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Implementation of Integrated Hygiene Education for the Prevention of Soil-Transmitted Helminths in Young Children

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Abstract

Soil-transmitted helminth (STH) infection continues to affect children attending early childhood education (ECE) despite improvements in hygiene behavior, especially in low-resource settings. This study aimed to determine the feasibility and short-term effects of an integrated model of hygiene education in a PAUD setting. Eight children attending a PAUD facility and their parents were enrolled in a pre-post intervention study. The intervention components included limited stool examinations for STHs using NaCl flotation, child-directed handwashing education, and health education for parents. The handwashing technique was assessed among children, and parental knowledge was assessed before and after the intervention. The proportion of children who performed all six steps of handwashing correctly increased from 25% pre-intervention to 75% post-intervention (n = 8). The proportion of parents demonstrating good knowledge increased from 37.5% before the intervention to 87.5% afterward (n = 8). Hookworm eggs were identified in 12.5% (n = 8) of the children's stool samples post-intervention. These preliminary data suggest the feasibility and effectiveness of this integrated intervention in improving short-term handwashing among children and knowledge among parents attending the PAUD facility. In addition, this intervention increased participants' awareness of infection risk. Similar intervention approaches may be appropriate for other low-resource PAUD settings.

Keywords: Soil-transmitted helminths, handwashing, hygiene education, early childhood education, parental knowledge.

1. Introduction

Factors that potentially increase transmission risk in the Sangihe Islands region of North Sulawesi province include its archipelagic nature, remoteness from health services, poor sanitation [1], and disparities in disease control program coverage. Children aged 3–6 years are vulnerable to soil-transmitted helminth (STH) infection because of their behaviors, such as walking barefoot and poor handwashing practices [2]. Currently, there is no reported data on STH infection prevalence among young children in this region, and there has been no worm screening activity implemented in early childhood education (PAUD) institutions in Sangihe Islands. The lack of information does not imply the absence of the problem. Rather, this region has not yet been reached by either national or regional STH control programs. This highlights the need for evidence-based urgencies in the field.

STH infections are associated with malnutrition in children; however, several lines of evidence suggest that infection leads to malnutrition, and poor nutritional status can increase the risk of infection; the evidence for this bi-directional relationship has yet to be described [3–5]. Prospective cohort studies have demonstrated that exposure to soil-transmitted helminth infection in pregnancy does not have a long-lasting impact on the neurocognitive development of children. However, they can still be associated with abnormalities in emotional development domains, implying that the effects of infection are domain-specific and not completely explained by hypothesized biological mechanisms [6]. Without intervention, both children will be affected, as well as having a burden on the health island economic system with limited resources. The observation results indicate that the Biji Sesawi Tahuna Trilingual Early Childhood Education Center (PAUD) can be a strategic school environment. The students are accustomed to wearing shoes in the classroom as entry to develop hygiene behavior taught in PAUD. However, sometimes at PAUD, they take off their socks in places like bathrooms because there is no special footwear. Water contamination may increase owing to this behavior [7]. PAUD students have handwashing spots that provide soap for handwashing, although this has not been maximized. However, based on these results, behavior education to promote healthy living needs to be reinforced with continuous training. In addition to playing barefoot as part of their routine behavior at

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home, PAUD can also strengthen efforts to break the chain of STH transmission through education. Therefore, PAUD as a school environment can be a medium for constructive education to break the STH transmission chain at an early age.

The policy can be scientifically justified because it has been proven that stunting due to STH infection in children has a close relationship with personal hygiene behavior such as hand washing behavior, nail cutting behavior, wearing shoes behavior [8,9]. Facility and hygiene-related components in PAUD 3 Bahasa Biji Sesawi Tahuna were scattered and were not implemented consistently every day.

According to a pre-intervention field survey finding, the participants had facilities related to hygiene issues, but hygiene behavior was not practiced properly. Some children had long nails and dirty fingernails, and hand washing before eating was not practiced. Facilities were distributed but were not maximally used and lacked monitoring. Additionally, there was no worm screening program or integrated program of hygiene behavior. This means that although they were given facilities, behavior has not been established from previous independent interventions. An integrated intervention should be provided to children, parents, and teachers.

From this condition, it can be concluded that the biggest obstacle is not only the lack of programs but also the inability to implement them sustainably and integrally. Hygienic behavior changes will not last if there is no active participation from all parties. Therefore, there is a possibility of infection going in cycles. We need to improve an intervention strategy that is more structured based on education and can involve children, teachers, and parents simultaneously.

