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# USE OF MOBILE APPLICATION AS A STRATEGY FOR CONTINUITY IN THE TREATMENT OF PHONOLOGICAL DISORDERS AT HOME ENVIRONMENT

## USO DE APLICACIÓN MÓVIL COMO ESTRATEGIA DE CONTINUIDAD EM EL TRATAMIENTO DE TRANSTORNOS FONOLÓGICOS EM EL ENTORNO DOMICILIARIO

## UTILIZAÇÃO DE APLICATIVO MÓVEL COMO ESTRATÉGIA DE CONTINUIDADE DE TRATAMENTO DE DESVIO FONOLÓGICO EM AMBIENTE DOMICILIAR

Mére Lander Moura Lins [1]
Almira Alves dos Santos [2]
Luciana Costa Melo [3]

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**Abstract**
The study aimed to evaluate the applicability of a mobile application (App) to be used in the treatment process of Phonological Disorder (PD) in school-age children. For this, in the screening, the imitation test and an illustrative image of the ABFW protocol were used, then speech data were collected through the naming of figures with the ABFW phonology test and spontaneous speech to identify the process. A comparative analysis of the phonetic inventory was performed before and after the intervention period. The results show that the prevalence of SCD in schools 1 and 2 was, respectively, 11.5% and 9.4%. There was a concentration of PD in children in the 1st, 2nd and 3rd school years. Of the twenty volunteers who completed the survey, 40% automated the worked phoneme, 45% acquired it in a non-systematic way and 15% did not acquire it. It is concluded that the educational application is a useful tool in speech therapy for children with PD and proved to be an aid tool in the process of automating the installed phoneme.

**Keywords**: Mobile applications; Speech therapy; Child language; Phonological disorder.

**Resumen**
El estudio tuvo como objetivo evaluar la aplicabilidad de una aplicación móvil (App) para ser utilizada en el proceso de tratamiento del Trastorno Fonológico (TP) en niños en edad escolar. Para ello, en el cribado se utilizó el test de imitación y una imagen ilustrativa del protocolo ABFW, luego se recogieron datos del habla a través de la denominación de

1 Master's student in Teaching in Health and Technology at the State University of Health Sciences of Alagoas. Specialist in Orofacial Motricity with Emphasis in Hospital Speech Therapy by the Center for Teaching and Research in Medical Emergencies. Speech Therapist at Public Health Network of Maceió. ORCID: https://orcid.org/0000-0003-2194-9891 Contact: merelander80@gmail.com
2 Doctorate in Dental Sciences from Universidade Estadual Paulista, with a Post-Doctorate in Education from the Lusófona University of Humanities and Technologies. Professor at the Professional Master's Degree in Health and Technology Teaching at the State University of Health Sciences of Alagoas.
ORCID: https://orcid.org/0000-0001-9489-7602 Contact: almira.alves@uncisal.edu.br
3 Doctorate in Health Sciences from the Federal University of Alagoas. Professor in the Master's Degree in Health Sciences at the State University of Health Sciences of Alagoas and in the Postgraduate Program in Nutrition at the Federal University of Alagoas.
ORCID: https://orcid.org/0000-0002-4498-5855 Contact: luciana.melo@uncisal.edu.br

imágenes con el test de fonología ABFW y habla espontánea para identificar el proceso. Se realizó un análisis comparativo del inventario fonético antes y después del período de intervención. Los resultados muestran que la prevalencia de TP en las escuelas 1 y 2 fue, respectivamente, de 11,5% y 9,4%. Hubo una concentración de TP en niños de 1°, 2° y 3° año escolar. De los veinte voluntarios que completaron la encuesta, el 40% automatizó el fonema trabajado, el 45% lo adquirió de forma asistemática y el 15% no lo adquirió. Se concluye que la aplicación educativa es una herramienta útil en la logopedia de niños con EP y demostró ser una herramienta de ayuda en el proceso de automatización del fonema instalado.

