



EFFECTIVENESS OF EDUCATIONAL INTERVENTION ON DEVELOPMENTAL RISK MITIGATION STRATEGIES IN TODDLERS USING THE DENVER DEVELOPMENTAL SCREENING TEST

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ABSTRACT

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Early childhood development is crucial for a child's future. Developmental delays can have long-lasting consequences, emphasizing the importance of early detection and intervention. This study aimed to enhance caregivers' knowledge and skills using the Denver Developmental Screening Test (DDST) to identify potential developmental delays in toddlers in Sleman, Yogyakarta. A quasi-experimental design was applied with a pre-test and post-test to evaluate changes in caregivers' knowledge across key areas, including a basic understanding of DDST, its purpose and function, timing and method of administration, and strategies for mitigating developmental risks. Data were collected through a structured knowledge-based questionnaire measuring caregivers' familiarity with these domains before and after an educational intervention. The Wilcoxon Signed-Rank Test revealed a significant increase in caregivers' knowledge scores post-intervention, particularly in understanding the purpose, function, and practical application of DDST ($p = 0.046$). Moreover, caregivers reported increased confidence in using the DDST to monitor their child's development. These findings highlight the effectiveness of educational interventions in improving caregivers' knowledge and skills in using the DDST. However, further research is needed to explore the long-term impact of such interventions and examine the findings' generalizability to other settings.

Keywords:

Caregivers' knowledge, Denver developmental screening test, Developmental delays, Early childhood development, Educational intervention

BACKGROUND

Developmental delays in young children are a significant public health issue that can impact various domains of growth, including physical, social, and cognitive development (Olusanya et al., 2018; Zablotzky et al., 2019). Studies have highlighted that prevalence of developmental delays in Indonesia remains relatively high, especially in language and fine motor skills, which can impact children's future learning and adaptation skills (Widyawati et al., 2021; Meylia et al., 2022). Early detection and intervention are essential not only to prevent long-term negative impacts but also to promote children's overall well-being and development (Lucas et al., 2018).

The Denver Developmental Screening Test (DDST) has been identified as a robust screening tool for detecting potential developmental delays, with high sensitivity and specificity that make it particularly useful in community settings (Faruk et al., 2020; Kumar & Subashini, 2024). However, its use in community settings, especially at village level, needs to be revised. However, its use in community settings, especially at village level, needs to be revised. One of key challenges is that many caregivers, primarily mothers, have limited knowledge and training in utilizing and interpreting DDST results, often due to a lack of accessible training resources and the relatively complex scoring system of the tool (Kim, 2022; Metwally et al., 2023). While other screening instruments are available, DDST's higher accuracy for early detection provides an essential advantage, emphasizing the need to enhance caregiver training specifically for DDST.

In Kwadungan, Widodomartani, Kecamatan Ngemplak, Kabupaten Sleman, and Yogyakarta, as in many other regions, early detection of developmental delays remains a community concern. Despite this need, reports from community health initiatives indicate that DDST usage at the village level is under 30%, showing a substantial gap in implementation and awareness. Caregivers, particularly non-health workers, often face challenges in correctly applying DDST without proper guidance and tools, further limiting early intervention efforts. Caregivers, as the closest figures to the child, play a critical role in identifying early signs of developmental delays and supporting timely interventions. Improving caregivers' knowledge and skills in DDST application not only aids in preventing severe developmental impacts but also fosters a proactive approach to nurturing children's optimal growth and potential (Ayob et al., 2021).

METHODS

This study used a quasi-experimental research design with a pre-test and post-test setup within an intervention group. A quasi-experimental approach was chosen to evaluate the effectiveness of educational interventions in a real-world setting where randomization was not feasible. This design allowed for the assessment of the educational intervention's impact on caregivers' knowledge for mitigating developmental risks in toddlers using the Denver Developmental Screening Test (DDST). The study was conducted in Kwadungan hamlet, Widodomartani, Ngemplak, Sleman, and Yogyakarta from April to September 2024, involving 17 caregiver respondents. The independent variable was the educational intervention focusing on developmental risk mitigation strategies using DDST. In contrast, the dependent variable was the caregivers' knowledge level, assessed by their knowledge of developmental risk mitigation strategies before and after the intervention.