This issue stems from the lack of an integrated intervention package that fits within the setting of early childhood education in island communities. One-way informative interventions are generally unsuccessful because children do not learn by listening to others lecture; they learn by doing and seeing. Additionally, parents have never previously been given the opportunity to participate in STH programs; therefore, the information provided does not fully permeate to the family level. Schools are also on the frontlines and are unable to promote behavioral change because of both structural limitations and teachers' lack of knowledge. If only one component is targeted during an intervention without a focus on others, there will be limited success in halting the transmission of STH.

The innovation seeks to implement the three components in one simultaneous intervention pathway, which will mutually reinforce each other. Stool testing has been identified as the ‘teachable moment’, around which the integrated intervention pathway was developed. This approach leverages parents seeing the worms they have learned about come out of their child’s stool as they conduct the stool test onsite. This physical reminder builds collective awareness that is far more effective than conceptual health education. Furthermore, children will learn the proper six-step handwashing technique through games and activities, while their parents participate in training on home-based prevention and care for STH. Although each component has been used previously in the literature on comprehensive elimination, implementing all three together will yield the strongest results: parasitological proof sparks awareness, experience-based learning solidifies behavior change in children, and bolstered parenting capacity creates a positive enablement at home. Lastly, this innovation seeks to be replicable on similar islands. The aims of this intervention were to measure enhanced performance by children of all six steps of the WHO handwashing technique correctly, and improvement in the percentage of parents reaching good knowledge scores (≥ 7) about STH prevention.

2. Methods

2.1 Intervention Design and Approach

This activity is classified as a community service activity based on program implementation using an integrated approach of education and prevention. This activity has a pretest-posttest design without a control group and is conducted on one target group before and after intervention. This type of design is used to describe changes that occur after implementation and not to causally test the effectiveness of the intervention.

The experiential learning approach was used for children aged 3–6 years because learning in early childhood, especially for nutrition education and healthy eating behavior, is better absorbed through experience, light physical movement, and repeating images than through passive lectures [10].

The parent engagement approach was implemented because changes in hygiene practices at home can be better achieved by providing parents with information that triggers emotional motivation (i.e., the results of their child's own tests) than by simply passing on information about health in a passive way [11].

The integration logic between the stages is chronological. Children become exposed first through exposure to education in multiple forms. Parents are given reinforcement through exposure to education in the form of classes and by seeing the results of their children's stool examinations. Teachers are empowered to become agents of sustainability in schools.

Implementation was carried out on October 1, 2025, in PAUD 3 Bahasa Biji Sesawi, Tahuna, Sangihe Islands. The targets were eight children aged 3–6 years, eight parents, and two teachers. The total duration was 240 minutes (4 hours), with various stages conducted in parallel.

2.2 Intervention Stages

2.2.1 Preparation Stage

The preparation involved collaboration with PAUD institutions, seeking approval from school leaders, preparation of learning materials, lab equipment for stool testing, and assessment tools, as well as obtaining parental consent.

2.2.2 Implementation Stage

Implementation comprised of five steps of planned activities aimed at providing a comprehensive intervention delivered to children, parents, and teachers:

Step 1: Child education using chants, picture quizzes, and cartoon videos (1 hour).

Step 2: Observation and practice of proper handwashing technique using the WHO six-step method and pre/post intervention checklist assessment performed by one observer. Handwashing lesson (1 h) [12].

Step 3: Side-by-side demonstration of worm eggs found during saturated NaCl flotation by directly placing the child's stool under a microscope, with the parents observing (behavioral trigger) (no extra time) [13].

Step 4: Parent education session on the prevention and treatment of STH (1 h).

Step 5: Teacher delivery of the intervention involved parents to promote sustainability and was accompanied by an easy-to-use practical guide (1 h).

Stool specimens were processed under universal precautions, including gloves, sealed containers, disinfectant chemical toilets for disposal of materials that came into contact with stool, and regular disposal.

2.2.3 Evaluation Stage

The evaluation stage involved pre- and post-intervention assessment of children's handwashing skills using the WHO six-step checklist and parental knowledge using a ten-item questionnaire. Changes were described based on the proportion of children correctly performing all six handwashing steps and the proportion of parents achieving good knowledge scores (≥7), as well as the direction of improvement across participants.

2.3 Instruments and Achievement Indicators

The measurement of hand-washing skills among children was based on the completion of the six-step WHO hand-washing checklist, which was used here as an implementation monitoring tool to observe changes over the course of implementation rather than as a standardized instrument of measurement [12]. Measurement of parental knowledge was based on a ten-item true-false questionnaire that had undergone face validity testing. Reliability testing has not been formally conducted on either instrument; thus, the results are reported as suggestive evidence of cognitive and behavioral change rather than standardized metrics. Achievement indicators for implementation were pragmatically defined, with analyses driven by measures of the direction and consistency of change across participants rather than measures of statistical significance: (1) change in the proportion of children able to perform all six steps of hand-washing; minimum pragmatic feasibility target: 50% of participating children demonstrated improvement; (2) change in the proportion of parents demonstrating good knowledge (score ≥7); minimum pragmatic feasibility target: 60%; (3) successful completion of intervention stages as outlined in Figure 2; and (4) reflective responses from parents following microscopic observation to suggest early indications of eliciting a teachable moment.

