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Investigating Phonological Awareness in Persian-Speaking Children With Phonological Disorders

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Abstract

Background: In terms of error patterns, children with phonological disorders (PD) are a heterogeneous population. These children are at risk for phonological awareness (PA) deficits.

Objectives: This study aimed to investigate phonological awareness in Persian-speaking children with phonological disorders.

Patients and Methods: Thirty-six children with PD aged 5 - 6 years were selected by a convenience sampling method during 12 months. Children with PD were divided into three groups according to their error patterns. Fourteen normally developing (ND) children were selected as the control group. In order to equalize socioeconomic status, ND children were similar to the PD groups based on age, residential area, and mothers' educational attainments. Language, speech sound production, oro-motor, and PA skills were investigated. Intra-syllabic and phonological awareness (PA) were compared to investigate PA skills in the four groups. Relation between percent consonant correct (PCC) and PA was also investigated in the four groups. Fourteen children with phonological delay, 12 children with consistent atypical phonological disorders (CAP), and 10 children with inconsistent phonological disorders (ICP) formed the PD groups.

Results: The CAP group showed significant difference with the ND group in alliteration ($P = 0.001$), rhyme ($P = 0.001$), identification of words with the same initial phoneme ($P = 0.002$), and identification of words with the same final phoneme ($P = 0.001$) [except blending phonemes ($P = 0.504$)]. Though performing more poorly, the delayed group did not show significant difference with ND group ($P > 0.05$). The ICP and ND groups did not show significant difference in PA except in identifying words with the same final phoneme ($P = 0.008$). The relation between PCC and PA was observed only in the CAP group ($P = 0.021$).

Conclusions: The results suggested that PA skills in children with phonological disorders are affected by error type. We also found the type of errors that can play a more effective role in PA investigations as compared to PCC. The results also showed that children with CAP require special attention.

Keywords: Speech-Sound Disorder, Child, Classification, Iran

1. Background

Studies have demonstrated that literacy abilities, such as spelling and reading, are related to phonological awareness (PA) skills (1-3). Some studies have shown that children with phonological disorders (PD) are at risk for PA deficits (4, 5). Children with PD of unknown origin are the largest group of children with speech-sound disorders (SSD) (6). The phrase SSD is used to explain disruption in early speech development (7). SSD comprise of numerous speech-sound production impairments and can range from mild articulation disorders (involving a limited error) to severe phonologic disorders (involving numerous errors) (8). Even under treatment conditions, children with PD can still experience PA problems (9).

The ability to manipulate the sound structure of words (regardless of their meaning) is referred to as PA (10). PA skills are developed during preschool and the first years of primary school. There are two total patterns for PA development, which overlap each other. In the first pattern, children become sensitive to words and their smaller units as they develop. They grow to become increasingly sensitive to syllables, intrasyllabic units, and phonemes. The second pattern involves children recognizing similar and dissimilar sounds of words before acquiring the ability of phoneme segmentation (11).

In addition to being inter-related, speech production and PA both require internal representation of phonological structure (12). Phonological representation is the base of speech production (13). Therefore, PA is associated with correct speech production and comprehension (12). Several studies have shown that children with PD and language impairment (LI) were more at risk for PA, reading, and writing difficulties as compared to children with PD without LI (8, 14).

Children with PD differ in terms of their error type and frequency. Some researchers have indicated the effect of

error type on PA. They found that children with more atypical errors experience inferior performance in PA skills (12, 15, 16). The literature has also shown that there is a positive relation between speech sound accuracy measured by percent consonant correct (PCC) and PA skills (17). Although the literature suggests there is a relationship between PD and PA, it has also been shown that children with SSD do not exhibit PA problems (18, 19). From Dodd's point of view, children with PD are classified into three groups including phonological delay, consistent atypical phonological disorder (CAP), and inconsistent phonological disorder (ICP). The error patterns are different in these children. Children with phonological delay make errors identical to what children produce in the early stages of normal development. Children with CAP use atypical error patterns more than typical ones in their speech. These atypical patterns are evidence for a deficiency in acquiring rules and phonological structures. Children with ICP make multiple error forms for the same lexical item. Inconsistent errors in their speech are due to a deficit in phonological planning that subsequently leads to an unstable phonological system. Phonological planning is defined as the process of selecting and sequencing phonemes (20, 21).