The intervention comprised four structured workshops conducted bi-weekly over one month. Each two-hour session involved lectures, interactive discussions, and practical demonstrations. Caregivers were introduced to fundamental concepts of the DDST, including its purpose, methodology, and the importance of early detection of developmental delays. To reinforce practical skills, participants engaged in hands-on activities to become familiar with the DDST assessment tools and strategies for supporting toddler development (Diagram 1).

Follow-up sessions included group discussions, enabling caregivers to share insights and reflect on their experiences applying the knowledge gained during the workshops. These follow-ups also allowed caregivers to seek clarification on developmental risk mitigation strategies. A post-test was administered at the end of the intervention to evaluate changes in caregiver knowledge levels. Caregivers were encouraged to stay engaged through interactive discussions and personalized feedback during each session to enhance participant retention.

The caregiver knowledge assessment on DDST, covering four main variables-Basic Knowledge of DDST, Purpose and Function of DDST, Timing and Method of DDST, and Developmental Risk Mitigation Strategies-was designed with specific sub-indicators to evaluate caregivers' understanding comprehensively (Table 1). Each item was rated on a 3-point Likert scale: a correct answer scored 2, a partially correct answer scored 1, and an incorrect answer scored 0. The total score was calculated by

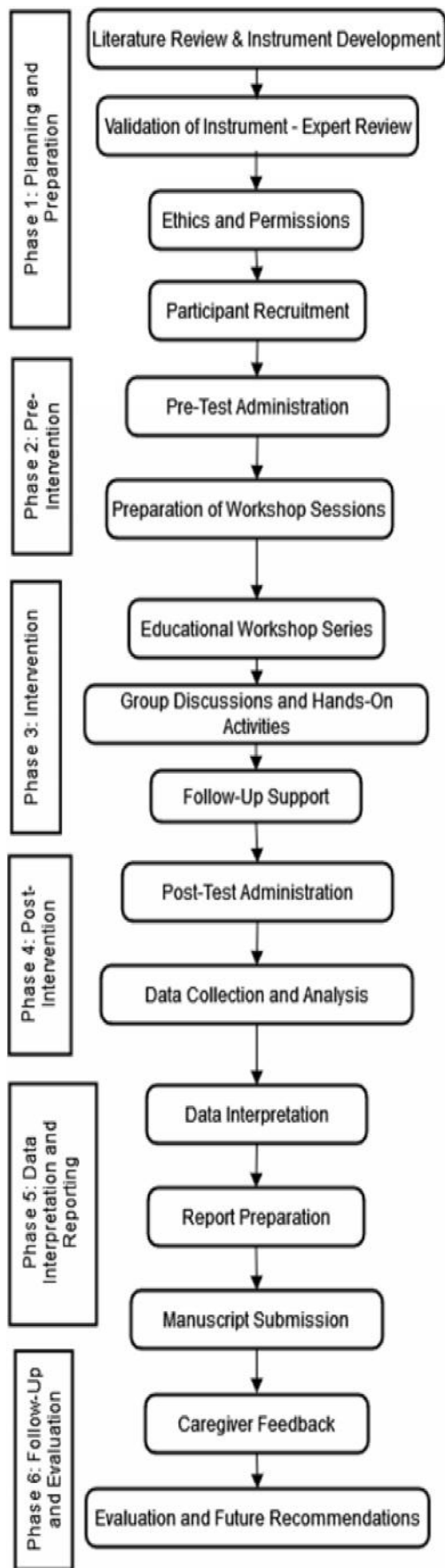


Diagram 1. Flowchart of Research Procedure

summing all item scores per variable, with the results categorized into Poor (0-33% of the maximum score), Fair (34-66%), and Good (67-100%) knowledge levels.

This instrument underwent expert validation involving a panel of child development and psychology specialists who evaluated each item for relevance and clarity. The Content Validity Index (CVI) was calculated to ensure each item's appropriateness, achieving an average CVI score of 0.83, indicating strong content validity. This validation process assures the instrument's robustness and accuracy in measuring caregiver knowledge on developmental risk mitigation for toddlers using DDST.

