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Hand Hygiene Interventions in Children: A Review Study

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Summary

Objective: To map current intervention methods used in the field of improving hand hygiene in preschool and school-age children.

Design: systematic review

Methods: PubMed, EBSCOhost and ProQuest databases were searched. The period 201-2024 was chosen. All forms of interventions aimed at improving hand hygiene in children were included. Subsequently, a critical appraisal of the selected studies was performed.

Results: Our review confirmed the tendency of current research to focus mainly on education in the prevention of poor hand hygiene in children, mainly using multimedia support. Twelve studies confirmed the effectiveness of the intervention, one study did not. Most of the included studies were randomized and controlled, two studies were quasi-experimental.

Conclusion: Various forms of educational interventions are presented as essential interventions in the field of good hand hygiene in children. However, the level of evidence presented must always be evaluated in the context of the conclusions presented.

Keywords Handhygiene. Children. Interventions. Review.

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1 INTRODUCTION

The most common causes of death worldwide are infectious diseases, especially respiratory diseases and gastrointestinal diseases. More than 2 million people die each year from these diseases (UNICEF, 2023) and infections account for more than 19% of child deaths (WHO, 2020). These diseases can be effectively prevented or treated if access to simple and affordable interventions is provided. Infectious diseases in childhood lead to increased school absenteeism and consequently poor academic performance (Tsang et al., 2023). The basic recommendation in the prevention of infectious diseases is to observe hygiene measures. Appropriate hand hygiene interventions included with children as early as preschool age lead to a reduction in institutional absenteeism due to illness (Mohamed et al., 2020). Hand hygiene (washing hands with soap and water at key moments) is considered a simple, effective and inexpensive way to directly impact the prevention of many infectious diseases (CDC, 2023). However, in children, only about 42% show good hygiene according to research (Chen et al., 2020). At the beginning of schooling (around the age of seven), the child should be able to gradually assume basic responsibility for self-care and hygiene. Habits that are formed during childhood then tend to persist into adulthood (Movassagh et al., 2017) Therefore, children need to be taught proper hand hygiene at an early age. Children aged 5-14 years are considered the target group for targeting hand hygiene interventions (Kyu

et al., 2018). Among the recommended effective interventions for ensuring good hand hygiene, environmental actions such as ensuring the availability of safe water, sanitation facilities, and especially educational interventions are mentioned (Lange et al., 2021).

The aim of the study is to map current intervention methods used in the field of improving hand hygiene in preschool and school-age children, to present their content and to provide the most up-to-date summary of the topic for use in practice or in further research.

2 Methods

A systematic review design was chosen. Studies were included that were published in the period 2021-2024, in peer-reviewed sources and in English.

To identify the tools, a research question was formulated using a modified PICo tool structure: Participant; Phenomena of Interest and Context (Higgins, 2013). What interventions (I) are used to improve hand hygiene (Co) in children (P)? After the formulation of the research question, keywords were selected (Table 1).

Table 1 Research questions in PICo format and keywords

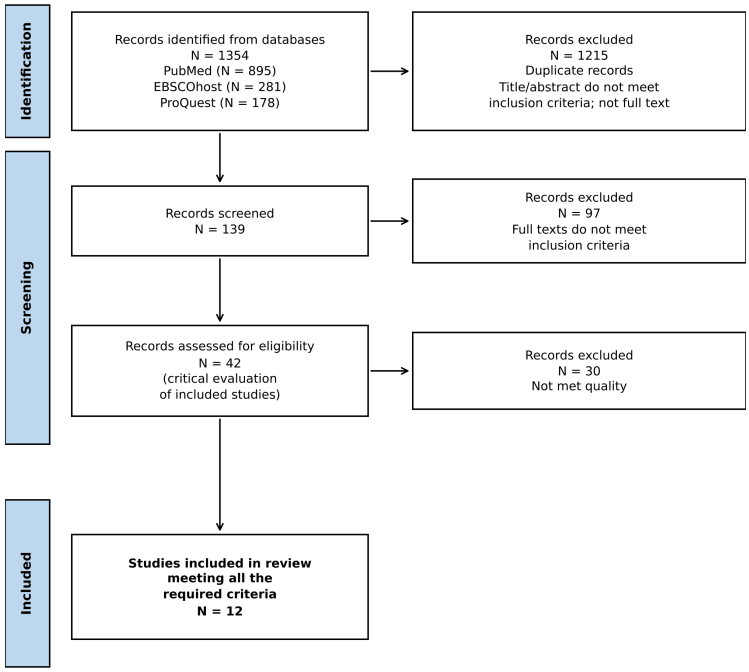
What interventions (I) are used to improve hand hygiene (Co) in children (P)?		
1	**children* OR children* OR youth***	**P**
2	intervention* OR strategie*	I
3	hand hygiene OR handwashing	Co
4	1 AND 2 AND 3	PICo

