% of participants. Twenty students (40.8%) were in grade III and 29 (59.2%) in grade IV (Table 1).

Table 1. Participant characteristics (n = 49)

Characteristic	Frequency	Percentage (%)
Age		
Age: 8 years	17	34.7
Age: 9 years	16	32.7
Age: 10 years	14	28.6
Age: 11 years	2	4.1
Gender		
Male	19	38.8
Female	30	61.2
Grade		
Grade III	20	40.8
Grade IV	29	59.2

Knowledge scores across the intervention period

Mean knowledge scores increased from 13.35 at baseline to 17.37 after day one and 19.53 after day two (Table 2). Final scores ranged from 18 to 20, and 33 students (67.3%) attained the maximum score, indicating a marked ceiling effect.

Table 2. Knowledge scores before and after the educational program (n = 49)

Assessment	Mean	SD	Range
Baseline	13.35	2.08	9–17
Posttest, day one	17.37	1.32	15–19
Posttest, day two	19.53	0.74	18–20

Baseline-to-final comparison

The baseline-to-final mean increase was 6.18 points (95% CI 5.61–6.76; $t(48) = 21.68$, $p < 0.001$; Table 3). This is an estimate of immediate within-group change based on the recorded totals, rather than an effect relative to a comparison group.

Table 3. Baseline-to-final paired comparison (n = 49)

Mean increase	95% CI	t (df)	p-value
6.18	5.61–6.76	21.68 (48)	< 0.001

DISCUSSION

Interpretation in relation to storytelling and visual learning

The principal finding was an immediate mean increase of 6.18 points in handwashing knowledge after the two-session educational program. The finding was directionally consistent with Indonesian investigations of storytelling for handwashing education (Lestiawati et al., 2025; Srinatania et al., 2022). Visual characters and interactive activities may have supported recall, but attention, engagement, and recall mechanisms were not measured. Any explanation involving identification with characters or narrative memory therefore remains a proposed mechanism rather than a demonstrated mediator.

Studies combining storytelling with demonstration and audiovisual delivery also reported favorable hygiene-related outcomes (Hidayati et al., 2023; Lestari & Putri, 2024). The present SAP included storytelling, discussion, and planned movement rehearsal, so the results concern the complete educational program rather than an isolated narrative component. Completion of every planned component was not independently verified. The study cannot establish superiority over demonstration, routine instruction, or another active teaching method.

The use of recognizable characters can be considered alongside approaches that make contamination observable. Gupta and Anand evaluated a simulated-germ intervention among rural schoolchildren, while Oura and colleagues used biological feedback to help students examine handwashing (Gupta & Anand, 2023; Oura et al., 2024). Both approaches connect health information with concrete experience. The present story used visual representations rather than biological measurement, so its results concern conceptual learning rather than confirmation that students removed contamination more effectively.

Narrative learning also has applications outside handwashing. Interactive reading about peanut allergy and robot-assisted storytelling for hospitalized children showed educational or communication benefits in different populations (Chang et al., 2023; Vollmer et al., 2023). Their relevance lies in illustrating how child-oriented narratives can support discussion of health topics. Differences in setting, technology, outcome, and emotional context preclude using these findings as direct estimates of the effectiveness of classroom hygiene storytelling.

Repetition, reinforcement, and the limits of immediate assessment

The additional increase after the second session was compatible with further learning during repeated exposure. However, the design could not distinguish reinforcement of the health message from familiarity with the questionnaire, recall of previous answers, or informal discussion between assessments. The smaller second-day increase also occurred when many students were already approaching the maximum score. Thus, the trajectory should not be interpreted as establishing an optimal two-session dose.

