

Teacher modeling for waste disposal: Preschool behavioral development in Makassar and Gowa, Indonesia

Abd Majid HR Lagu¹, Muhammad Rusmin²

^{1,2} Department of Public Health, Faculty of Medicine and Health Sciences, Universitas Islam Negeri Alauddin Makassar, Makassar, Indonesia

ABSTRACT

Early childhood environmental interventions increasingly promote waste-disposal habits, yet limited community-based programs have combined teacher modeling, child-friendly waste infrastructure, and multidimensional behavioral assessment among preschool children. This community engagement program aimed to improve teachers' waste-disposal behavior and modeling capacity while strengthening preschool children's positive waste-disposal development in six kindergartens in Makassar and Gowa, South Sulawesi, Indonesia. A Participatory Action Research approach was applied through advocacy, focus group discussions, instrument assessment, enumerator training, baseline measurement, teacher-modeling training, school-based mentoring, post-intervention assessment, reflection, and program revision. Twelve teachers participated in the training, and each school received segregated waste bins for organic, inorganic, and hazardous waste with color-coded labels and visual illustrations. Teachers demonstrated significant improvements in modeling ability, knowledge, attitudes, and practices after the intervention, with all Wilcoxon signed-rank test results showing $p < 0.001$. Preschool children also showed significant improvements in cognitive, language, motor, social, and affective domains, with posttest scores exceeding pretest scores across all participating schools. The findings indicate that teacher modeling supported by accessible waste-disposal facilities can serve as a practical school-based environmental-health intervention for establishing positive habits during early childhood.

ABSTRAK

Intervensi lingkungan pada anak usia dini semakin menekankan pembentukan kebiasaan membuang sampah dengan benar. Namun, masih terbatas program berbasis masyarakat yang menggabungkan modeling oleh guru, penyediaan sarana persampahan yang ramah anak, dan penilaian perilaku multidimensional pada anak usia prasekolah. Program pengabdian masyarakat ini bertujuan untuk meningkatkan perilaku membuang sampah dan kemampuan modeling guru, sekaligus memperkuat perkembangan perilaku positif membuang sampah pada anak usia prasekolah di enam taman kanak-kanak di Makassar dan Gowa, Sulawesi Selatan, Indonesia. Pendekatan Participatory Action Research diterapkan melalui advokasi, focus group discussion, penilaian instrumen, pelatihan enumerator, pengukuran awal, pelatihan modeling guru, pendampingan berbasis sekolah, pengukuran pascaintervensi, refleksi, dan revisi program. Sebanyak 12 guru mengikuti pelatihan, dan setiap sekolah memperoleh tempat sampah terpilah untuk sampah organik, anorganik, dan bahan berbahaya dan beracun yang dilengkapi label berwarna serta ilustrasi visual. Guru menunjukkan peningkatan yang signifikan pada kemampuan modeling, pengetahuan, sikap, dan tindakan setelah intervensi, dengan seluruh hasil uji Wilcoxon signed-rank menunjukkan nilai $p < 0,001$. Anak usia prasekolah juga menunjukkan peningkatan yang signifikan pada domain kognitif, bahasa, motorik, sosial, dan afektif, dengan skor posttest yang lebih tinggi dibandingkan skor pretest di seluruh sekolah peserta. Temuan ini menunjukkan bahwa modeling oleh guru yang didukung oleh sarana persampahan yang mudah diakses dapat menjadi intervensi kesehatan lingkungan berbasis sekolah yang praktis untuk membentuk kebiasaan positif sejak usia dini.

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AUTHOR(S) INFO

Correspondence Email

abd.majid@uin-alauddin.ac.id

Address

Jl. Sultan Alauddin No.63, Romangpolong, Kec. Somba Opu,
Kabupaten Gowa, Sulawesi Selatan 92113, Indonesia



INTRODUCTION

Early childhood is a critical period for establishing daily habits, social behaviors, and long-term environmental responsibility. During the preschool years, particularly between the ages of 4 and 6 years, children are highly receptive to repetitive learning experiences that shape routine actions and influence later behavior. Introducing consistent practices, including correct waste disposal, sorting, and recycling, can establish habits that persist into later childhood and adulthood (Lee & Manfredi, 2021; Sihvonen et al., 2024). Play-based activities, nature-oriented learning, and classroom routines can help children internalize environmentally responsible actions as habitual responses rather than occasional deliberate decisions (Brinton et al., 2022).

