Original Article

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WHOLE WORD PHONOLOGICAL MEASURES IN TYPICALLY DEVELOPING NATIVE NEPALI SPEAKING CHILDREN: A CROSS-SECTIONAL COMPARATIVE STUDY

ABSTRACT

Aims and Objectives: To establish preliminary normative reference data for Phonological Mean Length of Utterance, Proportion of Word Proximity, and Percentage of Words Correct in native Nepali-speaking children aged 2 to 3 years and examine developmental differences between age groups.

Methods: Twenty-four typically developing children (12 males, 12 females) were recruited from a Kathmandu preschool, divided into two groups ≥2.0 to <2.6 years (n=12) and ≥2.6 to <3.0 years (n=12). Participants completed a picture-naming task using 50 familiar stimuli. Speech samples were audio-recorded and phonetically transcribed. Phonological Mean Length of Utterance, Proportion of Word Proximity, and Percentage of Words Correct were calculated following established protocols.

Results: Significant age-related improvements were observed across all whole-word phonological measures. Children aged 2.5–3.0 years demonstrated higher Phonological Mean Length of Utterance, Proportion of Word Proximity, and Percentage of Words Correct scores than those aged 2.0–2.5 years ($p < 0.05$). Strong positive correlations were found between chronological age and Phonological Mean Length of Utterance ($r = 0.76$) and Percentage of Words Correct ($r = 0.79$), while Proportion of Word Proximity showed a moderate positive correlation ($r = 0.58$). These findings indicate progressive improvement in phonological complexity and accuracy with age in Nepali-speaking children.

Conclusion: Results demonstrated developmental progression in phonological complexity and accuracy between 2 and 3 years in Nepali-speaking children. These preliminary normative reference values provided valuable reference data for clinical assessment and research in this understudied population.

Keywords: Nepali language, phonological development, speech assessment, whole-word measures, phonological mean length of utterance, percentage of words correct, proportion of whole-word proximity

INTRODUCTION

Phonological assessment has traditionally relied on segmental accuracy measures; however, these measures do not adequately capture the complexity and accuracy of children's whole-word productions.[1,2] To address this limitation, whole-word measures such as Phonological Mean Length of Utterance (PMLU), Proportion of Whole-Word Proximity (PWP), and Percentage of Words Correct (PWC) have been developed to provide a more comprehensive evaluation of phonological development.[3,4] Previous studies across languages, including Finnish, Persian, Arabic, Hindi, and Kannada, have demonstrated that these measures are sensitive to developmental changes and language-specific phonological structures. [5-13] Research has also shown their clinical relevance in identifying phonological delays and differentiating children with phonological disorders from typically developing peers.[11,12]

Despite growing evidence supporting whole-word measures, normative reference values for Nepali-speaking children are lacking. Nepali contains unique phonological features such as aspirated stops, retroflex consonants, and consonant clusters, which may influence whole-word phonological performance. Establishing language-specific reference is therefore essential for accurate clinical assessment and intervention planning. The present study aims to investigate PMLU, PWP, and PWC in typically developing Nepali-speaking children aged 2-3 years and to contribute normative reference values for clinical use.

METHODS

This cross-sectional study employed a comparative design to examine phonological development across two age groups of typically developing Nepali-speaking children. Twenty-four children (12 males, 12 females) aged 2.0 to 3.0 years participated in this study. All participants were recruited from City Montessori, a preschool in Kathmandu, Nepal. This study utilized data collected as part of the author's ongoing doctoral thesis, which has not yet been submitted, published, or archived. The present manuscript represents an original and independent analysis of the thesis dataset. Ethical approval for the research was obtained under the thesis protocol from the Nepal Health Research Council and AIISH Ethics Committee. Children were stratified into two equal groups: younger group (≥2.0 to <2.6 years, n=12) and older group (≥2.6 to <3.0 years, n=12). Participants were native Nepali-speaking children aged 2.0 to 3.0 years with typical cognitive and motor development and no reported speech, language, hearing, or neurological concerns. Children were excluded if they had significant multilingual exposure, sensory impairments, diagnosed disorders, medical conditions affecting speech, or were acutely ill during assessment.

A comprehensive set of 90 pictures representing common Nepali vocabulary was initially compiled. These stimuli targeted various Nepali consonants across different word positions to ensure comprehensive phonological sampling. Three certified speech-language pathologists (SLPs) with expertise in Nepali phonology rated each picture for familiarity using a 5-point Likert scale (1=very unfamiliar, 5=very familiar). The final stimulus set comprised 50 pictures rated as highly familiar (mean rating ≥4.0) across all evaluators. This selection ensured that lexical familiarity would not confound phonological performance measures. Stimuli included words varying in syllable structure, length, and phonological complexity to provide a representative sample of Nepali phonology. Speech samples were collected using a Zoom H1 Handy Recorder positioned approximately 15cm from the child's mouth to ensure optimal audio quality while maintaining ecological validity.