Longer educational studies provide a useful contrast. A Japanese kindergarten program evaluated sequential activities involving researchers, teachers, and parents and found partial maintenance or improvement of handwashing skills (Ueno, Miyake, Shimada, & Tomokawa, 2024). A 2026 proof-of-concept study reported improved technique following musical instruction over several weeks (Thampi et al., 2026). Animated feedback in a controlled field trial increased children's soaping time during the intervention period (Graichen et al., 2024). These outcomes were observed or assessed over longer intervals and demonstrate why a final questionnaire administered immediately after a story cannot establish durable handwashing competence.

Other research has measured skills or behaviors following demonstration-based training and classroom instruction (Erkoca, Dündar, & Çal, 2025; Malik et al., 2022). A theory-informed school program reported lower respiratory illness and absenteeism without a between-group difference in its hand hygiene behavior score (Uyanık & Dağhan, 2025). Such findings reinforce the need to specify what improved, how it was measured, and when it was assessed. For the present study, the defensible outcome was immediate knowledge performance on a 20-item instrument.

Knowledge gains within the school hygiene environment

Educational improvement does not ensure that children will have soap, water, time, or encouragement to act on the message. Observational studies have identified resource constraints and coordination problems within school hygiene programs (Enkhbat et al., 2022; Melaku & Addis, 2023). The Philippine trial similarly combined education with supplies, policy activities, and facility repairs, making it different from a brief standalone story (Sangalang et al., 2022). Storytelling should therefore be considered as a possible educational component within a broader school hygiene program.

Evidence is not uniformly positive. A school intervention in Belize did not improve overall hand hygiene knowledge, attitudes, or practices, and observed soap use after toilet visits declined between assessments (Ly et al., 2025). A Guatemalan program evaluated changes following hygiene events, environmental prompts, and product provision, while also identifying issues of product acceptability (Pieters et al., 2025). These experiences indicate that response to a school hygiene program depends on implementation and context; a favorable immediate questionnaire result should not be extrapolated to sustained uptake across schools.

Environmental and interpersonal factors merit separate attention. A school-based architectural intervention study examined how handwashing spaces could support compliance (Bai, Li, Yan, Yang, & Tu, 2022). A parent-child study linked features of interaction during a home science activity with children's subsequent soap use (Sobel & Stricker, 2022). In addition, psychosocial research highlighted skills and social norms rather than knowledge alone (Appiah-Brempong & Appiah-Brempong, 2024). These findings suggest that future adaptations should evaluate practical support, teacher involvement, and opportunities for children to act independently, rather than assuming that improved recall will automatically produce a habit.

Educational format and broader school health relevance

Studies in oral hygiene provide adjacent evidence on how educational format can influence learning and skills. Trials have compared verbal and video instruction, conventional teaching and board games, and interactive visual games with educational talks (Demirel, Güçlü, Güçlü, & Bağış, 2025; K et al., 2022; Shi et al., 2023). A study of primary school children also compared animation,

verbal explanation, and peer-led video content (Bayraktar Nahir, Coşgun, Şahin, & Altan, 2025). These investigations are relevant to the design of engaging health education, but oral hygiene outcomes cannot be treated as evidence that the present handwashing story changed behavior. Their practical implication is that future comparisons should include a credible active teaching alternative.

The present questionnaire also assessed a narrower construct than general health literacy. A randomized trial in early adolescence evaluated health literacy at one and three months, whereas an Austrian elementary-school program examined child-oriented education over several years (Breil & Lillich, 2024; Yüksek & Ayaz-Alkaya, 2024). A Chinese trial studied health literacy, emotions, and coping during public health emergencies (Wang et al., 2023). These studies illustrate broader and longitudinal measurement approaches. Improved performance on the current knowledge test does not establish corresponding changes in the ability to obtain, appraise, communicate, or apply health information.

Similarly, a cluster-randomized trial of influenza education measured both health literacy and vaccination uptake and found modest behavioral improvement (Chen et al., 2025). School health programs may therefore require distinct indicators for knowledge acquisition, decisions, behaviors, and clinical outcomes. Maintaining these distinctions would strengthen future evaluations of clean and healthy living education and prevent overstatement of what a brief educational encounter achieves.