**Palabras clave:** Aplicaciones móviles; Terapia del lenguaje; Lenguaje infantil; Trastorno fonológico.

**Resumo**
O estudo objetivou avaliar a aplicabilidade de um aplicativo móvel (App) para ser utilizado no processo de tratamento do Desvio Fonológico (DF) em crianças em idade escolar. Para isso, na triagem, foi utilizado o teste de imitação e uma imagem ilustrativa do protocolo ABFW, em seguida foram coletados os dados de fala por meio da nomeação de figuras com o teste de fonologia ABFW e fala espontânea para identificação do processo. Foi realizada uma análise comparativa do inventário fonético antes e após o período de intervenção. Os resultados mostram que a prevalência de DF nas escolas 1 e 2 foi, respectivamente, 11,5% e 9,4%. Houve concentração de DP em crianças do 1º, 2º e 3º anos escolares. Dos vinte voluntários que completaram a pesquisa, 40% automatizaram o fonema trabalhado, 45% o adquiriram de forma não sistemática e 15% não o adquiriram. Conclui-se que o aplicativo educacional é uma ferramenta útil na terapia fonoaudiológica de crianças com DP e mostrou-se uma ferramenta de auxílio no processo de automatização do fonema instalado.

**Palavras-chave:** Aplicativos móveis; Fonoterapia; Linguagem infantil; Transtorno fonológico.

## Introduction

Speech is one of the human communication channels, in which the production and reception of the sounds that constitute it is necessary for the transmission of a message. The intelligibility of speech, or better, a good pronunciation, is a decisive factor for the message transmission process, for this to happen, the child needs to learn to produce well the contrastive sounds that are part of their language (CAMPOS et al. 2014; ZORZI, 1998).

Phonological disorder (PD) is characterized by speech alterations, taking as a parameter the adult pattern of the linguistic community in which the child lives. They are identified through phonological processes where the child, in an attempt to match the sounds or a class of sounds, erases, distorts and/or replaces them without any organic alterations (COSTA; MEZZOMO; KESKE-SOARES, 2013).

The performance regarding the phonological inventory improves with age, that is, in a typical phonological acquisition, as a child develops, they acquire the phonemes and overcome the difficulties. This phonological mastery may occur, in Brazilian Portuguese, around 5 years of age, although this may vary from child to child (CERON *et al*. 2017).

Phonological alterations may persist in the speech of some children, beyond the expected age, for several reasons, such as: difficulties in executing an articulatory sequence (apraxia of speech), difficulties in articulatory production (phonetic deviation); and even difficulties in the mental organization of sound production (phonological deviation) (STRAND *et al.* 2013; NAMASIVAYAM *et al.* 2013).

Speech therapy has been increasing more and more with the use of technology through *tablets,* interactive games, mobile applications with individual games and the use of cameras, as motivating resources for the therapeutic process (NOBLAT; SILVA; CUNHA, 2020). The proper use of technology can lead to various forms of health benefits, and applications *(App)* are resources recognized by the World Health Organization (WHO) as a complement to the strengthening of health care, remembering the importance of evaluating and monitoring this resource (WHO, 2011).

Combining technology with phonological awareness activities for phonological disorder therapy can be a good strategy, taking into account that 85% of children between 09- and 17-years old use smartphones to access the internet (CETIC, 2020).

There are several proposals for models of speech therapy for phonological disorders, but the applicability of each one must take into account that each child has their own learning pace (SPÍNDOLA; PAYÃO; BANDINI, 2007; WIETHAN; MOTA, 2011). With the advancement of technology, there has been an expansion of possibilities of tools for the application of these models. Bearing in mind the playful characteristics of technology for children, this study proposes to evaluate the applicability of a mobile *App* in the treatment of PD in school-aged children.

## Material and methods

- Ethical aspects

A before-and-after uncontrolled clinical trial was carried out, approved by the Research Ethics Committee (CEP) of the State University of Health Sciences of Alagoas *Universidade Estadual de Ciências da Saúde de Alagoas* – UNCISAL) under protocol number 4,409,062.

The specific authorization of the research participants was requested by reading and signing the Free and Informed Consent Form by parents and/or guardians, as well as the children's consent through the Free and Informed Assent Term.