Descriptive analysis will include calculating frequencies and percentages for caregiver demographics and knowledge levels before and after the educational intervention. This method provides an overview of the participants' characteristics, such as age, gender, education, and occupation. It allows for a comprehensive understanding of the baseline knowledge levels of caregivers regarding the DDST. The results will be visually represented through tables, highlighting the percentage of caregivers who fall into categories of knowledge (Poor, Fair, and Good), thereby illustrating the distribution of knowledge across the study population.

For hypothesis testing, the Wilcoxon Signed-Rank Test will be utilized to assess the effectiveness of the educational intervention on caregiver knowledge regarding DDST. This non-parametric test is appropriate given the small sample size and the ordinal nature of the knowledge scores derived from the Likert scale. The null hypothesis posits no difference in caregiver knowledge before and after the intervention, while the alternative theory suggests that the intervention significantly improved knowledge levels. A p-value of less than 0.05 will indicate statistical significance, suggesting that the intervention had a meaningful impact on enhancing caregivers' understanding of developmental risk mitigation strategies using the DDST.

RESULTS

The results of this study illustrate the impact of an educational intervention on caregivers' knowledge regarding developmental risk mitigation strategies for toddlers, as assessed through pre-test and post-test measures. Using the Denver Developmental Screening Test (DDST) as a core tool, the analysis highlights notable improvements in caregivers' understanding across key domains, including the pur-

Table 1. Caregiver Knowledge Instrument on DDST

Variable	Sub Variable	Answer Scoring		
		Correct	Partially Correct	Incorrect
Basic Knowledge of DDST	Definition of Denver Developmental Screening Test (DDST)	2	1	0
	Importance of developmental screening for children	2	1	0
	General structure and components of DDST	2	1	0
	Age range applicable for DDST testing	2	1	0
	Key developmental domains assessed in DDST (e.g., social, motor, language, and adaptive skills)	2	1	0
Purpose and Function of DDST	Understanding of DDST's role in identifying developmental delays	2	1	0
	Ability to interpret DDST results	2	1	0
	Recognizing the significance of early detection of developmental issues	2	1	0
	Knowledge of how DDST helps guide interventions for developmental delays	2	1	0
	Awareness of potential outcomes of DDST (e.g., pass, caution, delay)	2	1	0
Timing and Method of DDST	Optimal timing and frequency of administering DDST	2	1	0
	Correct procedures for conducting DDST	2	1	0
	Handling and interpretation of results by caregivers	2	1	0
	Awareness of materials required to conduct DDST	2	1	0
	Knowing how to prepare a child for the DDST assessment	2	1	0
Developmental Risk Mitigation Strategies	Recognizing early signs of developmental risks	2	1	0
	Understanding common developmental delays and potential interventions	2	1	0
	Knowledge of lifestyle adjustments to support healthy child development	2	1	0
	Awareness of resources for further developmental assessment and support	2	1	0
	Strategies for communicating DDST results and necessary actions to caregiver	2	1	0

pose, timing, and methods associated with administering the DDST. Visual representation of these pre- and post-test differences (see Table 4) reveals a statistically significant increase in knowledge, underscoring the efficacy of targeted educational interventions in enhancing caregivers' capacity to support early childhood developmental health.

Table 1 provides an overview of the demographic characteristics of caregivers and toddlers who participated in the study. Caregiver demographics include age, gender, educational background, occupa-

tion, and socioeconomic status, while toddler demographics cover age and gender distribution. The majority of caregivers were aged 31-40 years (47.1%), predominantly female (94.1%), with a high school education (53.0%), and primarily homemakers (70.6%). The majority reported a middle socioeconomic status (47.1%). The toddler age group was mainly 2-3 years old (41.2%), with a slight majority of female participants (58.8%). Analysis of demographic factors, such as caregiver education level and age, did not reveal any significant variation in out-

