

SPEECH DELAY AND EXCESSIVE GADGET USAGE: UNDERSTANDING PATHOPHYSIOLOGY MECHANISM AND PREVENTION TARGET AMONG CHILDREN POPULATION

Jopi Chandra Sindhutomo

General Practitioner, Panti Nugroho Purbalingga General Hospital, Indonesia

Email: jopichandrasindhutomo@gmail.com

ABSTRACT

In this state of modern era, usage of electronic gadget has increased excessively with the last ten years. Usage of devices has increased especially among children and adolescent population as a form for information display, education, and entertainment. Problems that arise of electronic gadget usage among children and adolescent population is excessive usage, which defined as usage of gadget over two hours per day. The huge pitfall of this phenomenon is the increasing incident of developmental delay within children population, specifically speech delay. Speech delay development found to be high prevalent in children under five years old, and there are several studies that have discussed correlation between speech delay and excessive usage of gadget. These studies have found that speech delay that led by excessive usage of gadget could occur due to understimulation of certain brain regions that involved in words sensory and recognition, and speech motoric ability, especially during neurodevelopmental period. Understanding of pathophysiology mechanism between speech delay and excessive gadget usage is important for every healthcare provider to educate family and creating preventive strategies from individual, family, and community aspect.

KEYWORDS *Gadget Usage, Speech Delay, Children, Pathophysiology, Prevention*



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INTRODUCTION

The widespread integration of electronic gadgets into the lives of children has sparked considerable interest and concern among parents, educators, and researchers alike. From smartphones and tablets to gaming consoles and wearable devices, the array of technological tools available to children is vast and continuously evolving (Liza et al., 2023). A data in 2018 displays that globally over 95% children have their own smartphone within their first decade of their life and this number is increased by 22% since 2014 (Anderson & Jiang, 2018). Another study also stated that 95.9% preschool children use digital device, with the most

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device being used is smartphone. This trend is happening influenced by huge factor within parents that allow their children to use these devices (Nathan et al., 2022).

With the widespread availability and usage of gadgets such as smartphones and tablets, there's a growing association between excessive screen time and speech delay in young children. Excessive usage of gadget is clearly defined as a usage of electronic device that is over two hours per day (Tsang et al., 2023). Trend of excessive gadget usage is also increasing, especially within the COVID-19 pandemic era. Studies have shown that over 60% of children and adolescents spent more than two hours watching television within a day. Another study in Australia found out that 87% of children used a screen-based media for over two hours on a daily basis. In America, there are studies that have reported that average time spent per day by children on screen-based media is 6.43 hours, which around three times over the limit of allocated screen time per day (Houghton et al., 2015). As these gadgets become increasingly ubiquitous in everyday life, questions arise regarding their impact on various aspects of child development, where one of it is speech development. Speech delay is defined as a condition where a child's language development lags behind their peers according to the age development milestone (Kumar et al., 2022). Speech delay has become a growing concern in today's digital age with development of gadgets usage among children. The allure of screens often competes with traditional forms of communication and interaction, potentially hindering the natural progression of language acquisition due to lack of adequate stimulus that couldn't be achieved by gadget usage (Nugraha et al., 2019; Putra et al., 2022). Understanding the nuanced relationship between gadget usage and speech delay is crucial for parents, educators, and healthcare professionals in order to promote healthy developmental milestones in children. This paper aims to explain the further mechanism of gadget usage and speech delay and discussing further preventive program of this situation among children.

RESEARCH METHOD

This study is using literature review method. Writer analysed the pathophysiology mechanism that is correlated between speech delay and excessive gadget usage among children population. Further analysis and data material used for discussion material acquired from journals of previous study of researches and reports that has been published in indexed scientific journal. There are journals that were obtained and screened for this study as main data of discussion in this article. Keywords that are used in this literature searching are speech delay, gadget usage, pathophysiology, and prevention.

RESULT AND DISCUSSION

Excessive Gadget Usage as Risk Factor of Speech Delay

There are several studies that have explained correlation between speech delay and excessive gadget usage. Within five years, these studies have proved that excessive gadget usage will increase the risk of speech delay incidents to occur among children. Usage of screen time over two hours, early possession of electronical devices, and constant exposure of screen-based media lead to higher risk and higher incidence of expressive speech delay problems. The result of the studies could be seen in Table 1.