Data collection occurred in a quiet room within the preschool setting to maximize participant comfort and cooperation. Each child was assessed individually during a single session lasting approximately 20-30 minutes. The examiner presented pictures one at a time, using the standardized prompt "What is this?" in Nepali. Children were encouraged to provide single-word responses, with minimal prompting allowed for non-responses.

All speech productions were audio-recorded for subsequent analysis. If children provided multiple attempts at a word, only the first clear attempt was included in the analysis to maintain consistency with established protocols. Similarly, all speech samples were orthographically transcribed and then phonetically transcribed using the International Phonetic Alphabet (IPA) by a certified SLP with extensive experience in Nepali phonology. To ensure transcription reliability, 25% of samples were independently transcribed by a second qualified SLP. Point-to-point agreement for phonemic transcription exceeded 90%, meeting established standards for phonological research.

Analysis Procedures

PMLU (Phonological Mean Length of Utterance) Calculation

PMLU for each word was calculated following Ingram's (3) established protocol:

- PMLU = (number of vowels produced + number of consonants substituted + 2 × number of consonants correct) / 1
- Overall PMLU = arithmetic mean of individual word PMLU scores

PWP (Proportion of Word Proximity) Calculation

PWP was calculated as the ratio between child's word PMLU and adult target PMLU:

- PWP = Child's PMLU / Adult Target PMLU
- Overall PWP = arithmetic mean of individual word PWP scores

PWC (Percentage of Words Correct) Calculation

PWC represented the percentage of words produced with complete accuracy:

- PWC = (number of completely correct words / total words attempted) × 100

Statistical Analysis

All analyses were conducted using SPSS version 28.0. Descriptive statistics (means, standard deviations, ranges) were calculated for all measures by age group. Normality was assessed using Shapiro-Wilk tests due to the small sample size. Independent samples t-tests were employed to examine group differences, with Welch's correction applied when equal variances assumption was violated (Levene's test $p<0.05$). Statistical significance was set at $\alpha=0.05$. Correlation analyses examined relationships between measures and chronological age. Preliminary normative ranges were established using ±1 standard deviation from group means.

RESULTS

Descriptive Statistics

Speech samples from all 24 participants were successfully collected and analyzed. Each sample contained 50 single-word productions elicited through the picture-naming task, yielding a total corpus of 1200 word productions for analysis. Table 1 presents descriptive statistics for all phonological measures by age group.

Table 1. Descriptive Statistics for Phonological Measures by Age Group

Measure	2.0-2.5 years (n=12)	2.5-3.0 years (n=12)
PMLU (Phonological Mean Length of Utterance)		
Mean (SD)	5.82 (0.11)	6.07 (0.06)
Range	5.64-5.96	5.96-6.12
PWP (Proportion of Word Proximity)		
Mean (SD)	0.94 (0.01)	0.98 (0.02)
Range	0.92-0.97	0.93-1.00
PWC (%) (Percentage of Words Correct)		
Mean (SD)	71.00 (8.92)	91.33 (9.00)
Range	62-82	78-100

Note: PMLU = Phonological Mean Length of Utterance; PWP = Proportion of Whole-Word Proximity; PWC = Percentage of Words Correct; SD = Standard Deviation

Statistical Assumptions

Normality testing using Shapiro-Wilk tests indicated that all measures met assumptions for parametric analysis. PMLU scores were normally distributed for both younger (W=0.89, p=0.32) and older (W=0.82, p=0.08) age groups. Similar results were obtained for PWP (younger: W=0.91, p=0.42; older: W=0.87, p=0.24) and PWC (younger: W=0.93, p=0.58; older: W=0.89, p=0.33).

Group Comparisons

PMLU Analysis

Levene's test revealed unequal variances between groups for PMLU (F=6.92, p=0.025), necessitating Welch's adjusted t-test. Results demonstrated a statistically significant difference between age groups, with older children achieving higher PMLU scores (M=6.07, SD=0.06) compared to younger children (M=5.82, SD=0.11), t(7.24)=-3.97, p=0.005.

PWP Analysis

Equal variances were assumed for PWP (Levene's F=2.15, p=0.173). Independent samples t-test revealed a significant difference between groups, t(10)=-2.24, p=0.048, with older children demonstrating higher PWP values (M=0.98, SD=0.02) than younger children (M=0.94, SD=0.01).