Waste-disposal behavior is an essential component of early environmental education because it is closely related to personal hygiene, school cleanliness, disease prevention, and environmental sustainability. Teaching preschool children to dispose of and sort waste appropriately can reduce littering and encourage responsible participation in maintaining healthy surroundings (Pawenrusi et al., 2022). Structured activities, such as waste-sorting games, hands-on recycling, and the use of visual cues, can strengthen children's understanding of environmental responsibility and support the formation of automatic disposal routines (Brinton et al., 2022; Rosanti & Alviyani, 2023). Although effectiveness may be influenced by infrastructure, cultural context, family practices, and peer behavior, the preschool period remains a strategic opportunity to promote durable pro-environmental habits (Mazar et al., 2021; Pawenrusi et al., 2022).

Despite the importance of early habit formation, inappropriate waste-disposal behavior remains common when environmental education is not reinforced through consistent examples and accessible facilities. Knowledge alone may be insufficient because young children primarily learn through observation, imitation, repetition, and reinforcement. In preschool settings, teachers play a central role in shaping routines because they interact with children during daily activities and can consistently demonstrate correct waste disposal and sorting practices. Teacher-led modeling, supported by positive reinforcement and repeated practice, can help children develop automatic and socially responsible waste-management behavior (Nurjanah et al., 2025; Rulli et al., 2024).

Teacher modeling is appropriate for preschool education because children learn effectively by observing adults in their immediate environment. When teachers consistently demonstrate behaviors such as placing waste in designated bins, separating waste by type, and reusing materials, children are more likely to imitate these actions in the classroom and other settings. Integrating demonstrations into daily routines allows environmental education to become part of children's lived experience rather than a stand-alone lesson. Immediate feedback, verbal encouragement, and positive reinforcement can further strengthen children's motivation to repeat appropriate actions until they become stable habits (Buil et al., 2019; Li et al., 2024).

Teacher training should be complemented by child-friendly waste-management infrastructure to translate knowledge into consistent practice. Segregated waste bins, clear labels, visual symbols, and accessible placement can reduce cognitive barriers and help preschool children identify the correct disposal process independently. The physical environment functions as an instructional scaffold by connecting teachers' demonstrations with observable cues and predictable routines. When classroom activities incorporate simple disposal steps, verbal prompts, and repeated practice, children are more likely to transfer these behaviors from school to home and sustain them over time (Mostafa et al., 2023; Orbanić & Kovač, 2021). The integration of teacher training with accessible infrastructure is therefore a promising strategy for promoting long-term waste-management habits among preschool children (Buil et al., 2019; Schill et al., 2020).

Previous studies have emphasized environmental education, parental involvement, play-based learning, visual cues, and school infrastructure in shaping children's waste-management practices (Buil et al., 2019; Rosanti & Alviyani, 2023; Sihvonen et al., 2024). However, limited attention has been given to community-based interventions that position teachers as behavioral models while simultaneously providing segregated waste bins and evaluating children's development across multiple domains. This community engagement program addresses this gap by integrating teacher training, behavioral modeling, child-friendly infrastructure, and participatory evaluation. Its novelty lies

in applying a Participatory Action Research approach involving teachers, school principals, parents or guardians, and health experts throughout problem identification, planning, implementation, reflection, and revision. The program evaluated changes in children's waste-disposal behavior across cognitive, language, motor, social, and affective domains. Its objective was to strengthen appropriate waste-disposal behavior among preschool children through teacher training as a modeling intervention in six kindergartens in Makassar and Gowa, South Sulawesi, Indonesia.

METHODS

Study design and approach

This community engagement program applied a Participatory Action Research (PAR) approach with a one-group pretest–posttest design. PAR involved teachers, school principals, parents or guardians, and relevant experts in problem identification, intervention planning, implementation, evaluation, and revision. The intervention aimed to strengthen preschool children's waste-disposal behavior through teacher modeling and the provision of segregated waste bins.

Study period and setting

The program was implemented from August to November 2024 in six kindergartens in Makassar City and Gowa Regency, South Sulawesi, Indonesia: TK Islam Al Azhar, TK Nurul Fadhilah, TK Nur Inayah, TK Illiyyin Tompobalang, TK Aisyiyah I Sungguminasa, and TK Islam Cendekia Berseri. The schools were selected based on their willingness to participate in the intervention.