Table 2. Demographic Data of Caregivers and Toddlers

Variable	Frequency (f)	Percentage (%)
Caregiver's Age		
20-30 years	5	29.4
31-40 years	8	47.1
41-50 years	3	17.6
>50 years	1	5.9
Caregiver's Gender		
Female	16	94.1
Male	1	5.9
Highest Education Level		
Middle School	4	23.5
High School	9	53
College	4	23.5
Caregiver's Occupation		
Housewife	12	70.6
Private Sector Worker	3	17.6
Entrepreneur	2	11.8
Economic Status		
Lower Middle	4	23.5
Middle	8	47.1
Upper Middle	5	29.4
Toddler's Age		
0-1 year	4	23.5
2-3 years	7	41.2
4-5 years	6	35.3
Toddler's Gender		
Female	10	58.8
Male	7	41.2

Table 3. DDST Results for Toddlers

Developmental Domain	Normal (f/%)
Gross Motor Development	17 (100%)
Fine Motor Development	16 (94.1%)
Language Development	17 (100%)
Social-Personal Development	17 (100%)

Table 4. Comparison of Caregiver Knowledge Levels on DDST Before and After Intervention

Caregiver Knowledge of DDST	Before				After				P Value
	Fair		Good		Fair		Good		
	f	%	f	%	f	%	f	%	
Knowledge Total	7	39.7	10	60.3	3	14.7	15	85.3	0.046*
1. Basic Knowledge	8	47.1	9	52.9	3	17.6	14	82.4	
2. Purpose and Function	9	52.9	8	47.1	2	11.8	15	88.2	
3. Timing and Method	7	41.2	10	58.8	4	23.5	13	76.5	
4. Developmental Risk Mitigation Strategies	3	17.6	14	82.4	1	5.9	16	94.1	

*) Wilcoxon Signed-Rank Test

comes, suggesting that the intervention's impact on knowledge was broadly effective across these groups.

The Denver Developmental Screening Test (DDST) results indicate that nearly all toddlers achieved normal developmental milestones across the assessed domains, with 100% of toddlers demonstrating normal development in gross motor, language, and social-personal skills. Notably, a slightly lower percentage (94.1%) achieved normal development in fine motor skills, though this percentage still reflects a strong developmental baseline. "Normal" in this context indicates that toddlers met developmental expectations for their age range based on standardized DDST criteria, suggesting that caregivers are effectively supporting general developmental health.

Table 4 compares caregivers' knowledge levels regarding the Denver Developmental Screening Test (DDST) before and after the intervention. The data reveal marked improvements across all domains assessed. For instance, in the category of basic knowledge about DDST, the proportion of caregivers with "Good" knowledge increased from 52.9% to 82.4% following the intervention, with a p-value of 0.046, signifying statistical significance ($p < 0.05$). This trend holds across additional domains, such as purpose and function, timing and methods, and developmental risk mitigation strategies, collectively reinforcing the intervention's effectiveness. While this quantitative analysis highlights these knowledge gains, qualitative feedback from caregivers—such as increased confidence in using DDST and recognizing early developmental signs—further supports the value of the educational program.

DISCUSSION

The findings from this study highlight the significant role of educational interventions in improving caregivers' knowledge of developmental risk mitigation strategies for toddlers, specifically using the Denver Developmental Screening Test (DDST) as a foundational tool. Previous research has underscored the necessity of such interventions, with several studies reporting similar findings on the effectiveness of caregiver education in promoting early developmental monitoring (Scharf et al., 2016; Choo et al., 2019). For instance, a study emphasized that caregivers with adequate knowledge regarding developmental assessments are more likely to proactively monitor their children's growth, leading to earlier identification of developmental delays (Lipkin et al., 2020b; Gmmash and Faquih, 2022). This study aligns with similar research by others, who found that educational inter-

ventions significantly improve caregivers' ability to monitor developmental progress (Chi et al., 2016; Arikpo et al., 2018). The alignment of this study with existing literature reinforces the critical need for educational programs to empower caregivers to support their toddlers' developmental health effectively.