- Sample selection

A convenience sample composed of all children aged 6 to 12 years old with phonological disorders enrolled in two public schools of the state of Alagoas was defined. 409 children were screened, 113 from school 1 and 296 from school 2.

The screening process was carried out in a room reserved for this purpose, ensuring privacy and an environment conducive to the evaluation protocol. The identification of alterations in the children's speech was carried out with the imitation test (39 words containing Brazilian Portuguese phonemes), in which the child was instructed to repeat the words after listening to them, being registered with phonetic transcription. An illustrative image of the ABFW language test by Wertzner (2016) for observation of spontaneous speech was also used.

For the phonetic assessment, the imitation (39 words) and naming (34 images) tests of the ABFW language test were performed and recorded through phonetic transcription.

The evaluation of the phonoarticulatory organs was performed based on the MBGR Orofacial Myofunctional Examination (adapted) by Genaro *et al.* (2014) to examine the anatomy and position of intraoral structures such as lips, tongue, hard palate and soft palate, palatine tonsils, teeth and dental occlusion, as well as the mobility of the lips, tongue, soft palate and mandible, in addition to the tonicity of the lips, tongue and cheeks.

The children were referred for auditory evaluation with tonal audiometry and immittanciometry to rule out any degree of hearing loss and for otorhinolaryngological evaluation whenever a wax plug was detected in the meatoscopy exam.

The flow diagram that illustrates the selection and inclusion of the children in the research is shown in Table 1.

**Table 1 -** Sample selection flow diagram

| School | Enrolled | Screening | DF | Start of protocol |
|---|---|---|---|---|
| 1 | n = 193 | n = 113 | n = 13 | n = 10 |
| 2 | n = 358 | n = 296 | n = 29 | n = 19 |

**Source**: Elaborated by the authors (2022).

- Mobile app

The application used in this research was developed by the authors themselves. The resource uses an approach based on phonological awareness seeking the perception of segmentation and syllable synthesis in order to stimulate the installed phoneme. It was built with folders separated by Brazilian Portuguese phonemes with images and gaps to be filled in by the child. The gap with the target sound is shown with a color and brightness stimulus, promoting visuospatial perception of the structure of the word and the exact moment of emission of the stimulated phoneme. In addition, it shows the shading of the syllables to facilitate their placement in their respective gaps and the auditory stimulus, favoring the repetition of syllables and words by the children.

- Intervention protocol

Those responsible for the children who met the inclusion criteria were invited to come to the school for a consultation.

With the 20 children included in the research, a pre-therapy and post-therapy evaluation was carried out with the tasks of imitation (repetition of a list of 39 words) and naming (with 34 pictures) of the ABFW language test, where the speech data were transcribed phonetically.

Before making the application available, a phoneme was installed in the child's speech (the phoneme to be installed was selected in order of acquisition of the phonological process), through the articulatory therapeutic approach that consists of multisensory work that leads the child to perceive the articulatory point, emphasizing the tactile and kinesthetic sensation (REHDER *apud* FERREIRA; BEFI-LOPES; LIMONGI, 2004; ISSLER, 1996).

Therefore, materials such as a tongue depressor and a mirror were used to favor the installation of the phoneme. The procedure was carried out in a room of the school with the presence of the guardian. The perception of the sound's articulation, as an observable level of speech, is a factor adjunct to the phoneme automation process (MOTA, 2001).

The parents or guardians were instructed to download the application, then an access link was sent to download it, as the application is not yet available in virtual stores. After the download, the responsible was instructed to open the application for registration (with email and password), and then its functioning was presented. The responsible, together with the child, was instructed on the use of the resource twice a day (mornings and evenings). Two follow-up consultations were carried out (15 and 30 days after starting to use the *App*) in order to reinforce guidelines regarding the stimuli and the importance of their frequency. Among the folders of available phonemes in the application, only the target phoneme folder was intended for use by the child. A post-therapy assessment was performed (after 45 days) using the imitation and naming tasks of the ABFW language test to reassess the child's phonetic profile.