Participants and sampling technique

The program involved preschool children, teachers, school principals, parents or guardians, child-development experts, and environmental-health experts. A purposive sampling technique was used to select the participating schools. Twelve teachers participated as behavioral role models, while 103 preschool children aged 4-6 years completed the behavioral assessment.

Children were included if they were enrolled in one of the participating schools, attended the intervention activities, and received parental or guardian consent. Children who did not complete both the pretest and posttest assessments were excluded.

Participatory action research procedures

The PAR process consisted of five stages: problem identification, planning, implementation, reflection, and revision. Formal correspondence and advocacy were conducted to secure institutional support. A focus group discussion involving school representatives, parents or guardians, and experts was held to identify challenges and establish a shared understanding of early waste-disposal education.

Figure 1

School permits, training implementation, and interventions for students`



The planning stage included teacher-training materials, classroom modeling strategies, segregated waste bins, and assessment instruments. Teachers were trained to demonstrate correct waste disposal, explain waste categories, guide children in selecting appropriate bins, and provide positive reinforcement.

During implementation, teachers integrated demonstrations, repeated practice, verbal prompts, and supervised sorting into daily classroom activities. The intervention was monitored using observation checklists and teacher activity records. Reflection involved pretest and posttest assessments of children's cognitive, language, motor, social, and affective development, as well as teacher feedback. The intervention was then revised to improve instructional clarity, facility accessibility, and consistency of reinforcement (See [Figure 1](#)).

Data collection

Data were collected using structured observation instruments before and after the intervention. Children's waste-disposal behavior was assessed across cognitive, language, motor, social, and affective domains. Teacher outcomes included modeling ability, knowledge, attitudes, and practices. Implementation notes and teacher feedback were also documented.

Data analysis

Data were analyzed using IBM SPSS Statistics version 21. Descriptive statistics were presented as means, standard deviations, frequencies, and percentages. The Wilcoxon signed-rank test was used to compare teachers' pretest and posttest scores. Paired-samples *t*-tests were used to assess changes in children's developmental domains. Statistical significance was determined at $p < 0.05$.

Data presentation

Results were presented in tables showing pretest and posttest scores, standard deviations, test statistics, and *p*-values. Narrative descriptions were used to summarize the implementation process and PAR revisions.

Informed Consent

Permission was obtained from the participating schools before implementation. Parents or guardians were informed about the objectives, procedures, benefits, and voluntary nature of participation. Consent was obtained before children were included in the assessment, and participant confidentiality was maintained throughout the program.

RESULTS AND DISCUSSION

Implementation of the participatory action research intervention

The community engagement program applied a Participatory Action Research approach in six kindergartens in Makassar City and Gowa Regency, South Sulawesi, Indonesia. Conducted from August to November 2024, the program included advocacy, stakeholder consultation, instrument development, teacher training, school-based mentoring, and outcome evaluation.

Table 1
Distribution of preschool-aged children in each school

School	Boys, n (%)	Girls, n (%)	4 years, n (%)	5 years, n (%)	6 years, n (%)
TK Islam Al Azhar	7 (6.8)	11 (10.7)	0 (0.0)	16 (15.5)	2 (1.9)
TK Nurul Fadhillah	7 (6.8)	9 (8.7)	2 (1.9)	10 (9.7)	4 (3.9)
TK Nur Inayah	7 (6.8)	9 (8.7)	0 (0.0)	13 (12.6)	3 (2.9)
TK Illiyyin Tompobalang	8 (7.8)	9 (8.7)	1 (1.0)	10 (9.7)	6 (5.8)
TK Aisyiyah I Sungguminasa	11 (10.7)	11 (10.7)	0 (0.0)	14 (13.6)	8 (7.8)
TK Islam Cendekia Berseri	13 (12.6)	1 (1.0)	0 (0.0)	7 (6.8)	7 (6.8)
Total, N (%)	53 (51.5)	50 (48.5)	3 (2.9)	70 (68.0)	30 (29.1)

Advocacy activities were conducted from 26 to 30 August 2024 to secure institutional support and confirm each school's participation. A focus group discussion was held on 31 August 2024 at the Training Centre of UIN Alauddin Makassar. The discussion involved child-development experts, environmental-health experts, school principals, preschool teachers, and parents or guardians. It established a shared understanding of early waste-disposal education and generated instruments for assessing school infrastructure, teacher behavior, modeling practices, classroom conditions, and children's development.

