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# Word-level Speech Intelligibility, Percentage of Consonants and Vowels Correct Indonesian Children Using Preschool Sound Production Test

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**ABSTRACT**

**Background:** Instruments and normative data of children's speech intelligibility in Indonesian are still a challenge and obstacle for speech therapists in Indonesia to objectively identify whether children's speech intelligibility is age-appropriate or not. This study aims to identify normative data of word-level speech intelligibility, percentage of consonants correct (PCC), and percentage of vowels correct (PVC) in Indonesian children using the Preschool Sound Production Test (Tes Produksi Bunyi Bicara Prasekolah).

**Method:** This study is a descriptive quantitative study. This study involved 365 typical children aged four to five years. The first language and the language used by the samples for daily communication is Indonesian. The study was conducted from September to October 2024. Each child was tested individually using the Preschool Sound Production Test (Tes Produksi Bunyi Bicara Prasekolah).

**Result:** Based on the results of data analysis, it was found that word-level speech intelligibility ($F = 73.7$; $p < .001$), percentage of consonants correct ($F = 29.1$; $p < .001$), and percentage of vowels correct ($F = 20.7$; $p < .001$) of four-year-old children were different from those of five and six years old.

**Conclusion**: The Preschool Sound Production Test (Tes Produksi Bunyi Bicara Prasekolah) has been shown to have construct validity and can be used to identify typical and atypical speech intelligibility.



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## INTRODUCTION

Aphasia is one of problems with high prevalence. Twelve percent (12%) – 33% post-stroke patients Speech sound disorders are one of the types of speech disorders that occur during development. Speech sound disorders are defined as the inability of a child to produce clear sound production and this has a direct impact on effective communication carried out by the child (Taruna, 2024). Speech sound disorders can occur due to auditory perceptual disorders, phonological representation disorders, speech motor planning, or speech motor execution (neuromuscular or phonetic placement) (Stackhouse et al., 2007).

Speech sound disorders can be functional (idiopathic) or can occur in organic (neurological, structural, or sensory). Idiopathic (functional) speech sound disorders are classified into three types based on the underlying problem; functional articulation disorders, phonological disorders, and apraxia of speech in children (Dodd, 2014; McLeod & Baker, 2017; Taruna, 2024).

In the management of children with speech sound disorders, speech therapists play an important role in conducting assessments, diagnoses, preparing treatment plans, and carrying out treatment for children with

speech sound disorders (Bowen, 2015; McLeod & Baker, 2017). Considering the importance of assessment in establishing an accurate diagnosis of speech sound disorders, the limited standardized test instruments are still the main obstacle faced by speech therapists in Indonesia.

It is certain that the enforcement of an accurate diagnosis is highly dependent not only on the clinical reasoning ability of a speech therapist (Pindzola et al., 2016), but also on the availability of valid and reliable sound production test instruments. When in clinical practice speech therapists do not use valid and reliable instruments, then as a consequence, the assessment data obtained are estimated to be invalid and inconsistent, because the instruments used are not based on evidence of good psychometric properties (Domino & Domino, 2006; Kaplan & Saccuzzo, 2009; Urbina, 2004).

In 2024, for the first time the Preschool Sound Production Test (*Tes Produksi Bunyi Bicara Prasekolah*) was developed in Indonesia by Rexsy Taruna, Jumiarti, and Stella Rosalina Phandinata. This test has 31 items, which represent Indonesian consonants with various positions (initial, medial, final) and existing Indonesian phonotactic patterns, such as CV (bo-la), CVC (mobil), V (a-yam), CVCC (ku-ʧiŋ), CVCCV (te-liŋa), VCC (aŋ-gur), CVV (pi-sau), CCV (ña-muk), dan CCVC (ba-ñak). This test is designed to analyze a child's speech sound samples based on word-level speech intelligibility, percentage of consonants correct (PCC), and percentage of vowels correct (PVC).

Given the importance of speech sound production instruments in Indonesia, this study aims to describe the normative profile of word-level speech intelligibility (WLSI), percentage of consonants correct (PCC), and percentage of vowels correct (PVC) in children aged four to six years using the Preschool Sound Production Test (*Tes Produksi Bunyi Bicara Prasekolah*).

## METHOD

This study is a descriptive quantitative study. This study involved 365 typical children aged four to five years. The first language and the language used by the samples for daily communication is Indonesian. The study was conducted from September to October 2024. Each child was tested individually using the Preschool Sound Production Test (*Tes Produksi Bunyi Bicara Prasekolah*). In the speech sampling process, each child was asked to name 31 items represented by each picture. The child's responses were phonetically transcribed. The transcripts were then used to calculate word-level speech intelligibility, percentage of consonants correct (PCC), and percentage of vowels correct (PVC).