A systematic search for studies was conducted to identify and locate relevant sources. A search strategy using Boolean operators and truncation was used. PubMed, EBSCOhost and ProQuest databases were searched at all stages of the research. Any form of intervention (educational, behavioural or structural) aimed at improving hand hygiene in children was included. Case report or series, systematic review or meta-analysis studies were excluded.

Subsequently, a critical appraisal of the selected studies was performed. This evaluation was conducted using a modification of the critical appraisal tool of randomized controlled trials, RRAAMBO (acronym Recruitment, Allocation, Maintenance, Blind, Objective), (Glasziou et al., 2009). The RRAAMBO tool was developed by experts at the Centre for Evidence-based Medicine (CEMB) and is suitable for evaluating quantitative studies in primary research (Klugar, 2015). Studies were evaluated in several areas (research design questions). For the final assessment, a summary of the response scores is provided. There is an inverse relationship for this summary score, i.e. the lower the score, the better the scientific evidence of the study (Table 3).

The progression of the overall search strategy is demonstrated in the Prisma flow diagram (Figure 1).

Figure 1 PRISMA flow diagram



3 Results

Twelve studies were included in the final review (Table 2). The studies present interventions aimed at improving hand hygiene in preschool and school-age children.

Table 2 Overview of included studies

Study	Location	Age children	Sample size of children	Intervention period	Aim of the research	Intervention	Results
Hayat (2021)	**Indonesia**	**6th grade primary school**	**60**	**n/a**	**the impact of videoanimation on handwashing knowledge and skills**	**videoanimation**	**increase in knowledge (43.3%; p<0.05) in skills (65%; p<0.05)**
Khan et al. (2021)	Pakistan	6-10 years	93	two weeks	the effect of the intervention on handwashing techniques in school children	education and demonstration of washing protocol	improvement in handwashing practices (p=0.000)
Öncü, Vayısoğlu (2021)	Turkey	8-11 years	151	18 days	the effect of technique-based or duration-based education on children's development of handwashing skills	multi-step teaching	increase in handwashing efficiency (p=0.05)
Kothari et al. (2022)	India	10-12 years	115	five weeks	the impact of education on changing hand hygiene knowledge, attitudes and practices (KAP)	education in the form of a package	improved knowledge of correct technique and duration of effective hand washing (p<0.05); change in attitude

Study	Location	Age children	Sample size of children	Intervention period	Aim of the research	Intervention	Results
							and behaviour (p<0.05)
Fradianto et al. (2022)	Indonesia	primary school level, age not specified	100	three months	the impact of the play-based educational programme on children's knowledge, attitudes and practices in the area of handwashing	education+training in proper hand hygiene	increase knowledge (by 45%), attitudes (from 23% to 88%) and practices (by 64%)
Wu et al. (2022)	China	three to five years	72	four months	impact of interventions on hand hygiene in kindergartens	education + handwashing training	decrease in bacterial colonization of children's hands (p<0.001), improvement in the overall hand hygiene status of children (p<0.01)
Mohamed et al. (2023)	Malaysia	five to six years	36	n/a	development of a hand hygiene teaching module using a learning and play approach	educational sessions	increased knowledge of COVID-19 transmission, prevention and hand hygiene (p<0.001)
Nazirun, Sari (2023)	Indonesia	n/a	25 (with special needs)	n/a	to determine the effectiveness of health education using audiovisual media on the psychomotor ability of hand washing	stimulation by audiovisual media	improving psychomotor handwashing skills in children with special needs (p<0.05)
Watson et al. (2023)	Sudan	five to twelve years	200	16 weeks	the effect of a toy-in-soap intervention and a standard intervention on hand hygiene in an emergency setting	education and hand washing demonstration	no difference in the proportion of all handwashes that used soap; p=0.90)
Graichen et al. (2024)	Germany, Finland	three to six years	162	42 days	the impact of practical and scalable digital intervention on proper handwashing in young children (handwashing time)	digital handwashing tutorial+monitored washing processes	prolonged hand washing (p<0.001); prolonged soaping time (p<0.001) effect appears immediately and persists for the duration of the intervention phase
Parmar et al. (2024)	India	one to five years	800 childre children's day centres	six months	the impact of educational interventions on reducing microbial load, reducing illness and absenteeism in day care centres	education	effectiveness of the education programme (p<0.01), improved hand hygiene compliance (p<0.01) and disease reduction (p<0.01)
Wang et al. (2024)	Taiwan	three to five years	three children with autism spectrum disorder (ASD)	one month	the effect of video self-modelling (VSM) in teaching handwashing to preschool children with ASD	video (head-swapping technology)	demonstrating the effectiveness of an iVSM intervention to three children with ASD