Implications for school nursing and future research

For practice, the findings support considering storytelling as a complementary educational method, with local evaluation and reinforcement through teacher-supported activities. Routine use should be accompanied by access to functioning handwashing facilities and age-appropriate opportunities to practice. The present data do not justify claims that the story prevents diarrhea, reduces absenteeism, or replaces practical skill instruction.

Future studies should compare storytelling with usual education or another active teaching method, preferably using allocation at classroom or school level when contamination between students is likely. They should include baseline-adjusted analyses, account for clustering, and assess delayed knowledge retention and observed technique. Recording session attendance, fidelity, teacher input, and facility availability would help distinguish educational exposure from implementation conditions. Validated measures with sufficient difficulty and discrimination are particularly important when immediate posttest scores approach the upper limit.

Strengths and limitations

The study included the entire population of the two target grades and documented a clearly timed intervention with three assessments. These features provided a complete description of immediate score changes within that school population. However, total population sampling within one school does not establish representativeness of other schools or regions.

The absence of a concurrent control group prevents separation of intervention exposure from testing effects, expectations, and other influences. The two-day assessment period did not establish retention, and 67.3% of participants reached the final-score ceiling.

CONCLUSION

Two storytelling-based educational sessions were followed by a mean increase of 6.18 points in immediate handwashing knowledge among third- and fourth-grade students at SD Negeri 8 Mamboro. These findings support further controlled evaluation of storytelling within school hygiene education. The uncontrolled design, immediate assessment, limit causal and broader effectiveness claims. Future studies should verify scoring and assess delayed knowledge retention and observed handwashing.

Author's Contribution Statement: All authors contributed to the development and preparation of this manuscript in accordance with the CRediT (Contributor Roles Taxonomy). **NF**: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, and Writing – Original Draft Preparation. **AFS**: Supervision, Methodology, and Writing – Review & Editing. **FM**: Supervision, Validation, and Writing – Review & Editing.

Conflicts of Interest: The authors declare that they have no conflicts of interest related to the conduct of this study, the interpretation of the findings, or the publication of this manuscript.

Source of Funding Statements: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgments: The authors thank the administration and teachers of SD Negeri 8 Mamboro, as well as to all the students who participated in this study, for their cooperation and support throughout the research process.

Declaration of Artificial Intelligence (AI) Use: ChatGPT (OpenAI) assisted with English translation and drafting, language editing, manuscript organization, literature identification, reference formatting, source comparison, and computational checking of transcribed participant totals during revision. It did not generate participant data or independently validate the instrument. The authors are responsible for verifying the original records, analyses, references, and final manuscript.

REFERENCES

Appiah-Brempong, E., & Appiah-Brempong, M. (2024). Examining the psychosocial drivers of handwashing behaviour among school children. *Health Psychology and Behavioral Medicine, 12*(1), 2391932. https://doi.org/10.1080/21642850.2024.2391932

Bai, X., Li, X., Yan, D., Yang, H., & Tu, K. (2022). Effects of micro architectural environmental interventions on handwashing compliance of adolescents: A school-based intervention trial. *HERD, 15*(4), 81–95. https://doi.org/10.1177/19375867221104412

Bayraktar Nahir, C., Coşgun, A., Şahin, N. D., & Altan, H. (2025). Primary school children's oral hygiene knowledge assessed with different educational methods: A cross-sectional study. *BMC Oral Health, 25*(1), 148. https://doi.org/10.1186/s12903-025-05493-6

Bick, S., Ezezew, A., Opondo, C., Leurent, B., Argaw, W., Hunter, E. C., … Dreibelbis, R. (2024). Impact of a school-based water and hygiene intervention on child health and school attendance in Addis Ababa, Ethiopia: A cluster-randomised controlled trial. *BMC Medicine, 22*(1), 348. https://doi.org/10.1186/s12916-024-03558-x