Holm et al. showed that PA skills are different in the children aged 5 - 6 years. More specifically, children with CAP have less efficient PA skills. There was no significant difference between phonological delayed children and control group. While both the control and ICP groups performed similarly in recognizing rhyme and alliteration, children with ICP performed differently than their control peers in syllabic segmentation (22). Leitao et al. assessed segmentation, blending, and invented spelling abilities in 6-year-old children. The authors applied the framework developed by Dodd (1995) and placed the children into three groups: delayed, inconsistent deviant, and deviant production. Children who had low scores on the PA tasks had deviant phonological production. Therefore, children with deviant errors are at higher risk for phonological processing disorders when compared to children with delayed errors (23).

The prevalence rates for children with phonological delay, CAP, and ICP have been respectively reported at 57.5%, 20.6% and 9.4% (24). Furthermore, the prevalence of children with SSD was reported to be 13.8% in Iran (25). With regard to the high prevalence of SSD, studying the PA difficulties these children experience is important because it facilitates the identification of children at high risk for reading problems. It is hypothesized that PA skills are different among 3 groups of children with PD, based on their error type. It is also believed that the error types can characterize internal representation of phonological structures. If the representation is not developed correctly, the awareness of words' sound structure is subsequently affected.

2. Objectives

This study investigated PA in Persian-speaking children with PD categorized according to Dodd's classification. Phonemic awareness compared to intra-syllabic is a better predictor of early reading skills (26). Therefore, these children's performances in phonemic awareness and intra-syllable tasks were assessed.

3. Patients and Methods

3.1. Subjects

Fifty-two children of age 5 - 6 participated in this study. Two children were excluded due to a lack of cooperation. Thirty-six children with PD were recruited from the speech therapy clinics at Tehran University of Medical Sciences. The PD children comprised of 14 delayed, 12 CAP, and 10 ICP. Fourteen normally developing (ND) children acting as a control group were recruited from Tehran's kindergartens. They were similar to the PD children in terms of age, residential area, and mother's education.

The inclusion criteria were as follows: 1) Normal hearing by parent report or by hearing test results that were documented in kindergarten and clinical records; 2) normal oro-motor function as assessed by the oro-motor subtest in the Persian diagnostic evaluation articulation and phonology (P-DEAP) (27) and no apparent structural problems in oral examinations; 3) native Persian speaker; and 4) lack of LI as assessed by the Persian version of the test of language development (TOLD-P:3) (28). P-DEAP assessment of the ND participants showed no speech disorder and these children's parents reported no history of speech and language disorder. Because no estimates exist on the number of Tehran-based children with, we spent approximately 12 months to select PD children from speech therapy clinics. Therefore, all PD children were selected through the convenience sampling method.

3.2. Instrument

The Persian PA test (29) was used to assess PA skills. Furthermore, P-DEAP was used to classify PD children (27), while TOLD-P:3 assessed their language ability (28). These tests' psychometric properties (e.g. content, discriminate validity and reliability) were studied. The results showed that these tests have acceptable psychometric properties. For example, the results of Cronbach's alpha for the Persian PA test and for TOLD-P:3 respectively were 0.982 (29) and 0.96 (28). The percent of agreement between analyzing error patterns in the test-retest was 100% for the P-DEAP (27).

3.3. Assessments and Procedure

Speech and language pathologist (SLP) assessed the participants in a quiet room of the kindergarten or speech therapy clinics. Participants were assessed in three sessions to reduce the effect of fatigue on the tests results. Each session lasted between 30 to 60 minutes. TOLD-P:3 (28) was administered in the first session. P-DEAP (27) and PA (29) test were respectively performed in second and third sessions.