Author (Year)	Study Design	Sample	Result
(Dewi et al., 2023)	Cross-Sectional	167 children within age 1-2 years old	Average age of introduction to screen-based media 9.84±4.04 months old. Screen time that is exceeding two hours per day were associated with speech delay (OR 6.15; 95%CI 2.84-13.30; p<0.001)
(Ramelan et al., 2019)	Cross-Sectional	100 parents who have young children	60% of parents do not accompany their children during gadget usage. 70% of the children use their gadget every day. 47% of the children has medium intensity of gadget usage and 36% has high intensity of gadget usage. Intensity of gadget usage has linear correlation with expressive speech problem among children (p<0.0001)
(Varadarajan et al., 2021)	Population-based Cross-Sectional	718 children within age range under 5 years old.	Average screen time found to be 2.39±2.18 hours per day and prevalence of excessive screen time found to be at 73% in total population of research. Excessive screen time associated with language delay in children aged >2 years old (AOR=52.92; 95%CI 12.33-227.21, p<0.001) and children aged <2 years old (AOR=20.93; 95%CI 2.68-163.32, p<0.01).
(Al Hosani et al., 2023)	Case-Control	454 children aged 12-48 months, with 227 children with	There are several factors that associated with speech delay development among children. Excessive device usage (OR

Author (Year)	Study Design	Sample	Result
		language delay and 227 normal children.	6.82; 95%CI 4.09-11.40; p<0.001), early onset of device usage <24 months (OR 8.22; 95%CI 1.71-39.55; p=0.009), and watching television 3 to 4 hours per day (OR 3.21; 95%CI 1.66-6.17; p<0.001)
(Dy et al., 2023)	Cross-Sectional	419 children within age range 24-36 months old	Duration of screen time that is over two hours per day related with the poorer outcome of speech and language development in receptive aspect and expressive aspect (p<0.001). This odd increase when children watch media content alone compared to with a parent or other children.

Pathophysiology Pathway of Speech Delay and Excessive Gadget Usage

There are several studies that have explored the correlation of speech delay that led by excessive gadget usage. A very distinct approach to understand the pathophysiology is through neurophysiology aspect. In early childhood stage of development, neurodevelopment plays a crucial role in building cognitive abilities, where one of it was speech and language ability. During this period, neuron has the highest ability of plasticity, differentiation, neurogenesis, and development of certain areas of brain. These areas will be developed and differentiated properly through adequate stimulus. Adequate stimulus is acquired from reading, interactive talking, direct listening, and words learning that is directly imposed toward the children from the environment. An adequate stimulus that leads to adequate development builds word processing, phonology understanding, sentence building, grammatical skills, and vocabulary growth, which in the end leads to proper expressive speech development (Huber et al., 2023; Huberty et al., 2023; Olulade et al., 2020).

Excessive gadget usage can lead to diminished verbal interactions between children and caregivers, which are crucial for language development. Vygotsky's sociocultural theory emphasizes the importance of social interaction in cognitive development. Reduced human interaction and increased passive consumption of digital content impede the development of phonological awareness, vocabulary, and syntactic skills. Interactive, reciprocal communication is vital for language acquisition, promoting cognitive functions such as attention, memory, and executive function. Digital gadgets, however, often provide one-way communication and overstimulation that can fragment attention and hinder these cognitive processes. Moreover, the high-paced visual and auditory stimuli from gadgets can impair the brain's ability to process and prioritize linguistic inputs,

leading to deficits in phonological processing, vocabulary acquisition, and syntactic understanding (Falikman, 2021; Vissers et al., 2020).

Excessive screen time during critical periods of brain development may disrupt the normal maturation of neural circuits essential for speech and language processing. The human brain undergoes significant synaptogenesis, synaptic pruning, and myelination during the first few years of life, which are critical for linguistic development. Gadgets, by providing passive stimuli, may lead to alterations in neural plasticity. Neuroimaging studies have shown that language acquisition is supported by a network of brain regions, including the left inferior frontal gyrus (Broca's area), the superior temporal gyrus (Wernicke's area), and the arcuate fasciculus, which connects these regions. Prolonged gadget use can lead to under-stimulation of these areas, resulting in delayed or aberrant development. The neural pathways involved in phonological processing, vocabulary development, and syntactic structuring are particularly susceptible to the impacts of inadequate stimulation during critical periods of development (Muppalla et al., 2023; Ono et al., 2022).