2.4 Ethics and Data Analysis

Written permission was obtained from the Head of PAUD while informed consent and assent including an explanation of safe fecal collection/transportation procedures were obtained from all parents. Quantitative data were described using proportions and percentages. Direction of change and consistency across participants were described. Due to the limited sample size (n=8) and lack of comparison group, inferential statistics could not be conducted and should not be used to make causal generalizations. Results will be shared as feasibility of implementation and indication of promise.

3. Results and Discussions

3.1 Participant Characteristics and Feasibility

Eight children, eight parents, and two teachers participated in all study procedures (100% retention). The median age of the child participants was 5 years. Of the children, 37.5% were male (n=3/8) and 62.5% were female (n=5/8). All parents who participated in the study were biological mothers.

High adherence reflects that the intervention was implemented feasibly and was acceptable in the PAUD setting. A small sample size (n=8) resulted in limited generalizability of these results; therefore, these results should be considered preliminary (proof-of-concept).

Parasitological Findings and Transmission Context

Hookworm eggs observed during stool examination are shown in Figure 1. Seven out of eight stool specimens analyzed using NaCl flotation were negative for hookworm eggs. One child's stool sample (12.5%) was positive for hookworm eggs. Morphologically, the detected eggs were consistent with hookworm eggs and measured approximately 60–75 μm × 35–40 μm [14]. The child was subsequently referred to the nearby Tahuna Community Health Center. The prevalence of hookworm among participants was within the previously documented range in North Sulawesi province, where prevalence varies between 5% and 20%

[14]. However, using only one screening method with low sensitivity would lead to false-negative results, especially among those infected with Ascaris or Trichuris eggs [15].

Nonetheless, detecting helminth eggs provided short-term, locally-specific evidence that children were at risk of helminth transmission. It represented an abstract risk for infection that parents and teachers were aware of and made it visible and observable to them. Evidence targeting a specific health risk can increase awareness of risk and improve behavioral change prompted by health education messaging [16]. In this case, the positive parasitology results raised awareness among both parents and teachers.

Figure 1. Hookworm Eggs Identified During a Worm Screening Examination of Pre-School Children, Magnified 100x

3.2 Changes in Children's Handwashing Skills

Improvements in children's handwashing performance are summarized in Table 1 and illustrated in Figure 2.

Table 1. Changes in Children's Handwashing Performance

Indicator	Pre (n, %)	Post (n, %)
Correct completion of all 6 steps	2 (25%)	7 (75%)

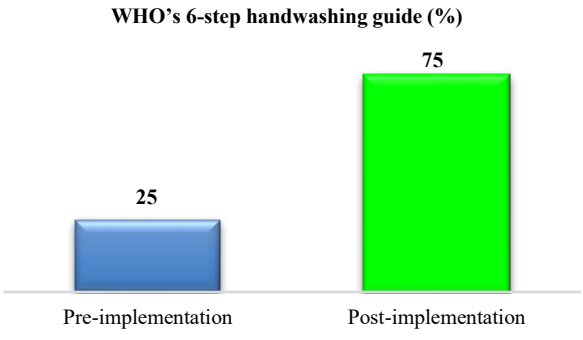

Figure 2. Changes in Children's Handwashing Skills

Of the eight children at baseline, only two (25%) performed all six steps correctly. The steps most frequently performed incorrectly comprised washing for less than 20 seconds, inadequate cleaning between the fingers, and omission of soap use. After completing the intervention, seven out of eight (75 %) children performed all steps correctly. Although this was a small sample size, the increase in students showing perfect procedural adherence demonstrates that there was a significant improvement in the short term.

This is in line with studies that have shown that interventions with components that target cognitive, motor, and environmental factors have the largest effect on behavior [17]. Because this study only assessed students after the educational intervention was completed, it is unknown whether students maintained their new behavior long-term. In addition, there is a risk that students performed better because they knew they were being observed, also known as the Hawthorne effect [18].

In terms of applied significance, this showed that children can apply what they know to proper hygiene that can be observed by others if taught in a stepwise, repetitive manner. For PAUD, this can help children create a routine for handwashing.

3.3 Improvement in Parental Knowledge

The changes in parental knowledge are summarized in Table 2 and illustrated in Figure 3.