The instruments were reviewed by experts from 2 to 6 September 2024. Twelve enumerators were trained on 7 September, and baseline assessments were conducted from 9 to 13 September. Teacher-modeling training was held on 14 September for 12 teachers from six schools involving 103 preschool children aged 4–6 years (See [Table 1](#)). School-based mentoring followed from 16 September to 25 October, while post-intervention assessments were conducted from 28 to 31 October 2024.

Each school received two sets of segregated waste bins for organic, inorganic, and hazardous waste. The bins used green, yellow, and red colors, respectively, with labels and illustrations to support children who had not yet developed fluent reading skills. These bins functioned as instructional tools that reinforced teacher demonstrations, verbal prompts, supervision, and positive feedback.

Visual cues such as colors, pictures, and symbols can reduce the cognitive demands of waste sorting and support faster recognition of appropriate disposal locations. When aligned with teacher instructions, the physical environment supports observation, imitation, and routine formation ([Rahman et al., 2021](#); [You et al., 2023](#)). Child-friendly infrastructure, repeated demonstrations, and accessible placement can strengthen independent waste sorting among preschool children ([Broström & Frøkjær, 2019](#); [Orbanić & Kovač, 2021](#)).

The PAR approach strengthened the intervention by combining stakeholder participation, teacher capacity building, environmental modification, and behavioral reinforcement. Its public-health relevance lies in supporting cleaner classrooms, improved hygiene, reduced environmental contamination, and early environmental responsibility. Establishing these habits during preschool may contribute to longer-term environmental stewardship ([Lee & Manfredi, 2021](#); [Sihvonen et al., 2024](#)).

Changes in teachers' modeling ability, knowledge, attitudes, and practices

The teacher-training intervention significantly improved all measured teacher-level outcomes. [Table 2](#) illustrates that the modeling ability increased from 13.08 (SD = 1.00) to 17.33 (SD = 0.78), knowledge increased from 8.17 (SD = 1.19) to 10.58 (SD = 0.51), attitudes increased from 35.92 (SD = 1.08) to 39.83 (SD = 1.39), and practices increased from 7.17 (SD = 0.94) to 9.67 (SD = 0.49). Wilcoxon signed-rank tests showed statistically significant differences between pretest and posttest scores for all variables ($p < 0.001$) (See also [Figure 2](#)).

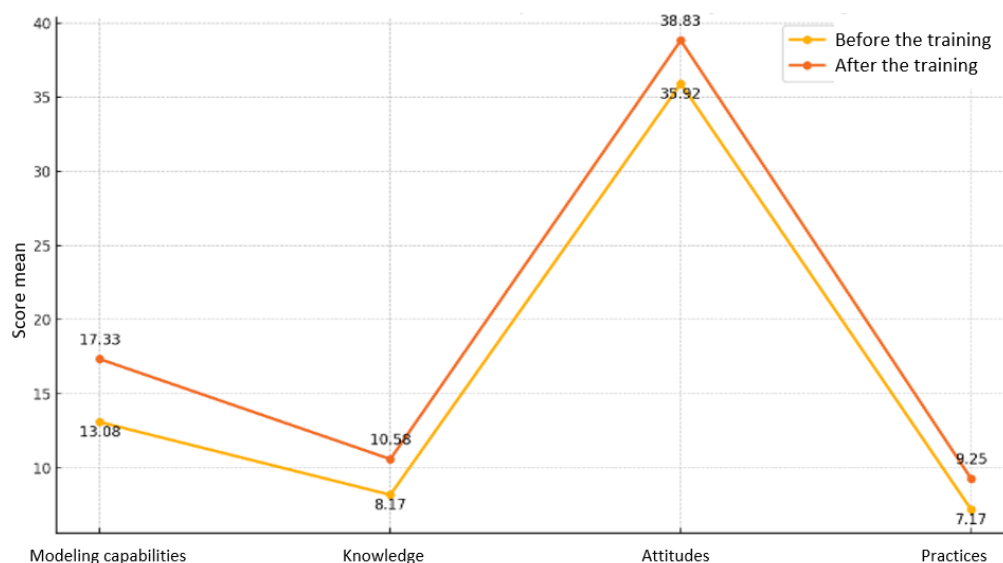
Table 2
Changes in teachers' waste-disposal modeling ability, knowledge, attitudes, and practices