- Data analysis

After data collection, the results were tabulated and examined performing a descriptive analysis of the data and a comparative analysis of before and after, referring to the number of children who automated (properly pronouncing the phoneme in all words spontaneously), did not acquire (did not pronounce the phoneme spontaneously) or acquired the phoneme unsystematically (sometimes pronouncing the phoneme correctly and sometimes not). By means of graphs, tables and charts, we sought to illustrate the data and evolution of the subjects for a better understanding of the reader. Numerical data are expressed as mean and standard deviation. The frequency distribution analysis of categorical data was performed using the Chi-square test using the *Bioestat software* 5.0. Statistical significance was considered for p values < 0.05.

## Results

- Sample characterization

The schools where the study was carried out have 551 children enrolled. Due to the difficulty in contacting the students' guardians, speech alterations were screened in only 409 children (219 females and 190 males). 42 of these children were diagnosed with a phonological disorder (10.3%). The prevalence of phonological disorders in schools 1 and 2 was 11.5% and 9.4%, respectively. A prevalence of 53.55% in girls and 46.45% in boys was verified. No statistical difference between genders was verified ($X^2$: 2.2889; p = 0.1303).

With regard to the distribution of PD between school years, a concentration of this disorder in children in the 1st, 2nd and 3rd years was verified. Using the Chi-square test for calculating the differences between school years (Table 2), a significance level of less than 0.05 was verified.

**Table 2 -** Characterization regarding the prevalence of phonological disorders in the children evaluated in the screening.

| School year | Students (n) | With PD (n) | Without PD (n) | PD prevalence (%) |
|---|---|---|---|---|
| 1 | 85 | 17 | 68 | 20.0 |
| 2 | 76 | 13 | 63 | 17.1 |
| 3 | 79 | 10 | 69 | 12.7 |
| 4 | 93 | 02 | 91 | 2.1* |
| 5 | 76 | 00 | 76 | 0.0* |
| Total | 409 | 42 | 367 | 10.3 |

*Chi-square test with a significance level of less than 0.05 for calculating the differences between school years. **Source**: Elaborated by the authors (2022).

Of the 13 children who presented phonetic alterations at School 1, two did not have a smartphone, one had alterations in its phonoarticulatory organs (anterior open bite) and still had the habit of thumb sucking. Five volunteers did not complete the protocol: three dropped out of the research and two did not keep in touch, leaving only five children. Of the 29 children with phonetic alterations enrolled in school 2, shortening of the frenulum of the tongue was identified in three, making the tongue's mobility difficult; one child did not have a smartphone; and it was not possible to make contact with the guardians of 6 children. In addition, 4 children did not continue with the protocol: 1 because of the App being uninstalled, 1 due to a shared custody process (destabilizing routines) and 2 did not keep in touch, leaving only fifteen children. Thus, eventually, twenty children participated in this research (Table 3).

**Table 3 -** Characterization of the sample regarding education, gender and age

| School year | PD diagnosis (n) | Gender | | Age (years) |
|---|---|---|---|---|
| | | female | male | Mean ± SD |
| 1 | 06 | 04 | 02 | 7 ± 0.63 |
| 2 | 06 | 04 | 02 | 8 ± 0.00 |
| 3 | 07 | 05 | 02 | 8.86 ± 0.63 |
| 4 | 01 | 01 | 00 | 10* |
| Total | 20 | 14 | 06 | - |

*Age of 4th grade child. SD: Standard deviation from the mean. PD: Phonological disorder. **Source**: Elaborated by the authors (2022).

There was a higher concentration of PD in children of the 1st, 2nd and 3rd year, however with the Chi-Square test we verified that there was no difference in the acquisition of phonemes between these school grades. Of the 20 children, 7 were from the 3rd year, where four automated the phonemes and three acquired them

unsystematically; six from the 2nd year, where one automated the phonemes, four acquired them unsystematically and one did not acquire them; and from the six children in the 1st year, two automated the phonemes, two acquired them unsystematically and two did not acquire them.

- Phonological processes

As for the phonetic inventory, 7 phonological processes were identified, among them: consonant cluster reduction[4] (10 children), final consonant reduction[5] (6 children), liquid simplification[6] (4 children), palatal frontalization[7] (2 children), posteriorization to palatal[8] (2 children), velar frontalization [9](1 child) and posteriorization to velar [10](1 child). One child had phonetic speech distortion. The phonemes were installed in the order of the phonological acquisition process.