The speech sounds produced were recorded using Kingston sound recorder model DVR-902. Furthermore, Persian phoneme spectrogramsin Praat were analyzed to detect the produced sound.

Speech-sounds production was assessed through P-DEAP (27). In the diagnostic screening, the participants named 14 pictures on two separate occasions in one session. When speech sounds were produced incorrectly, the examiner asked the participants to imitate these phonemes in an open syllable or in isolation. The participants who could imitate phonemes correctly were identified as PD children and were included in this research. In order to calculate the percentage of inconsistency, the number of words produced differently in two separate occasions was divided by the produced words and then multiplying this number by 100. When the percentage of inconsistency was below 21.42, the phonology subtest was administered; if the percentage was above 21.42, the inconsistency subtest was administered instead (27). Participants were asked to name 54 pictures in the phonology subtest, which elicited all Persian vowels and consonants in the syllable-initial and syllable-final positions. Phonological information extracted in this subtest was used to identify and classify surface error patterns, as well as to calculate the PCC and the percent of vowel correct (PVC). The children who scored below 95% were identified as PD, while those above 95% were identified as ND (30). Typical, delayed, or atypical error patterns in children with PD were detected by the P-DEAP manual.

In order to examine the extent of word production consistency, participants were asked to name the same 27 pictures three times in the assessment session. These trials were separated by an oro-motor task. If the three productions were the same, the child received a score of naught and if they were not the same, they received a score of one. To calculate the inconsistency score, the number of words produced differently was divided by 27 and then multiplied by 100. Furthermore, to identify those with an inconsistent disorder, this study used a minimum score of 24.44 and 25.19 respectively for children in the 5 - 5.5 and 5.5 - 6 age groups (27).

The oro-motor subtest (27) has 3 tasks: 1) Diadochokinesis, 2) isolated movements, and 3) sequence movements. To assess diadochokinesis, the participants were asked to repeat one syllable structure 10 times (e.g. Patukeik). For assessing single movements, participants imitated 4 tasks (e.g. could you move your tongue up like this?). The children were also asked to imitate three tasks in order to assess their sequential movements (e.g. could you yawn and lick around your lips like this?).

The six subtests of TOLD-P:3 (28) were used to measure the children's language skills, which included picture vocabulary, grammatical understanding, sentence imitation, grammatical completion, relational vocabulary, and oral vocabulary. The standard score of the TOLD-P:3 subtests were combined in various ways to give the following six composite quotients: semantics, syntax, listening, organizing, speaking, and spoken language. According to Sices et al. (8), children who scored 1.5 SD below the mean in spoken language quotient were identified as LI. In this study, we consider children as LI if their score was less than 86.97. These children were excluded from our study.

Vocabulary plays an important role in PA skills (17). To equalize the level of children's vocabulary, we compared TOLD-P:3's semantic quotient between groups. This composite quotient was calculated by a summation of the standard scores of the picture, relational, and oral vocabulary subtests. There was no significant difference between the ND and PD children in terms of their semantic quotient ($P = 0.36$).

The five Persian PA subtests (29) were administered to assess the participants' intra-syllabic and phonemic awareness. Alliteration and rhyme were used to assess children's ability to produce intra-syllabic units. Blending phonemes, identifying words with the same initial phoneme, and identifying words with the same final phoneme was used to assess of the participants' phonemic awareness. These subtests were selected because the Persian PA test's psychometric properties showed that they are appropriate for age 5 - 6 children. Each subtest consists of 2 practice items and 10 test items. In the alliteration task, the participants were asked to look at three pictures, name them, and then choose two of three pictures that initiated with the same initial sounds (e.g. sup, sut, tut in Persian that are soup, whistle, berry in English). In the rhyme task, the children were asked to look at three pictures, name them, and then choose two of three pictures that ended with the same final sounds (e.g. tup, sup, tab in Persian that are ball, soup, swing in English). The blending phonemes task assessed children's ability to blend discrete sound units. In this task, they were asked to listen to discrete phonemes that read by the examiner and then point to the related picture (e.g. sh, o, t, o, r are discrete phonemes of shotor in Persian, which means camel in English). In the task where they identified words with the same initial phoneme, the children were asked to look at three pictures and to name them. They then identified the two pictures that started with the same initial phonemes (e.g. susmar, komod, sabun in Persian that are iguana, commode, soap in English). In of the task where they identified words with the same final phoneme task, the children would look at three pictures and then name them. They subsequently identified the two pictures that ended with the same final phonemes (e.g. kuh, mah, nakh in Persian that are mountain, moon, and thread in English).