## RESULTS

### *Descriptive Statistics*

The Preschool Sound Production Test (*Tes Produksi Bunyi Bicara Prasekolah*) was administered to 365 typical children aged four to six years. There were 63 four year olds (17.3%), 230 five year olds (63%), and 72 six year olds (19.7%). Female were 50.1% and male were 49.9%.

**Table 1.** Descriptive Statistics

| Age | N | Word-level Speech Intelligibility | Percentage of Consonants Correct | Percentage of Vowels Correct |
|---|---|---|---|---|
| 4 years | 63 | 81.32 (13.5) | 88.57 (9.2) | 92.60 (8.2) |
| 5 years | 230 | 86.13 (14.0) | 90.57 (8.9) | 93.99 (8.1) |
| 6 years | 72 | 96.40 (4.2) | 95.19 (3.5) | 97.21 (2.3) |

### *Comparison of Word-level Speech Intelligibility (WLSI) by Age*

Based on descriptive analysis, it is known that as age increases, the WLSI level will increase. Referring to One-Way ANOVA, it was statistically found that there was a significant difference in WLSI between the age groups of four years, five years, and six years ($F = 73.7$; $p < .001$).

**Table 2.** Mean Differences (p-value) - WLSI

| | Age 4 | Age 5 | Age 6 |
|---|---|---|---|
| Age 4 | - | -4.81 (0.021) | -15.1 (<.001) |
| Age 5 | | - | -10.3 (<.001) |
| Age 6 | | | - |

MD (mean difference)

***Comparison of Percentage of Consonants Correct* (PCC) *by Age***

Based on descriptive analysis, it is known that as age increases, the PCC level will increase. Referring to One-Way ANOVA, it was statistically found that there was a significant difference in PCC between the age groups of four years, five years, and six years ($F = 29.1$; $p < .001$). However, more specifically, PCC at age four did not differ significantly from age five.

**Table 3.** Mean Differences (p-value) - PCC

| | **Age 4** | **Age 5** | **Age 6** |
|---|---|---|---|
| Age 4 | - | -2.00 (0.205) | -6.62 (<.001) |
| Age 5 | | - | -4.62 (<.001) |
| Age 6 | | | - |

MD (mean difference)

***Comparison of Percentage of Vowels Correct* (PVC) *by Age***

Based on descriptive analysis, it is known that as age increases, the PVC level will increase. Referring to One-Way ANOVA, it was statistically found that there was a significant difference in PVC between the age groups of four years, five years, and six years ($F = 20.7$; $p < .001$). However, more specifically, PVC at age four years was not significantly different from age five years.

**Table 4.** Mean Differences (p-value) - PCC

| | **Age 4** | **Age 5** | **Age 6** |
|---|---|---|---|
| Age 4 | - | -1.39 (0.383) | -4.61 (<.001) |
| Age 5 | | - | -3.22 (0.004) |
| Age 6 | | | - |

MD (mean difference)