- Adhesion to the mobile *App* for the treatment of phonological disorders

Twenty-nine volunteers started the protocol, 9 of them dropped out of the research, a loss of 31%. The losses were characterized by the lack of contact with 4 children, 3 of the guardians mentioned time unavailability to monitor the child's activity, reporting excess of formal, informal or domestic work; 1 responsible person uninstalled the application after two weeks of use, referring to the low memory capacity of the cell phone, although it was explained that the *App* did not interfere with this capacity. One guardian withdrew from follow-up due to instability in the

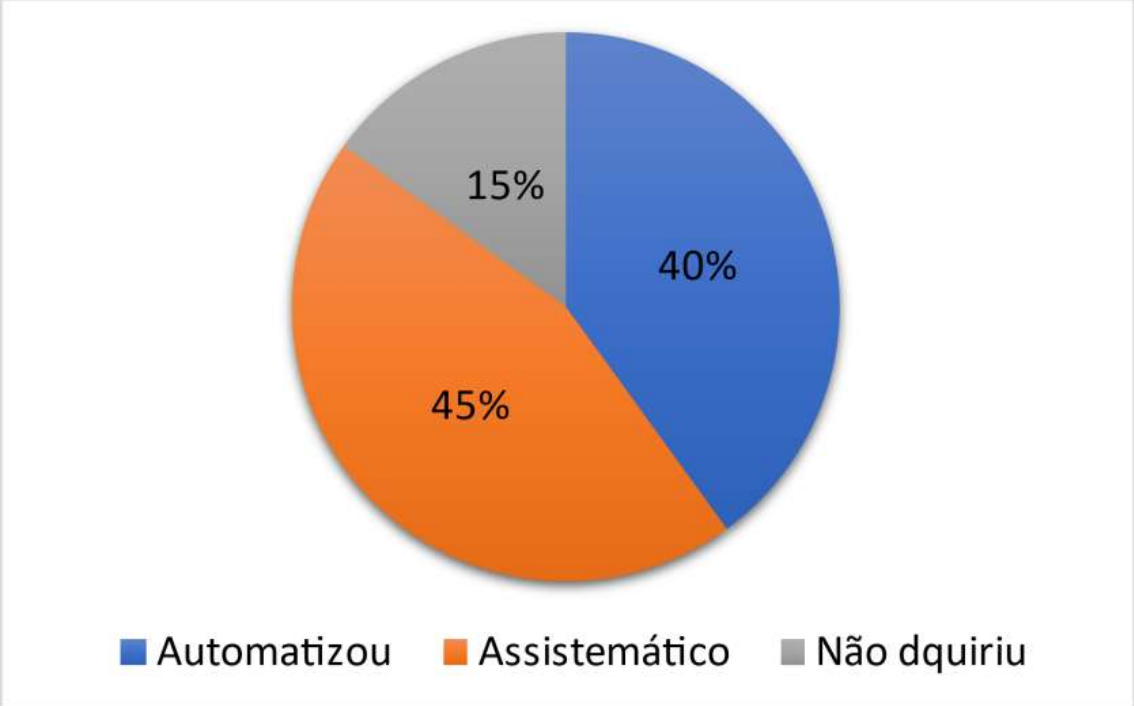
[4] Elimination of one of the elements of the cluster, usually the liquid consonant. Observed both in the structures consonant + /l/ + vowel (ClV) and consonant + /r/ + vowel (CrV). Ex.: /pRatu/- [patu]-[platu].
[5] Elimination or replacement of the final consonant of the word or syllable, in the syllable structure consonant + vowel + consonant (CVC). Ex.: /paSta/ - [pata].
[6] Includes substitution, semivocalization and the omission of vibrants. Eg: /sara/ - [sala] or [saya], /bola/ - [boya], /abeλa/ - [abeya] or [abea].
[7] Anterior production of a palatal fricative consonant, generally transforming it into an alveolar fricative. Eg: / **ʃave/ - [save],** / /3aka/ - [zaka].
[8] Alteration of the articulation zone transforming a palatal fricative phoneme into an alveolar fricative phoneme. Eg: /sapu/ - [**ʃapu], /zɛru/- [**3**ɛ**ru].
[9] Transformation of a velar plosive phoneme into a linguo-alveolar plosive phoneme. Ex.: /galu/ - [dalu].
[10] Transformation of a linguodental plosive phoneme into a velar plosive. Ex.: /tomada/ - [komaga] (WERTZNER, 2016).