3.4. Ethical Issues

The present study acquired approval from the ethics committee of the Tehran University of Medical Sciences. The number of the ethics committee for this study is

1391/d/260/1006. The aims of study were explained to the children's parents. Considering the inclusion criteria, the children who had signed written consent forms from their parents attended this study.

3.5. Statistical Analysis

The data were analyzed by SPSS version 20. One way ANOVA was used to compare the groups in different variables. The groups' PA skills performance was evaluated using the repeated measures ANOVA. Additionally, Pearson correlation was used to investigate the relationship between PCC and PA skills. The significance level is ≤ 0.05.

4. Results

Fifty participants entered in data analysis. The participants' mean (SD) features are shown in Table 1. One-way ANOVA was used to compare chronological age, speech production, language skills, and oro-motor abilities between the groups.

4.1. Age

There was no statistical significant difference between groups ($F_{3, 46} = 0.69$, $P = 0.55$).

4.2. Inconsistency Score

There was statistical significant difference between the groups ($F_{3, 46} = 78.27$ $P < 0.001$). Post-hoc Bonferroni multiple comparisons showed significant difference between the ICP group and the other groups.

4.3. PCC

Statistical significant difference was found between the groups ($F_{3, 46} = 26.72$ $P < 0.001$). Post-hoc Bonferroni multiple comparisons showed that each group significantly differed from the others but two groups of CAP and ICP had no significant difference ($P = 0.999$).

4.4. PVC

Statistical significant difference between the groups ($F_{3, 46} = 4.225$ $P = 0.01$) was found. Post-hoc Bonferroni multiple comparisons showed significant difference between ICP with delayed and ND groups, but no significant difference between ICP and CAP ($P = 0.524$).

4.5. TOLD-P: 3

Although language ability was in the normal range in each group, we observed statistical significant difference between the groups ($F_{3, 46} = 4.316$ $P = 0.009$). Post-hoc Bonferroni multiple comparisons showed significant difference between the CAP group and the other groups.

4.6. Oro-Motor Skills

The result of the ANOVA test showed there was no statistical significant difference between the groups on diadochokinesis ($F_{3, 46} = 2.526$ $P = 0.069$), isolated movements ($F_{3, 46} = 0.467$ $P = 0.706$), and sequence movements ($F_{3, 46} = 0.566$ $P = 0.641$).

Mean and standard deviation of PA tasks in each group are shown in Table 2. The results revealed that the mean of children with CAP in PA tasks was lower than the other groups.

The repeated measures ANOVA in PA within each group revealed that when compare to other tasks, the ND group performed better in the alliteration task but poorer in the identifying word with the same initial phoneme task. These results were also true for the delayed group, although they performed less well than the ND group. The CAP group performed better in the blending phonemes task and poorer in the identification of identical word-initial phoneme task when compared with the other tasks. The ICP group performed better in the alliteration task and poorer in the identification of identical word-final phoneme task as compared to the other tasks (Figure 1).