PWC Analysis

PWC showed developmental progression. Equal variances were assumed (Levene's F=0.018, p=0.896). The independent samples t-test revealed highly significant differences between groups, t(10)=-4.12, p=0.002, with older children achieving substantially higher accuracy (M=91.33%, SD=9.00) compared to younger children (M=71.00%, SD=8.92).

Correlation Analysis

Pearson correlation analyses examined relationships between chronological age and phonological measures across the entire sample:

- PMLU: r=0.76, p=0.004 (strong positive correlation)
- PWP: r=0.58, p=0.048 (moderate positive correlation)
- PWC: r=0.79, p=0.002 (strong positive correlation)

These correlations support the developmental sensitivity of all three measures within this age range.

Preliminary Normative Reference Values:

Based on the current sample, preliminary reference values (Mean ± 1 SD) are proposed:

Age ≥2.0 to <2.6 years	Age ≥2.6 to <3.0 years
PMLU: 5.71-5.93	PMLU: 6.01-6.13
PWP: 0.92-0.97	PWP: 0.96-1.00
PWC: 62.08-79.92%	PWC: 82.33-100%

DISCUSSION

This study represents the first systematic investigation of whole-word phonological measures in native Nepali-speaking children, providing crucial reference values for this understudied population. The findings demonstrated clear developmental progression in phonological complexity and accuracy during the critical 2.0 to 3.0 year period, consistent with cross-linguistic research, while also reflecting language-specific phonological characteristics of Nepali.

The results revealed significant age-related improvements across all measures. PMLU scores increased from 5.82 to 6.07 between age groups. This finding aligns with previous studies demonstrating steady increases in phonological complexity during early childhood.[5,6] PWP values also demonstrated significant developmental progression, increasing from 0.94 to 0.98. These relatively high PWP values indicate that Nepali-speaking children, even at 2.0 years, produce words that closely approximate adult targets in terms of phonological structure. Similarly, PWC improved markedly from 71.00% to 91.33%, suggesting rapid refinement in articulatory precision during this developmental period.

The observed performance patterns may partly reflect phonological characteristics specific to Nepali. Nepali contains aspirated stops, retroflex consonants, consonant clusters, and relatively predictable syllable structures, which may influence children's whole-word productions and target approximations. The relatively high PWP scores observed in the present study may indicate early acquisition of syllable-level organization despite ongoing refinement of complex consonantal contrasts such as aspiration and retroflexion. Similar patterns have been reported in other South Asian languages, including Hindi and Persian.[9,13]

When compared to other languages, Nepali-speaking children's PMLU values were comparable to those reported in Hindi-speaking children, although lower than the values reported by Jaisinghani and Sreedevi.[13] These differences may reflect methodological variations, including stimulus

selection, sample size, and transcription procedures. The PWP values observed in the present study closely parallel findings in Hindi and Persian, suggesting possible similarities in phonological organization among South Asian languages.[9,13]

These findings have important implications for clinical practice in Nepal. The preliminary ranges established in this study may assist speech-language pathologists and other related clinicians in identifying children with delayed or disordered phonological development at an early stage. Whole-word measures such as PMLU, PWP, and PWC may support more comprehensive assessment of speech sound development, aid differential diagnosis, and help monitor therapeutic progress in children with speech and language disorders. The strong relationship between these measures and chronological age further supports their clinical utility in developmental assessment and intervention planning for Nepali-speaking pediatric populations.

Although this study provides preliminary values for Nepali-speaking children, the findings should be interpreted with caution due to the relatively small sample size and recruitment from a single preschool in Kathmandu. The limited geographic, linguistic, and sociocultural representation may restrict the generalizability of the findings to the broader Nepali-speaking pediatric population, particularly children from rural communities, different dialectal backgrounds (western), and varying socioeconomic groups. Therefore, the present findings should be considered preliminary. Future studies involving larger and more diverse samples from multiple regions of Nepal are necessary to establish comprehensive normative data and improve the external validity of whole-word phonological measures in Nepali-speaking children.

CONCLUSION

This study presents the first preliminary reference values on whole-word phonological measures (PMLU, PWP, and PWC) in native Nepali-speaking children aged 2.0 to 3.0 years, showing clear developmental progression—especially in articulatory accuracy and phonological complexity. Strong correlations with age confirm the measures' developmental sensitivity and clinical utility. These findings provide valuable reference points for assessing Nepali-speaking children and support the cross-linguistic relevance of whole-word measures, while emphasizing the need for language-specific norms. Further research with larger, more diverse samples is essential to establish comprehensive databases and improve clinical assessment and intervention for South Asian linguistic populations. Future research should include larger and more diverse samples, longitudinal designs, a mix of familiar and unfamiliar stimuli, and exploration of clinical populations and relationships with vocabulary and grammar to deepen understanding of phonological development.

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