child's routine since the child was subject to shared custody and the communication between the parents was difficult. Of the 42 children with PD, only three did not have a smartphone (7.1%) and all the others had access to internet (92.9%). Among the difficulties found for adhering to the research, we observed family disinterest in monitoring activities, family instability, and difficulties maintaining access to the families. Those responsible for the children who continued with the protocol mentioned ease of monitoring due to the feasibility of the application, leaving the child with more autonomy during its use.

- *The* Application's applicability for the treatment of phonological disorders

Of the twenty volunteers who completed the survey, eight (40%) automated the worked phoneme, nine (45%) acquired it unsystematically and three (15%) did not acquire it (Graph 1).

**Graph 1** - Analysis of phoneme automation after the intervention




**Source:** Elaborated by the authors (2022)

## Discussion

The present study identified a prevalence of 10.3% of PD in school-aged children, predominantly in the first years of elementary school, with no differences between genders. Good adhesion to the developed mobile *App was observed,* making it possible to associate it with speech therapy for the treatment of PD with satisfactory results.

Phonological disorders are one of the most common speech-language disorders and are treated in the public service. There is variability in the percentages of prevalence for phonological disorders in the national literature, ranging from 4.2% to 63.2%. These data are justified by the different methodologies used in the evaluation and nomenclature of speech disorders (LOPES, 2018; CERON *et al*., 2017; CAVALHEIRO; BRANCALIONI; KESKE-SOARES, 2012).

The present study identified delays in the elimination of phonological processes; the most frequent ones were: consonant cluster reduction, final consonant reduction and liquid simplification, corroborating the results found in the studies by Ceron et al. (2017), Rios *et al.* (2021), Indrusiak and Rockenbacah (2012), who draw attention to the consonant cluster reduction and final consonant reduction processes expected to be eliminated by the age of seven. These processes are more common due to the fact that these children remain with sound substitution and/or omission strategies to resolve the complexity of the segment and/or syllabic structure that they still do not know or have not mastered (CERON et al. 2017).

The difficulty in articulating speech (speech apraxia), speech distortions (phonetic deviation) and difficulties in the mental organization in the production of sounds (phonological deviation) are factors that can contribute to the maintenance of these processes in older children (NAMASIVAYAM et *al.* 2013; CERON *et al.* 2017).

It was found in this study that 40% of the children automated the worked phoneme (properly speaking the phoneme in all words spontaneously), 45% acquired it unsystematically (speaking the phoneme correctly sometimes and sometimes not) and 15% did not acquire it (not speaking the phoneme spontaneously). The fact that some children were able to produce the worked sounds, but not systematically in

spontaneous speech, may have been due to the disposition of the stimuli or even to the duration of the treatment (MELO; WIETHAN; MOTA, 2012).

According to the speech therapy time marker, 2 weekly sessions lasting 45 minutes should be performed for the treatment of speech disorders (CFFa, 2013). Nevertheless, speech therapy work in Primary Care is quite broad, seeking to develop health-promoting actions both individually and collectively, acting in the promotion and protection of health, in the prevention of injuries, in the diagnosis, treatment, rehabilitation and maintenance of health (MOLINI-AVEJONAS; MENDES; AMATO, 2010). Considering this and considering the great outpatient demand for speech therapists in Primary Care, and aiming to reduce the repressed demand, a resource that enables and optimizes the duration of speech therapy is important (LOPES, 2018; MOREIRA; MOTA, 2009; MEDEIROS; LIMA, 2019).