Breil, C., & Lillich, M. (2024). Health literacy education of children in Austrian elementary schools. *Health Education Research, 39*(1), 29–39. https://doi.org/10.1093/her/cyad022

Chang, C. Y., Hwang, G. J., Chou, Y. L., Xu, Z. Y., & Jen, H. J. (2023). Effects of robot-assisted digital storytelling on hospitalized children's communication during the COVID-19 pandemic. *Educational Technology Research and Development, 71*(3), 793–805. https://doi.org/10.1007/s11423-023-10209-0

Chen, J., Xie, W., Huang, X., Huang, A., Lu, T., Zhang, R., … Xu, L. (2025). Impact of multifaceted health education on influenza vaccination health literacy in primary school students: A cluster randomized controlled trial. *BMC Medicine, 23*(1), 333. https://doi.org/10.1186/s12916-025-04156-1

Demirel, A., Güçlü, H. S., Güçlü, M., & Bağış, N. (2025). Evaluation of effects of verbal and video-based instructions on the improvement of oral hygiene status in children: A randomised clinical trial. *International Journal of Dental Hygiene, 23*(3), 575–583. https://doi.org/10.1111/idh.12898

Engdaw, G. T., Alemu, D., Alemayehu, M., & Tesfaye, A. H. (2024). Handwashing practices among public primary school students in East Dembiya District, Ethiopia. *The American Journal of Tropical Medicine and Hygiene, 110*(4), 826–834. https://doi.org/10.4269/ajtmh.23-0201

Enkhbat, M., Togoobaatar, G., Erdenee, O., & Katsumata, A. T. (2022). Handwashing practice among elementary schoolchildren in urban setting, Mongolia: A school-based cross-sectional survey. *Journal of Environmental and Public Health, 2022*, 3103241. https://doi.org/10.1155/2022/3103241

Erkoca, S., Dündar, N., & Çal, A. (2025). The effect of education given to secondary school students on hand hygiene behaviors: A quasi experimental study. *Journal of Evaluation in Clinical Practice, 31*(5), e14211. https://doi.org/10.1111/jep.14211

Graichen, J., Stingl, C., Pakarinen, A., Rosio, R., Terho, K., Günther, S. A., … Staake, T. (2024). Improving hand hygiene of young children with a digital intervention: A cluster-randomised controlled field trial. *Scientific Reports, 14*(1), 6157. https://doi.org/10.1038/s41598-024-56233-9

Gupta, V., & Anand, S. (2023). Making germs visible - assessing the impact of a school-based, low-cost intervention on hand hygiene knowledge, attitude and practice of children in rural India. *Journal of Health Communication, 28*(sup2), 25–31. https://doi.org/10.1080/10810730.2023.2231869

Hidayati, B. N., Romadhonika, F., & Salfarina, A. L. (2023). Pengaruh storytelling (audio visual) terhadap kepatuhan mencuci tangan pada anak pra sekolah di RA Baiturrahman Rembiga Kota Mataram. *Jurnal Kesehatan Qamarul Huda, 11*(1), 330–334. https://doi.org/10.37824/jkqh.v11i1.2023.480

K, R., Deshpande, A., Ankola, A., Sankeshwari, R., Jalihal, S., Hampiholi, V., … S, L. (2022). Effectiveness of a visual interactive game on oral hygiene knowledge, practices, and clinical parameters among adolescents: A randomized controlled trial. *Children, 9*(12), 1828. https://doi.org/10.3390/children9121828

Lestari, K. B., & Putri, A. W. (2024). Storytelling dan demonstrasi meningkatkan pengetahuan, sikap, dan tindakan cuci tangan pakai sabun pada anak. *NURSE: Journal of Nursing and Health Science, 3*(1), 12–23. https://doi.org/10.15408/nurse.v3i1.38633