Table 2. Changes in Parental Knowledge

Category	Pre (n, %)	Post (n, %)
Good kowledge (≥7)	3 (37.5%)	7 (87.5%)

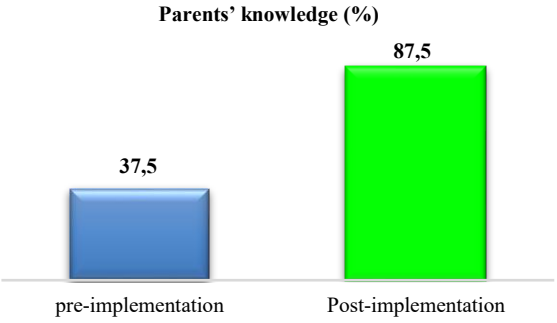

Figure 3. Parents' Knowledge of Soil-Transmitted Helminths, Especially Hookworms

The percentage of parents in the good knowledge category increased from 37.5% prior to the intervention to 87.5% post-intervention. Knowledge about hookworm infection being able to penetrate the skin and footwear providing prevention saw the greatest increases. This may indicate that the teaching strategy was successful in targeting practical knowledge that parents can implement to avoid infection. Research has found that formalized interpersonal education with visual accompaniment can effectively increase knowledge in community-based samples [19]. Parents

are the primary caregivers of children and serve as role models of hygienic practices within the home, indicating that increases in knowledge at this level will have further reach beyond PAUD.

3.4 Integrated Educational Approach and Behavioral Implications

The strengths of this intervention included combining parasitological screening, child-centered hygiene education, and parenting support within the same model. Displaying anonymized stool examination results allowed children to witness tangible proof of their infection-free status without attributing blame or stigma. This likely supported motivation to participate while building relevance [16]. Furthermore, this method may enhance the alignment between knowledge, perception, and behavioral change. Observing direct evidence of risk alongside skill building for preventive practices and parental technical support targeted multiple causes for behavior change within one intervention.

Figure 4. shows evidence of intervention with children, parents, and teachers. This shows evidence of the intervention completed through pictures.

3.5 Limitations and Directions for Development

The limitations of this work include the lack of a control group, small sample size (n = 8), reliance on a single screening method with low sensitivity, immediate post-intervention assessment, and non-validated measures. Also, this research activity was not subjected to formal ethical review through an IRB process. Although it would not have altered the decision to proceed, we obtained informed consent and permission from our institution. However, despite these limitations, our results suggest that the intervention can be feasibly implemented and may have short-term benefits. Future research should be conducted in larger populations with more rigorous study designs to determine long-term effectiveness and impact on infections.

4. Conclusions

The findings of this study suggest that this integrated hygiene education model can be feasibly implemented in a resource-limited PAUD setting and shows evidence of short-term efficacy. Handwashing performance among children improved, with scores of correct practice increasing from 25% before the intervention to 75% afterward. Parental knowledge also significantly increased after the intervention, with the proportion of parents scoring as having good knowledge increasing from 37.5% to 87.5%. The detection of hookworm eggs provided local evidence of current transmission, improving risk perception and motivating engagement in participants. The results suggest that children, parents, and teachers showed improved knowledge, practical skills, and intent for preventive behaviors after receiving the intervention. Despite limitations due to the small sample size and short period of observation, this model has potential for pragmatic application during the early phases of intervention in the PAUD setting and can serve as a foundation for larger-scale community-based studies.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	W
Dhito Dwi Pramardika	✓	✓	✓	✓	✓	✓		✓	✓
Meityn Disye Kasaluhe						✓		✓	
Grace Angel Wuaten		✓				✓			
Mareike Doherty Patras				✓					
Getruida Nita Mozes			✓		✓	✓	✓		
Agneta Sartika Lalombo				✓			✓		

C : Conceptualization
M : Methodology
So : Software
Va : Validation
Fo : Formal analysis
I : Investigation
R : Resources
D : Data Curation
W : Writing - Review

Conflict of Interest Statement

The authors declare no conflicts of interest.

Informed Consent

Written informed consent was obtained from all parents or guardians of children and teachers after providing a full explanation.

Ethical Approval

This activity was internally reviewed at the institutional level and was determined to be a minimal-risk community service activity that did not meet the requirements for ethical review according to Nusa Utara State Polytechnic policies. The activity did not involve any therapeutic interventions or invasive procedures. Stool examinations were performed during education, and parents helped to collect samples. Ethical considerations were met through informed consent, anonymizing joint observations, an informed right to withdraw, and consent from the PAUD principal. Obtaining formal ethical clearance was a limitation.

Data Availability

The data supporting the findings of this study are available from the corresponding author, [initials, DDP], upon reasonable request.

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