The result of the repeated measures ANOVA in all PA tasks showed the groups' term was significant ($F_{3, 46} = 9.66$, $P < 0.001$). Post-hoc Bonferroni corrected comparisons revealed that the CAP group performed weaker than the other groups. The tasks term was significant ($F_{4, 43} = 20.766$, $P < 0.001$) as well, but the interaction (group × task) was not significant ($F_{12, 135} = 0.959$, $P = 0.491$). Post-hoc Bonferroni multiple comparisons showed that the CAP group is significantly differentthan the ND group ($P < 0.001$), delayed group ($P = 0.002$), and ICP group ($P = 0.020$). This difference was not significant between the delayed and ND groups ($P = 0.856$), the delayed and ICP groups ($P = 0.999$), and between the ICP and ND groups ($P = 0.483$).

Regarding the tasks were significant, we used ANOVA to identify which tasks showed significant difference between the groups. By doing so, statistical significant difference was found between groupsforrhyme ($F_{3, 46} = 8.09$ $P < 0.001$), Alliteration ($F_{3, 46} = 7.67$ $P < 0.001$), identifying the same initial phoneme ($F_{3, 46} = 5.36$ $P = 0.003$), and identifying the same final phoneme ($F_{3, 46} = 8.63$ $P < 0.001$).However, no statistical significant difference was found forthe blending phonemes task ($F_{3, 46} = 0.79$, $P = 0.504$). Post-hoc Bonferroni multiple comparisons revealed that there was a significant difference between CAP with the ND and delayed groups in all tasks except blending phonemes. The CAP and ICP groupsdiffered significantlyin rhyme and alliteration tasks. ICP and ND groupsdiffered significantly in the identification same final phoneme task (Table 3).

Although this study was not primarily designed to investigate correlation between PCC and PA skills, we still examined their correlation (see Table 4). Significant correlation between these two skills was not found in ND ($r = 0.435$ $P = 0.120$), delayed ($r = 0.289$ $P = 0.316$), and ICP groups ($r = 0.187$ $P = 0.604$), but there was a significant correlation between PCC and PA in the CAP group ($r = 0.654$ $P = 0.021$).

Table 1. Mean (SD) Features of Participants' Skills

Variable	ND (n = 14)	Delay (n = 14)	CAP (n = 12)	ICP (n = 10)
Age, y	5.28 (0.23)	5.29 (0.28)	5.14 (0.37)	5.21 (0.29)
Inconsistency score, % [a]	8.99 (6.63)	9.77 (7.10)	10.21 (6.29)	50.42 (10.23)
Consonants correct,% [a]	97.64 (1.45)	86.18 (7.09)	74.08 (12.18)	71.62 (9.25)
Vowels correct, % [a]	99.31 (0.77)	99.23 (0.75)	98.69 (1.08)	97.88 (1.66)
Language skills [b]	102.57 (7.12)	100.57 (6.80)	93.83 (7.90)	95.60 (5.92)
Diadochokinesis [a]	8.50 (0.94)	8.28 (1.20)	7.16 (1.74)	7.30 (2.11)
Isolated movements [a]	11.78 (0.80)	11.78 (0.80)	11.50 (1.16)	11.40 (1.26)
Sequence movements [a]	17.07 (1.20)	16.92 (2.23)	16.25 (2.37)	16.20 (2.52)

Abbreviations: CAP, consistent atypical phonological disorders group; Delay, delay phonological disorders group; ICP, inconsistent phonological disorders group; ND, normal development children.
[a]Persian diagnostic evaluation articulation and phonology subtests data.
[b]Standard score average range: 90 - 110.

Table 2. Mean (SD) Characteristics of Groups in PA Tasks

Variable [a]	ND	Delay	CAP	ICP
Alliteration	6 (1.66)	5.64 (1.86)	3.25 (1.35)	5.50 (1.26)
Rhymea	5.85 (1.83)	5.14 (1.65)	3.16 (0.93)	5.30 (0.94)
Blending phonemesa	5.57 (3.15)	5.07 (2.01)	4.08 (2.35)	5.10 (2.18)
Identification the same initial phonemea	4.14 (1.46)	3.64 (1.21)	2.33 (0.88)	3.30 (0.94)
Identification the same final phonemea	4.57 (1.34)	3.71 (0.91)	2.58 (0.90)	3.10 (0.87)

Abbreviation: CAP, consistent atypical phonological disorders group; Delay, delay phonological disorders group; ICP, inconsistent phonological disorders group; ND, normal development children.
[a]Phonological awareness subtests data.