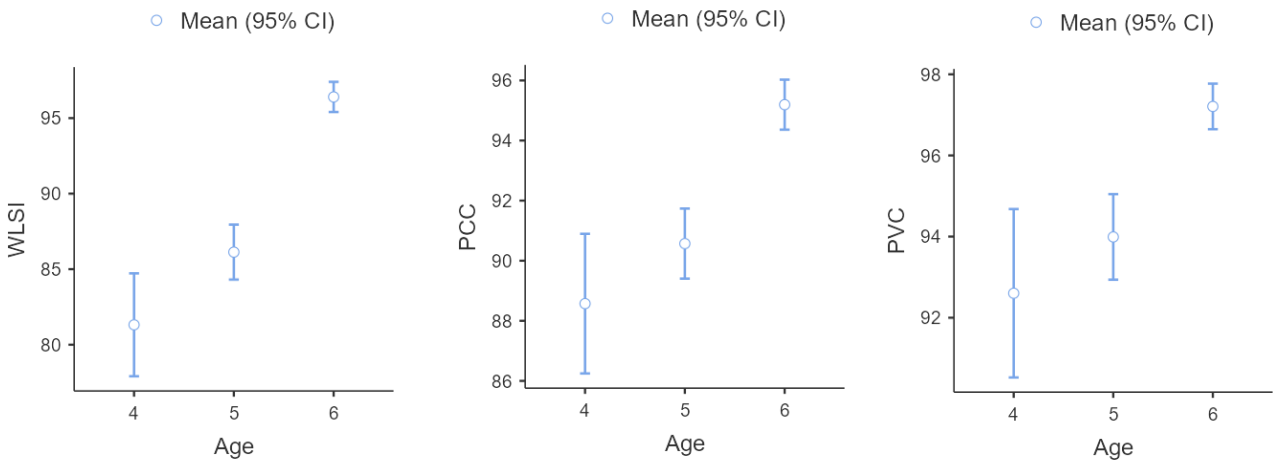


**Figure 1.** Descriptive Plots (WLSI, PCC, PVC)

***Normative Data by Age Group***

Based on normative analysis, it can be explained that each age group has a minimum percentage score to be categorized as a typical ability or in accordance with its age group. For example, word-level speech intelligibility is categorized according to the age of four years if it has a minimum percentage score of 67.82%, while for the age of five years, the child must have a minimum percentage score of 69.13% to be categorized as typical word-level speech intelligibility.

**Table 5.** Normative Data Age 4 Years

| Age | Word-level speech intelligibility | Percentage of consonants correct | Percentage of vowels correct |
|---|---|---|---|
| 4 years | Below average (<67.82%)<br>Average (67.82% - 94.82%)<br>High average (>94.82%) | Below average (<79.37%)<br>Average (79.37% - 97.77%)<br>High average (>97.77%) | Below average (<84.4%)<br>Average (84.4% - 100%) |

**Table 6.** Normative Data Age 5 Years

| Age | Word-level speech intelligibility | Percentage of consonants correct | Percentage of vowels correct |
|---|---|---|---|
| 5 years | Below average (<69.13%)<br>Average (69.13% - 97.13%)<br>High average (>97.13%) | Below average (<81.67%)<br>Average (81.67% - 99.47%)<br>High average (>99.47%) | Below average (<85.89%)<br>Average (85.89% - 100%) |

**Table 7.** Normative Data Age 6 Years

| Age | Word-level speech intelligibility | Percentage of consonants correct | Percentage of vowels correct |
|---|---|---|---|
| 6 years | Below average (<92.2%)<br>Average (92.2% - 100%) | Below average (<91.69%)<br>Average (91.69% - 98.69%)<br>High average (>98.69%) | Below average (<94.91%)<br>Average (94.91% - 99.51%)<br>High average (>99.51%) |

## DISCUSSION

Speech intelligibility is a child's ability to produce speech sounds clearly (Bauman-Waengler, 2016; Bernthal et al., 2017; Dodd, 2014). This ability is basically a benchmark for a child's competence in processing speech sounds. Speech intelligibility is generally influenced by several factors, consisting of auditory perception, phonological representation, speech motor planning, and speech motor execution (Anthony et al., 2011; Bowen, 2015; Taruna, 2024).

Deficit in one or more factors can significantly affect speech intelligibility. On that basis, speech intelligibility below the expected level of age is one of the diagnostic criteria for children with speech sound disorders (APA, 2013; Bernthal et al., 2017; WHO, 1992). Considering this, it is important for Indonesian speech therapists to have a normative reference to identify whether a child's speech clarity is below age or not.

This study has a significant influence on the practice of Indonesian speech therapists, especially in normatively assessing speech intelligibility in children aged four to six years. This study found that four-year-old children display different speech intelligibility from five-year-old and six-year old children, specifically average word-level speech intelligibility, percentage of consonant correct (PCC), and percentage of vowels correct (PVC). Statistically, this different is categorized as a significant, providing evidence that Preschool Sound Production Test is construct-valid.

Four-year-old children assessed using the Preschool Sound Production Test (*Tes Produksi Bunyi Bicara Prasekolah*) had typical word-level speech intelligibility with score ranging from 67.82% to 94.82%, compared to five-year-olds with scores ranging from 69.13% to 97.13%, and six-year-olds with scores ranging from 92.2% to 100%. This findings indicate that word-level speech intelligibility in children who primarily speak Indonesian is not significantly different from children in the United States who primarily speak English.

For example, Hustad et al. (2021) explained in one study that four-year-old children have typical word-level speech intelligibility score ranging from 62.8% to 84.69%, while five-year-olds scores ranging from 70% to 87.6%. Referring to this findings, it can be generally concluded that children in United States who primarily speak English exhibit different word-level speech intelligibility across the ages of four, five and six. This pattern is similar to the findings in children who use Indonesian as their primary language in communicating.

## CONCLUSION

Indonesian speech therapists can use the Preschool Sound Production Test (*Tes Produksi Bunyi Bicara Prasekolah*) to identify the level of speech intelligibility of children. When speech intelligibility is identified below the age, speech therapists are advised to conduct further assessments to clarify whether speech intelligibility is influenced by deficits in auditory perception, phonological representation, speech motor planning, or speech motor execution.

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