During this period, educational intervention dominated the research conducted. Digital support or multimedia support was used during training in six studies (Hayat, 2021; Kothari et al., 2023; Wu et al., 2022; Nazirun, Sari, 2023; Graichen et al., 2024; Wang et al., 2024). Some of the research focused on specific situations, taking into account the characteristics of the respondents, e.g. children with special needs (Nazirun, Sari, 2023) or children with autism spectrum disorder (Wang et al., 2024) or the research setting, e.g. a refugee settlement in Sudan (Watson et al., 2023) or community setting (Fradianto et al., 2022). A multi-tiered educational intervention included four studies (Öncü, Vayısoğlu, 2021; Kothari et al., 2023; Wu et al., 2022; Mohamed et al., 2023). In three studies UV light has been used to verify or enhance the effect of education (Khan et al., 2021; Öncü, Vayısoğlu 2021; Mohamed et al., 2023). Two studies (Graichen et al., 2024; Wang et al., 2024) used modern digital applications (digital sensors and specially adapted video modelling). A Taiwanese study (Wang et al., 2024) tested the programme on children with autism spectrum disorder (ASD). Ten included studies confirmed the effectiveness of the intervention, while one study (Watson et al., 2023) did not. The Taiwanese study (Wang et al., 2024) included only three participants in a specific situation, and no significance of the findings was noted in the Indonesian study (Fradianto et al., 2022).

3.1 Characteristics of included studies

The Indonesian quasi-experimental study Hayat (2021) focused on the effect of video animation on handwashing knowledge and skills among children. A six-step handwashing video animation (Kementerian Kesehatan Republik Indonesia, 2019) was presented to primary school students. The research was based on the prediction that motion graphic video media are more effective than conventional teaching.

A Pakistani randomized controlled trial Khan et al. (2021) evaluated the effectiveness of a handwashing technique intervention in school children. Ninety-three children were included in the study. The intervention consisted of education and involvement of children in hand washing. The first group was demonstrated only the hand washing protocol and the second group underwent the washing protocol through glow-gel hand washing technique. Verbal and visual (video) means were used. The evaluation used a glow gel and UV light visualization technique and a comparison of pre-intervention and post-intervention questionnaires.

A Turkish study Öncü, Vayısoğlu (2021) compared the effect of technique and duration of education on children's development of handwashing skills. A double-blind randomized controlled trial was conducted at baseline in 151 children. The first group was intervened with a multistep teaching technique (education, practical demonstration of hand washing and provision of pictorial cards for home use). The second group was given a hand-washing demonstration, supported by a song they sang. In the home environment, the children used picture cards by a song. The control group washed their hands as usual. Handwashing efficacy was assessed in all groups by analysis of scatter on fluorescent residues after glo-germ application using digital recordings from the Semmelweis hand in scan device.

The Indian study Kothari et al. (2023) presented research on 115 children. Children attended health talks, interactive sessions using audiovisual aids, videos and materials from the WHO and Centers for disease control and prevention (CDC) websites and live demonstrations of the handwashing steps. The evaluation assessed change in handwashing knowledge, attitude and practice (KAP).

The Indonesian study by Fradianto et al. (2022) aimed to increase school-aged children's knowledge, attitudes and practices of handwashing with a play-based educational program in a community setting where they spend time after school (a religious community). The twelve-week program enrolled 100 children at the primary school level. Structured play with game media was used in the six-step education (the concept of hand washing, the benefits, the right time to wash hands, how to wash hands properly, the impact of not washing hands, and a demonstration hand washing).