The prefrontal cortex, responsible for executive functions and language processing, exhibits reduced activity and structural alterations due to excessive screen time. Studies using neuroimaging techniques have demonstrated decreased cortical thickness and white matter integrity in regions associated with language processing in children with high screen exposure. Neurological studies have shown that excessive screen time can lead to structural changes in the brain. For instance, reduced grey matter density in the prefrontal cortex has been associated with higher screen time, which correlates with lower cognitive control and language abilities. Functional MRI studies have revealed altered activation patterns in the brain's language areas during linguistic tasks in children with high screen exposure, indicating a disruption in normal neural processing pathways (He et al., 2023; Hutton et al., 2020; Martins et al., 2020). Screen-based activities often involve passive viewing and listening, which do not provide the necessary interactive feedback for these neural circuits to mature. This can lead to deficiencies in phonological processing, vocabulary growth, and grammatical skills. Moreover, the overstimulation from rapid-paced, visually intense screen content can detract from the brain's ability to focus and sustain attention on linguistic inputs. This phenomenon can impair the development of executive functions, such as working memory and cognitive flexibility, which are vital for language learning and usage (Madigan et al., 2019).

Preventive Strategies of Speech Delay Through Gadget Usage Management

Preventive action is the most effective approach toward speech delay that caused by excessive gadget usage because of the progressive nature of speech delay problem. Prevention action should be taken through the gadget usage management within individual, family and community level, and should be done as early as possible to prevent speech delay problem occurrence (Alamri et al., 2023). There are several strategies that could be considered as preventive act to be done by healthcare provider, families, and community.

First strategy that could be done by parents toward children are limitation of screen-based media and electronic devices among children following the duration and age limit. The American Academy of Child & Adolescent Psychiatry recommends no screen time for children under 18 months, except for video chatting, and a maximum of one hour per day of high-quality programming for children aged 2 to 5 years, and increased up to 2 hours for children below 10 years old. These guidelines should be rigorously followed and communicated to parents and caregivers. Parents should also establish and consistently enforce rules regarding screen usage. This includes creating screen-free zones, such as during meals and before bedtime, to encourage direct interaction and communication, and another guideline stated that screen-time cannot be used as a positive reinforcement towards child behaviour (Morawska et al., 2023).

Second strategy is intervention of active language and speech environment. Parents and caregivers should be encouraged to engage in regular, meaningful conversations with their children. This includes reading aloud, storytelling, and discussing daily activities, which provide rich linguistic input and opportunities for language practice. Activities that involve turn-taking, role-playing, and problem-solving foster language development. Toys and games that require verbal interaction should be prioritized over passive screen-based entertainment (Feldman, 2019).

Third strategy is educational program intervention in family based or community based. Preschools and early education centers should incorporate structured language development activities into their curricula. Programs that emphasize phonological awareness, vocabulary building, and social communication can mitigate the risks associated with screen exposure. Besides education curriculum for the children, providing parents with resources and training on the importance of interactive communication and the risks of excessive screen time is crucial. Workshops and informational campaigns can equip parents with strategies to create a language-rich home environment (De las Heras et al., 2022; Voltmer et al., 2021).

And fourth strategy is application of public policy and community intervention. Government and health organizations should conduct public health campaigns to raise awareness about the impact of excessive screen time on speech development and promote best practices for screen usage. Awareness from public will create an atmosphere of working together to prevent development disorder among children that caused by technology. Community could work together to ensure that families have access to books, educational toys, and community programs that support language development is essential. Libraries, community centers, and pediatric clinics can serve as hubs for distributing these resources (Brown et al., 2016).

CONCLUSION

The correlation between excessive gadget usage and speech delay in children is substantiated by a growing body of empirical evidence. Prolonged exposure to screen-based activities often supplants critical face-to-face interactions and dynamic play, which are fundamental for linguistic development. The data suggests

that children who engage excessively with gadgets may experience reduced verbal stimulation, hindering the natural acquisition of language skills. In neurophysiological aspect it could lead also lack of development in several brain areas such as Broca's area, Wernicke's Area, prefrontal cortex, grey and white matter structure which are involved in language development and cognitive abilities. Moreover, the passive nature of screen engagement fails to elicit the active communicative responses necessary for speech progression. It is imperative for caregivers, healthcare provider, and policy makers to recognize the potential risks associated with excessive screen time and to create and effective strategies through individual, family, and community aspects to an environment that support optimal speech and language development in early childhood in prevention of speech delay.

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