Variable	Pretest, mean (SD)	Posttest, mean (SD)	p-value
Modeling ability	13.08 (1.00)	17.33 (0.78)	< 0.001
Knowledge	8.17 (1.19)	10.58 (0.51)	< 0.001
Attitudes	35.92 (1.08)	39.83 (1.39)	< 0.001
Practices	7.17 (0.94)	9.67 (0.49)	< 0.001

These improvements are important because preschool children learn through observation, imitation, repetition, and reinforcement. Teachers act as visible role models whose actions shape classroom norms. Consistent demonstrations of correct waste disposal, combined with verbal instructions and positive feedback, can help children develop automatic routines rather than behaviors that depend solely on reminders ([You et al., 2023](#); [Poague et al., 2023](#)).

Figure 2

Teachers' modeling behaviors and skills before and after training



The consistency between teachers' explanations and observable practices is particularly important. When teachers both explain and demonstrate correct waste sorting, children receive clear behavioral cues, reducing confusion and strengthening classroom expectations (You et al., 2023; Nurjanah et al., 2025; Indumathi & Komalavalli, 2022). These findings support previous studies showing that educators can integrate waste disposal, sorting, reuse, and cleanliness into daily routines, transforming environmental education into repeated practice (Broström & Frøkjær, 2019; Buil et al., 2019).

The findings also indicate that teacher training should address multiple dimensions simultaneously. Knowledge and attitudes alone may not lead to behavioral change unless teachers demonstrate appropriate practices and have access to suitable facilities. School-based mentoring strengthened the intervention by supporting repeated application in real classroom settings. Sustained implementation therefore requires continued support from school principals, accessible waste-disposal facilities, periodic reinforcement, and collaboration with parents or guardians to promote consistent practices at school and home (Buil et al., 2019; Sihvonen et al., 2024).

Changes in preschool children's waste-disposal behavior

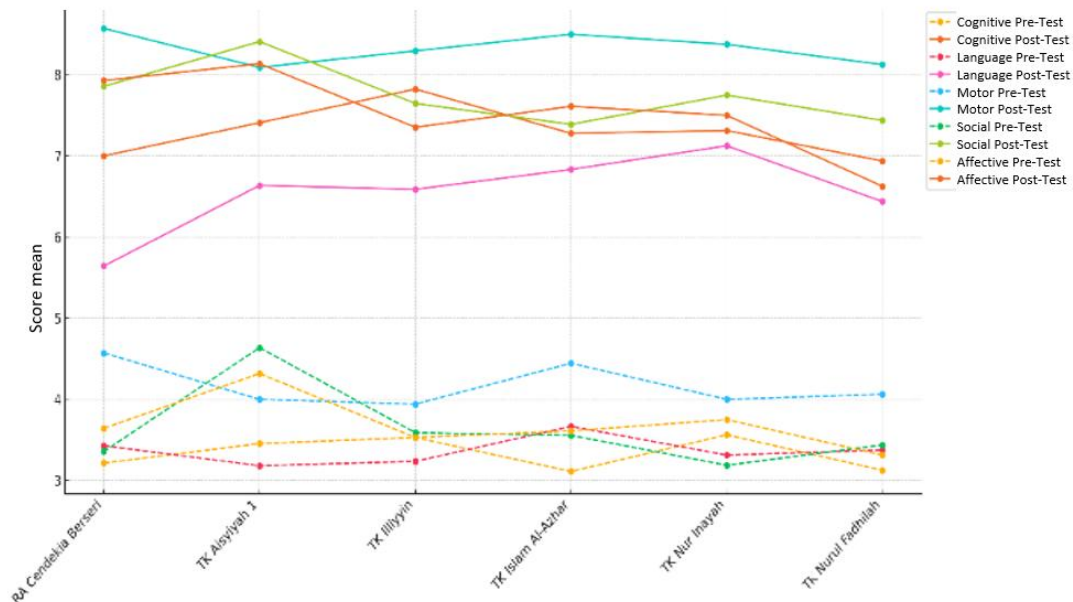
Figure 3 shows that all variables exhibited an increase in average scores from the pre-test to the post-test. This indicates the success of the intervention in improving the children's abilities across various aspects of development. As shown in the diagram, variables such as Motor Skills and Social Skills appear to have shown a relatively greater increase compared to other variables. This may indicate that the intervention

The intervention improved preschool children's waste-disposal behavior across cognitive, language, motor, social, and affective domains. Posttest scores were higher than pretest scores in all participating schools, and Wilcoxon signed-rank tests showed statistically significant differences across all domains ($p < 0.05$). The cognitive domain reflected children's understanding of waste categories and disposal locations. The language domain assessed their ability to recognize and respond to waste-related instructions. The motor domain reflected their ability to place waste in designated bins. The social domain assessed cooperation and participation, while the affective domain reflected motivation and willingness to maintain cleanliness.