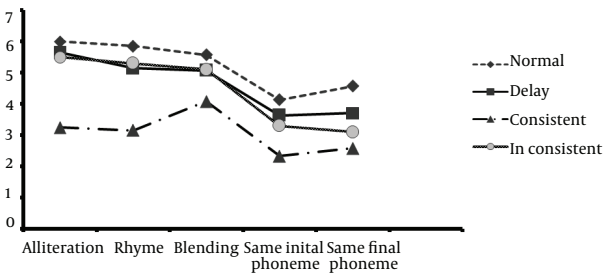

Figure 1. Interaction Between Groups and PA Tasks.

Table 3. Comparison Performance of Groups in PA Tasks

Comparison	Rhyme	Alliteration	Initial Phoneme	Final Phoneme
Delay vs. ND	0.999	0.999	.999	0.210
CAP vs. ND	< 0.001 [a]	< 0.001 [b]	.002 [a]	< 0.001 [b]
ICP vs. ND	0.999	0.999	.542	0.008 [a]
Delay vs. CAP	0.007 [a]	0.002 [a]	.041 [a]	0.05 [a]
Delay vs. ICP	0.999	0.999	.999	0.97
CAP vs. ICP	0.008 [a]	0.011 [a]	.368	0.999

Abbreviations: CAP, consistent atypical phonological disorders group; Delay, delay phonological disorders group; Final phoneme, identification words with the same final phoneme; ICP, inconsistent phonological disorders group; Initial phoneme, identification words with the same initial phoneme; ND, normal development children.
[a]Significant difference between groups on PA tasks, P ≤ 0.05.
[b]Significant difference between groups on PA tasks, P < 0.001.

Table 4. Correlation Between PCC and PA Skills

Group	R	P Value
ND	.435	.120
Delay	.289	.316
CAP	.654	.021 [a]
ICP	.185	.604

Abbreviations: CAP, consistent atypical phonological disorders group; Delay, delay phonological disorders group; ICP, inconsistent phonological disorders group; ND, normal development children; R, regression.
[a]Significant difference, P < 0.05.

5. Discussion

This study investigated PA skills across the four following groups: ND, delayed, ICP, and CAP. Subsequently, different profiles in speech production, language, and PA were found. Analysis of speech production showed the ICP group differed from the ND and delayed groups in PCC and PVC. The comparison of language skills between groups indicated that the CAP group was the least efficient although their score was within normal range.

Similar to Holm et al. (22), ND children obtained a better score in PA test as compared to children with PD. Phonological delayed and ND children were not different in terms of PA skills. The performance of phonological delayed children in PA skills corresponds to their delay in speech production. Since both speech production and PA need representation of phonological structure (12), we believe delay in early phonological development also postpone other skills that need phonological representation; this is consistent with Mann and Foy (2007) (12).

Children with CAP had difficulty in PA tasks. They performed better in the blending phonemes activities. Assessment of intra-syllabic awareness tasks revealed that only the CAP group experienced difficulty in these tasks. This finding is consistent with the results from Raitano et al. (14), Holm et al. (22), and Peterson et al. (15). Corresponding to other studies (12, 16, 31), this study has also shown that the children had more atypical error patterns in their speech have more problems with their PA skills.

Children with CAP and ICP showed sound disorders in this study, but CAP children experience more phonological awareness difficulties. Both speech production and PA require internal representation of phonological structures (12). Therefore, impaired PA is due to CAP children's poor phonological representation (32). Mota et al. (9) indicated that PA deficiencies can persist even when speech problems were removed. In other words, children with weak phonological representations and atypical speech errors show lastingPA deficiencies.