Lestiawati, E., Hapsari, R. P., & Retnaningsih, L. N. (2025). The difference in effectiveness between demonstration and storytelling methods of handwashing knowledge of first-graders elementary school children. *Jurnal Kesehatan Kusuma Husada, 16*(2), 19–28. https://doi.org/10.34035/jk.v16i2.1769

Ly, A. N., Craig, C., McDavid, K., Maheia, D., Gongora, Y., Morey, F., … Murray, K. O. (2025). Hand hygiene knowledge, attitudes, practices, and hand dirtiness of primary school students before and after a behavioral change intervention during the COVID-19 pandemic, Belize 2022-2023. *The American Journal of Tropical Medicine and Hygiene, 113*(2), 427–436. https://doi.org/10.4269/ajtmh.24-0617

Malik, F. R., Reman, A., Niazi, A., Kifayat, F., Afridi, N., Khan, S., & Khan, K. (2022). A quasi experimental study on hand hygiene practices among secondary school children in Khyber PakhtunKhwa. *Journal of the Pakistan Medical Association, 72*(4), 664–668. https://doi.org/10.47391/jpma.2051

McNicholl, J., Younie, S., Crosby, S., & Laird, K. (2024). A clinical trial evaluation of handwashing products and educational resources to improve hand hygiene in paediatric patients and school children. *Frontiers in Public Health, 12*, 1427749. https://doi.org/10.3389/fpubh.2024.1427749

Melaku, A., & Addis, T. (2023). Handwashing practices and associated factors among school children in Kirkos and Akaki Kality sub-cities, Addis Ababa, Ethiopia. *Environmental Health Insights, 17*, 11786302231156299. https://doi.org/10.1177/11786302231156299

Omura, M., Venkatesh, M., Khandaker, I., & Rahman, A. (2025). The effects of skill-based health education-a randomised-controlled intervention in primary schools in rural Bangladesh. *PLOS ONE, 20*(7), e0327325. https://doi.org/10.1371/journal.pone.0327325

Oura, A., Naito, Y., Yako-Suketomo, H., Nakata, K., Koyama, M., & Ohnishi, H. (2024). Science behind children's handwashing: Action study of 9- to 10-years-old elementary school students in Japan. *Frontiers in Public Health, 12*, 1425646. https://doi.org/10.3389/fpubh.2024.1425646

Pieters, M. M., Fahsen, N., Craig, C., McDavid, K., Ishida, K., Hug, C., … Lozier, M. J. (2025). Changes in hand hygiene knowledge, attitudes, and practices among primary school students: Insights from a promotion program in Guatemala. *International Journal of Environmental Research and Public Health, 22*(3), 424. https://doi.org/10.3390/ijerph22030424

Sangalang, S. O., Lemence, A. L. G., Ottong, Z. J., Valencia, J. C., Olaguera, M., Canja, R. J. F., … Kistemann, T. (2022). School water, sanitation, and hygiene (WASH) intervention to improve malnutrition, dehydration, health literacy, and handwashing: A cluster-randomised controlled trial in Metro Manila, Philippines. *BMC Public Health, 22*(1), 2034. https://doi.org/10.1186/s12889-022-14398-w

Shi, Y., Wu, W. Z., Huo, A., Wang, H. H., Lu, W. B., & Jin, X. H. (2023). Effect of conventional and "Dental Truth or Dare" board game on oral hygiene knowledge and oral hygiene status of preschool children. *Games for Health Journal, 12*(2), 125–131. https://doi.org/10.1089/g4h.2022.0059

Sobel, D. M., & Stricker, L. W. (2022). Parent-child interaction during a home STEM activity and children's handwashing behaviors. *Frontiers in Psychology, 13*, 992710. https://doi.org/10.3389/fpsyg.2022.992710

Srinatania, D., Dahlia, L., & Perdani, A. L. (2022). The effectiveness of storytelling to improve handwashing knowledge and attitude in school-age children in Indonesia. *KnE Life Sciences, 7*(2), 467–472. https://doi.org/10.18502/kls.v7i2.10343