A Chinese quasi-experimental study Wu et al. (2022) was conducted over a period of four months. Two kindergartens were the subject of the research. The intervention programme focused on both teachers and children and consisted of a lecture on infectious diseases (teachers), a lecture on hand hygiene (teachers) and hand washing practice

(teachers followed by children). The programme was developed in accordance with handwashing guidelines based on hand hygiene training developed in the Netherlands (Zomer et al., 2013). Children's hand bacterial colonization and hand hygiene environment were assessed.

A Malaysian study Mohamed et al. (2023) presented the development of a hand hygiene module using a learn and play approach. The module was designed based on suggestions from public health experts and focused on the 'learn and play' approach. The comprehensive educational module, which consisted of three educational units, focused on the basics of infectious diseases, transmission and prevention options, the importance of hand hygiene and the importance of soap when washing hands. Fun play elements such as UV light, glitter and toys were used for education.

The Indonesian study Nazirun and Sari (2023) aimed to determine the effectiveness of health education using audiovisual media on the psychomotor ability of hand washing in children (with mental retardation). Twenty-five children with special needs were included in the research. This study analyzed the success rate of washing hands before and after being given audiovisual media. After the application of education with the help of audiovisual media (handwashing videos), the psychomotor skills of handwashing were identified again.

A cluster randomized controlled trial Watson et al. (2023), conducted in a refugee settlement in Sudan, focused on 200 children. The aim was to compare the effect of surprise soap (a glitter game to demonstrate germs spreading, toy soap; education) and a standard intervention involving brief education in the children's home environment and distribution of plain soap. Comparisons and observations were made four times, each at five key moments: after defecating or using the toilet, before eating, before preparing food, before giving food to another person, and after cleaning up another child's feces.

A cluster randomised controlled and blinded trial Graichen et al. (2024) was conducted in four day care centres in Finland (two) and Germany (two), with one control and one experimental group each time. The study included 167 children. The study looked at the impact of digital interventions on correct handwashing in young children. The bathrooms of the participating centers were equipped with the study hardware (automatic faucets and automatic sensors, soap dispensers with digital metering unit and gates). The system was linked to tablets above the sinks (presenting animated instructions), which were triggered by the use of water and soap. Digital sensors measured the flow rate, temperature, time and duration of each water and soap extraction. Data from the sensors was sent via Bluetooth to a gateway installed in the ceiling.

The aim of the Indian cluster randomized six-month study Parmar et al. (2024) was to evaluate the effectiveness of hand hygiene education in reducing disease transmission in children attending day care centers. Interventions included handwashing with soap and water, use of hand sanitizers, and an educational program on hygiene habits. The control group applied routine hand hygiene without further intervention.

The aim of the Taiwanese study Wang et al. (2024) was to examine the effectiveness of Video Self-Modeling (VSM) in teaching handwashing to preschool children with Autism Spectrum Disorder (ASD). The study used an innovative iVSM approach which utilizes the head-swapping technique to generate self-modeling videos. Three children with autism spectrum disorder aged three to five were included. In total, the child performed nine steps in three observations as part of his daily routine. The generic peer-modeling video was generated into self-modeling two-minute videos that were subsequently used during hand hygiene.

3. 2 Critical evaluation of the results

A critical evaluation of the results was carried out with regard to the level of scientific evidence being translated. Most of the included studies were randomised controlled trials according to the level of effectiveness of evidence-based medicine (Khan et al., 2021; Öncü, Vayısoğlu, 2021; Kothari et al., 2022; Mohamed et al., 2023; Watson et al., 2023; Graichen et al., 2024; Parmar et al., 2024); two studies were blinded (Öncü, Vayısoğlu, 2021; Graichen et al., 2024). Other levels of evidence for efficacy included quasi-experimental research designs (Hayat. 2021; Wu et al., 2022) that lacked random assignment of participants to groups. The other included studies were observational-analytic

study designs (Fradianto et al., 2022; Nazirun, Sari, 2023; Wang et al., 2024). A summary of the scores for the evaluated areas of individual research is presented in Table 3. Here, the lower the score, the more scientific evidence the study provides. The table also ranks studies that are not randomised and whose higher final score confirms a lower level of scientific evidence. Thus, the highest quality scientific evidence according to this assessment is provided by the double-blind randomised controlled trial (Öncü, Vayısoğlu, 2021) and the blinded study (Mohamed et al., 2023), which were able to report a positive response to all domains of the RRAAMBO assessment tool. The Taiwanese study (Wang et al., 2024) could not be evaluated with this tool due to the specificity of the research situation.