The magnitude of improvement varied between schools, potentially due to differences in classroom routines, reinforcement intensity, mentoring frequency, and children's baseline

characteristics. However, the overall pattern remained consistent. Motor and social outcomes appeared to improve more substantially, likely because the intervention emphasized hands-on practice, repeated actions, peer observation, and shared classroom routines.

Figure 3
Pre- and post-test on children's behavior by school



The findings indicate that waste-disposal activities can support multidimensional development. Sorting waste requires children to identify objects, classify them, and select appropriate bins, thereby strengthening problem-solving and decision-making skills (Aadland et al., 2020). Language development is reinforced when children identify waste categories, follow instructions, and communicate with teachers and peers (Gibb et al., 2021). Repeated sorting also promotes fine motor coordination through grasping, carrying, and placing objects in designated bins (Aadland et al., 2020; Olive et al., 2024).

The intervention also strengthened social and affective development. Shared classroom routines encouraged cooperation, peer modeling, and collective responsibility for cleanliness. Positive reinforcement from teachers supported motivation, confidence, and pride in environmentally responsible behavior (Gibb et al., 2021).

The principal contribution of this program lies in combining teacher training, behavioral modeling, mentoring, and child-friendly waste-disposal infrastructure. Color-coded bins and illustrated waste categories reduced reliance on reading ability and helped children translate instructions into action. These findings support the integration of waste-management education into preschool health-promotion programs rather than treating it as an isolated educational message (Brinton et al., 2022; Herdiansyah et al., 2021; Pawenrusi et al., 2022).

The findings should be interpreted cautiously because the intervention involved only six kindergartens, did not include a comparison group, and assessed short-term changes. Future studies should include larger samples, longer follow-up periods, comparison groups, and direct measurement of behavioral transfer from school to home. Strengthening parental involvement may also support the sustainability of waste-disposal habits across settings.

CONCLUSION

The teacher-modeling intervention significantly improved teachers' waste-disposal behavior and their ability to demonstrate appropriate waste-disposal practices in preschool settings. Following

the training and school-based mentoring activities, teachers showed significant improvements in modeling ability, knowledge, attitudes, and practices related to waste disposal. These findings indicate that teachers can serve as effective behavioral role models when they receive structured training, practical guidance, and appropriate environmental support.

The intervention was also associated with positive development in preschool children's waste-disposal behavior across cognitive, language, motor, social, and affective domains in the six participating schools. The use of repeated teacher demonstrations, verbal instructions, positive reinforcement, and child-friendly segregated waste bins helped children recognize waste categories, practice correct disposal, participate in shared classroom routines, and develop positive attitudes toward cleanliness and environmental responsibility.

This program demonstrates that waste-disposal education can function as both an environmental-health intervention and an early childhood development strategy. Its contribution lies in integrating teacher capacity building, behavioral modeling, participatory school engagement, and accessible waste-management infrastructure within a single intervention. The approach may be adapted for broader implementation in preschool institutions, particularly in communities where early environmental-health education remains limited. Future interventions should also strengthen parental involvement and evaluate whether habits developed at school are transferred to the home environment and maintained over time.

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AUTHORS' INFORMATION

Abd Majid HR Lagu is a senior lecturer and head of department in the Department of Public Health, Faculty of Medicine and Health Sciences, Universitas Islam Negeri Alauddin Makassar, Makassar, Indonesia. Muhammad Rusmin is a senior lecturer in the Department of Public Health, Faculty of Medicine and Health Sciences, Universitas Islam Negeri Alauddin Makassar, Makassar, Indonesia.

AUTHORS' CONTRIBUTION

Abd Majid HR Lagu contributed to the conceptualization of the study, methodology development, data interpretation, and manuscript preparation. Muhammad Rusmin contributed to data analysis, literature review, and critical revision of the manuscript. Both authors reviewed and approved the final version of the manuscript.

COMPETING INTEREST

The author(s) declare no potential conflict of interest with respect to the research, authorship, or publication

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