Steinbauer, P., Bichler, M., Fuiko, R., Seferagic, S., Haas, H., Lisy, T., … Giordano, V. (2025). CARTOON-based educational intervention for children to foster hygiene knowledge and emotional resilience in preschool children: A randomized controlled trial. *Frontiers in Pediatrics, 13*, 1514793. https://doi.org/10.3389/fped.2025.1514793

Tadesse, G., Wuletaw, Y., Mekete, K., Sime, H., Yard, E., Appleby, L., … Drake, L. (2024). Investigating the effect of a school-based WASH intervention on soil-transmitted helminth and schistosome infections and nutritional status of school children in Ethiopia: A quasi-experimental study. *Parasites & Vectors, 17*(1), 130. https://doi.org/10.1186/s13071-024-06155-2

Thampi, N., Darbha, A., Zumbansen, A., Comeau, G., Tsampalieros, A., & Longtin, Y. (2026). A musical mnemonic to recall handwashing technique among young children: A proof-of-concept study. *American Journal of Infection Control, 54*(7), 805–809. https://doi.org/10.1016/j.ajic.2026.02.005

Tolan, P. H., Harris, A. R., Burchinal, M., & Jennings, P. A. (2024). Promoting 21st century health and wellness skills in elementary school children: A group randomized trial. *Prevention Science, 25*(6), 919–933. https://doi.org/10.1007/s11121-024-01717-3

Ueno, M., Miyake, K., Shimada, H., & Tomokawa, S. (2024). Effectiveness of a continuous handwashing education program with multiple activities at a Japanese kindergarten school. *Health Promotion International, 39*(3), daae056. https://doi.org/10.1093/heapro/daae056

Uyanık, G., & Dağhan, Ş. (2025). The effect of the theory of planned behavior based hand hygiene intervention program on the health outcomes and school absenteeism of the primary school students: Quasi-experimental study. *Journal of Infection Prevention, 26*(3), 103–113. https://doi.org/10.1177/17571774241300481

Vollmer, M. L., Thompson, P., & Schimelpfenig, M. (2023). Educating children through the art of storytelling using a medically-informed children's book. *South Dakota Medicine, 76*(7), 314–320. https://pubmed.ncbi.nlm.nih.gov/37733963/

Wang, Z., Gao, T., Li, G., Dong, G., Zhan, Y., Wang, B., & Sun, X. (2023). Effects of health education during public health emergencies on the health literacy, emotion and coping style of Chinese junior middle school students: A randomized controlled trial. *BMC Public Health, 23*(1), 2187. https://doi.org/10.1186/s12889-023-17108-2

World Health Organization, & United Nations Children's Fund. (2024). *Progress on drinking water, sanitation and hygiene in schools 2015–2023: Special focus on menstrual health.* Geneva, Switzerland: World Health Organization. https://www.who.int/publications/i/item/9789240097490

Yüksek, B. N., & Ayaz-Alkaya, S. (2024). Effectiveness of health literacy education on health literacy in early adolescence: A randomized controlled trial. *Public Health, 237*, 135–140. https://doi.org/10.1016/j.puhe.2024.09.024

Zhang, X., Wen, Y. J., Han, N., & Jiang, Y. (2024). The effect of a video-assisted health education program followed by peer education on the health literacy of COVID-19 and other infectious diseases among school children: Quasi-randomized controlled trial. *JMIR Human Factors, 11*, e43943. https://doi.org/10.2196/43943

Zhao, X., Niu, L., Shih, Y. A., Wu, Y., Li, C., & Fan, W. (2026). Train-the-trainer model in public health practice: Feasibility of senior nursing students as catalysts for hand hygiene education in school-aged children. *Journal of Family Medicine and Primary Care, 15*(2), 801–809. https://doi.org/10.4103/jfmpc.jfmpc_1845_25