The application for phonological disorder therapy becomes thus a tool for maintaining and increasing therapy practices outside the outpatient clinic, being able to optimize the time of therapy planning and also monitor the performance and progress of the patient (FURLONG et al. 2018; JESUS *et al.* 2019).

In Brazilian Portuguese, a test to verify speech stimulability in children was proposed by Castro and Wertzner (2009), in this test, when the child is stimulable, they can produce sound even with a deficit in their mental representation, but when a child is not stimulable they present difficulties in producing the articulatory gestures for this sound, requiring intervention to be able to produce it, as shown by studies that present techniques for the motor production of speech (NAMASIVAYAM *et al.* 2022).

Consistency in the frequency of the activities and family monitoring are also fundamental for the automation of phonemes in children's speech. The study carried out by Fernandes and Souto (2021) concluded that some parents and guardians of children with PD considered family dedication important and participated actively in the activities. Others stated that environmental and personal conditions made it difficult for them to participate in the continuity of the therapeutic project. There were even some who did not understand the importance of the partnership between the family and the therapist in the treatment process, focusing their expectations on the therapy.

The integration of those responsible for the children with the practitioner and with the entire therapeutic process is essential (SOUZA, 2013). The use of the application does not exclude the role of the family, which is responsible for monitoring the activities carried out at home. In the present study, we observed, in the meetings with the children and the guardians, that the work of the parents and the care of other children would be impeding factors for maintaining follow-up, even with all the guidance on the importance of assistance during the use of the *App,* some guardians let the child alone with the resource.

Both the family and the environment can influence language development as well as the production and maintenance of an alteration. Some studies show the importance of the family's participation in the speech therapy process, of the family's history of speech and language disorders, of the relationship between the socioeconomic level of the family, of the parents' education level and of the interaction between parents and children with the language development in children (ZHAO *et al.*, 2022; SOUZA, 2013; CARVALHO; LEMOS; GOULART, 2016).

The highest rate of PD was found in children in the 1st, 2nd and 3rd year. Taking into account that the child needs phonological mastery for the process of learning to read and write, it is necessary to detect speech disorders early, even before starting literacy, preventing repetition in school grades (GOULART; CHIARI, 2014).

Currently, the use of apps has become increasingly accessible to therapists and children from different social and sociocultural classes, as technology is already part of children's daily lives (CETIC, 2020; LEITE et al. 2018). The *App* presented in this study was developed with an easy-to-use operating system, a colorful interface, with images known to children, visual and auditory stimuli, and easy to apply, favoring phonological awareness, that is, perception of the sound worked within the word and, consequently, the automation process. The *App* is based on phonological awareness that allows the child to understand the structure of the word (divisible into syllables) and the exact moment to emit the target sound in the initial, medial and final position of the word in a repetitive way to favor the automation of the worked phoneme.

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Adhering to the *App* involved several factors such as the need for *internet access*, which requires the use of mobile network data or access to the *Wi-Fi network*; the incompatibility of schedules, time devoted to activities, family dynamics and commitment. Despite these factors, these issues were not a problem for most subjects of the sample.

This study was limited due to the period of the COVID 19 pandemic and consequently the number of children included in the sample. It is believed that a larger sample could bring better results regarding the benefits of the *App*.

The treatment of speech in children, as one of the study purposes of speech therapy, requires great attention from public health actions, as it ensures the individual to become a transforming agent of society and of their life. In view of the great demand in speech therapy and in the quest to prioritize speech therapy needs in the public service, it is necessary to create technological resources that accelerate discharge in speech therapy (MOREIRA; MOTA, 2009).

Given this, and supported by the results of the present study, it was observed that the use of the technological tool does not replace speech therapy but becomes an ally in its progress and in the work process in public health.

## Conclusion

The mobile application was effective as a tool for continuing the speech therapy process for phonological disorders in the home environment. The technological resource developed showed good adhesion and effectiveness for the automation of phonemes in children with PD.

The present study shows that despite the technology and user-friendliness of the application, it is necessary to accompany the parents and monitor the therapist in the process of automating the worked phoneme, that is, the use of the application should not rule out speech therapy, but rather join this procedure.

## Conflict of interests

The authors declare that there is no conflict of interest regarding the publication of this article.

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