Our finding showed CAP's language ability was significantly lower than the other groups. This finding can be explained by the psycholinguistic model (13). According to the psycholinguistic model, visual PA tasks involved lexical representation (including phonological and semantic representation). This study used a visual PA test and thus promoted phonological and semantic representation. We conclude that the performance of the CAP group in the PA test was similar to the result of TOLD: P 3, such that they both result from underlying problems in these children's speech processing system.

As mentioned above, children with CAP and ND did not perform differently in the blending phonemes tasks. Children listened to the separate phonemes of a word and selected the related picture in this task. We think it to be a relatively simple task that could be used as a treatment. More specifically, it has been shown that focusing on speech sounds in treatment can increase children's metaphonological awareness (33).

Consistent with Holm et al. (22), children with ICP performed somewhat similarly to ND children in all tasks except when identifying words with the same final phoneme. It seems ICP children have the correct phonological representation. The inconsistency in word production is probably due to a failure to assemble an accurate phonological plan for word production. In this condition, even if correct phonemes are selected, the decomposition leads to phonetic variability (22).

Larrivee and Catts (32) claimed that phonological representation deficiency is the basic cause for expressive speech disorders. Consistent with Holm et al. (22), we believe it is insufficient to only define expressive speech disorders through phonological representation difficulties. In addition to phonological representation, other skills (e.g. phonological assembly) are important as well.

We demonstrated that children acquired a lower score in phonemic tasks as compared to intra-syllabic ones (Figure 1). This finding is consistent with Carroll et al. (34), who indicated that the development of syllabic and intra-syllabic awareness happen earlier than phonemic awareness.

Although there was no significant difference in PCC between ICP and CAP, the relation between PA and PCC was only observed in the CAP group. Therefore, we can conclude that PCC has little impact on PA. These results are consistent with other studies (16, 35) that stated although PCC is widely used to measure the severity of speech production problems, it is not the best measure to show the relationship between speech sound accuracy and PA. Furthermore, when calculating PCC, all speech sound errors are considered the same. Therefore, two children with SSD may be show the same level of PCC but experience different severity in speech production problems due to the nature of the errors produced. It seems that the effect of PD on PA can be better shown through error type.

This study's limitations should be considered in future investigations. Firstly, although socioeconomic status (SES) is important when studying children with SSD (17), no valid and reliable instrument exists to measure socioeconomic status in Iran. In order to diminish SES' effect, we tried to select children based on residential area and mother's education. Secondly, controversy exists on the effect of gender on PA skills (36-38). Our study lasted approximately 1 year and we selected all children who met the inclusion criteria. However, we did not have sufficient samples to consider the effect of gender. Thirdly, due to limitations in samples, we could not select children without a history of treatment. As noted in the discussion, PD children who are receiving treatment may be sensitive to a place with sounds. Although Mota et al. (9) have shown that a history of treatment has little impact on PA skills, this sensitivity may affect their PA abilities. For future studies, we suggest it is better to select children who have not received treatment or are in early stages of treatment.

5.1. Conclusions

The result of this study showed that compared to children with typical error patterns, those with atypical errors have a more severe speech impairment. Furthermore, the results also imply that children with atypical speech errors are at risk of experiencing poor PA skills more than children who make inconsistent or delayed speech errors. Due to the importance of PA, poor PA must be recognized and appropriate intervention needs to be offered. Early intervention can help to prevent future literacy problems for these children.

The present study's result confirmed Dodd's classification system is useful for studying PA skills in PD children. The present study also suggests that error type is more practical than PCC for investigating PA.

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Footnotes

Authors' Contribution: Navideh Shakeri collected the data and drafted the manuscript. Zahra Soleymani prepared the manuscript preparation and is the corresponding author and study designer. Talieh Zarifian edited the manuscript and Mohammad Kamali provided analysis to the data.

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