Moreover, the results of this study are particularly pertinent in light of recent trends in early childhood education and developmental screening practices. The American Academy of Pediatrics recommends routine developmental screening at specific intervals, enhancing early identification and intervention for developmental delays (Barger et al., 2018; Lipkin et al., 2020a). By utilizing the DDST, caregivers in this study improved their theoretical understanding and gained practical skills in identifying developmental milestones. This dual focus on knowledge acquisition and practical application is crucial, as highlighted by recent literature indicating that effective intervention strategies must combine both theoretical and experiential learning to promote long-term retention of knowledge (Khalil and Elkhider, 2016; Darling-Hammond et al., 2020; Widaryanti et al., 2024).

One key factor that made this intervention particularly successful was its focus on both knowledge and skills development. Unlike many traditional interventions primarily focusing on theoretical knowledge, this program incorporated hands-on training, enabling caregivers to directly apply the DDST in assessing developmental milestones. Additionally, the demographic profile of caregivers in this study provides valuable insights into the broader context of early childhood development. The predominance of younger caregivers, primarily female and with a high school education, aligns with demographic trends observed in other studies focused on caregiver populations. Other research suggests that younger caregivers, while often more engaged, may also require additional support and resources to navigate developmental screening processes (Salomone et al., 2019; D'Amen et al., 2021). This finding emphasizes the need for tailored educational interventions that consider the specific characteristics and needs of the target population. By addressing these nuances, educational programs can better equip caregivers to implement developmental risk mitigation strategies effectively.

Furthermore, the substantial improvements observed in caregiver knowledge levels post-intervention underscore the necessity for ongoing educational initiatives. As the data in Table 4 indicates, caregivers' understanding of DDST concepts and their application in mitigating developmental risks signifi-

cantly increased after the intervention. This is consistent with findings from other studies that demonstrate the effectiveness of targeted educational programs in fostering knowledge retention among caregivers (Salazar et al., 2016; Kemmis-Riggs et al., 2018; Lotty et al., 2020). Specific factors contributing to this intervention's success included interactive teaching methods and follow-up support, which enhanced caregivers' engagement and understanding. The shift from "Fair" to "Good" knowledge among caregivers signifies an increase in confidence and a greater capacity to engage in informed discussions with healthcare providers regarding their children's developmental health. Unexpected challenges included logistical issues related to participant availability and varying baseline knowledge levels, addressed through flexible scheduling and customized educational materials.

Lastly, the implications of these findings extend beyond the immediate study population. The success of this educational intervention suggests a model that can be replicated in various community settings, particularly in underserved areas where caregivers may have limited access to developmental health resources. Future research should focus on long-term outcomes associated with caregiver education, exploring how improved knowledge translates into practical actions that promote healthier developmental trajectories for toddlers. As highlighted by recent systematic reviews, integrating community-based educational interventions into standard pediatric care could significantly enhance the early identification and management of developmental delays (Burkhart et al., 2020; Faruk et al., 2020; Nickel and Von Dem Knesebeck, 2020; Nahmias et al., 2019). While this study provides valuable insights into the effectiveness of educational interventions in improving caregivers' knowledge of the DDST, it is important to acknowledge several limitations. The small sample size and the focus on a single village may limit the generalizability of the findings. Additionally, more than the relatively short duration of the intervention may be required to assess long-term changes in caregivers' practices. Future research with larger sample sizes and extended follow-up periods is needed to confirm these findings and explore the potential for scaling up this intervention. Unexpected challenges during the intervention included caregiver availability and engagement, as some caregivers had difficulty attending all sessions due to work or family commitments. However, flexible session schedules and local community-based delivery mitigated these issues.

CONCLUSION

In summary, this study's outcomes emphasize the critical role of educational interventions in improving caregivers' knowledge of developmental risk mitigation strategies using the DDST. These findings contribute to the existing body of literature by addressing the gap in caregiver education on developmental milestones and screening methods and pave the way for future research and the development of comprehensive community-based educational programs. Future research should focus on the long-term impacts of such educational interventions, exploring how sustained caregiver knowledge translates to better developmental outcomes for children and assessing the scalability of these programs across diverse communities. By prioritizing caregiver education, we can foster a more informed and proactive approach to early childhood development, ultimately leading to better health outcomes for children.

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