Table 3 Modified Critical Appraisal Instrument for Outcomes

RRAAMBO Study	R Was the assignment/ assignment of participants random?	R Were IG and CG similar at the beginning of the research?	A Were IG and CG (excluding interventions) treated equally?	A Former participants instructed and analyzed in the groups assigned?	B Was there a blindside in the group?	∑
Hayat (2021)	**2**	**3**	**3**	**1**	**2**	**11**
Khan et al. (2021)	**1**	**1**	**1**	**1**	**2**	**6**
Öncü, Vayısoğlu (2021)	**1**	**1**	**1**	**1**	**1**	**5**
Kothari et al. (2022)	**1**	**3**	**3**	**1**	**2**	**10**
Fradianto et al. (2022)	**2**	**3**	**3**	**1**	**2**	**11**
Wu et al. (2022)	**2**	**3**	**3**	**1**	**2**	**11**
Mohamed et al. (2023)	**1**	**3**	**3**	**1**	**2**	**10**
Nazirun, Sari (2023)	**2**	**3**	**3**	**1**	**2**	**11**
Watson et al. (2023)	**1**	**1**	**1**	**1**	**2**	**6**
Graichen et al. (2024)	**1**	**1**	**1**	**1**	**1**	**5**
Parmar et al. (2024)	**1**	**1**	**1**	**1**	**2**	**6**
Wang et al. (2024)	**3**	**3**	**3**	**3**	**3**	**15**

1-yes; 2-no; 3-unclear; IG-intervention group; CG-control group; ∑-total points

4 Discussion

Hand hygiene is considered an important preventive method in reducing the incidence of infectious diseases (Luangasanatip et al., 2015; Mbakaya et al., 2017). Effective methods that ensure sustainability of outcomes in the longer term include educational interventions using digital technologies (Ofori et al., 2022). Videos are considered to be an effective educational intervention for improving handwashing and the use of detailed video presentations, handwashing leads to better compliance compared to traditional methods (Chen, Chiang, 2007). Our review of studies confirms the current research efforts to focus mainly on education in the prevention of poor hand hygiene in children and confirms that multimedia and digital support appears to be a necessity in the current educational process. Multimedia is a common part of life for today's child population and the educational use of digital technologies seems to be essential. The cost or time of implementation may be a limiting factor for uptake, as suggested by some previous research

(Boudjema et al., 2016) and confirmed by one study (Watson et al., 2023) in our review.

The didactically correct choice of content in accordance with the educational goal (and not only in multimedia) is also important. An educational objective is usually specified as a clear, intended result of an educational activity. However, learning based on didactic transfer alone is not effective (Ginnis, 2002). Early childhood represents a crucial period for children's physical, social, affective, mental and emotional development. Educational interventions should therefore be based on an approach based on the child's experience, activity and play (Nielsen-Rodríguez et al., 2021). The use of activation methods is clearly recommended in the education of preschool and school-age children, which is evident in the included studies.

However, in the context of the conclusions presented, the level of evidence presented also needs to be assessed, as indicated by the result of the critical appraisal (Table 3). In this review, some studies (Khan et al., 2021; Öncü, Vayısoğlu, 2021; Kothari et al.,2023; Mohamed et al., 2023; Watson et al., 2023; Graichen et al., 2024; Parmar et al., 2024) can be considered as the highest level of the evidence pyramid (randomised controlled trials). Only two studies are blinded (Öncü, Vayısoğlu, 2021; Graichen et al., 2024). Randomized controlled trials identify true effects and reduce the potential for research bias (Tina et al., 2021). Randomly assigning participants to either the experimental or control group allows for a comparison of the effect of the independent variable on the dependent variable. In quasi-experiments, which are other included studies, this random assignment is often not possible or ethically permissible, leading to the adoption of alternative strategies. However, the presentation of cohort and observational studies can lead to further inspiration for research endeavours and provides information on research activities in different locations.

5 CONCLUSIONS

Various forms of educational interventions are presented as essential interventions in the field of good hand hygiene in children. However, the level of evidence presented must always be evaluated in the context of the conclusions presented. Replication of effective interventions can inspire follow-up research.

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