

## Research Paper

# Investigating Feeding Problems and Oral Motor Skills in Children With Cerebral Palsy



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### ABSTRACT

**Objectives:** Cerebral palsy (CP) can cause motor, sensory, cognitive, and communicative problems and poor feeding performances in children. Feeding problems could be life-threatening and negatively affect cognitive and physical growth. This study investigates the frequency of response to oral motor skills, the frequency and severity of feeding problems, and the relationship between age and oral motor skills with feeding problems in children with CP aged 2 to 7 years.

**Methods:** This was an observational and cross-sectional study. The participants were 60 children (26 girls and 34 boys) with CP with a mean age of  $4.76 \pm 1.71$  years. The screening tool for eating problems and oral motor assessment scale assessed participants' feeding and oral motor skills. The Spearman test determined the correlation between age and oral motor dysfunctions with feeding problems.

**Results:** The present study revealed that 80% of participants indicated feeding problems in the screening tool of the eating problems test. Problems with feeding skills (51.5%) were the most frequent. Furthermore, the most frequent response of participants to "closing the lips while feeding with a spoon" was 46.7%, and "sucking with straw," equaled 55.0%, which was passive. For other items, the most frequent response of the examinees was "functional." Finally, the results showed no significant correlation ( $P < 0.05$ ) between age and mean scores of frequency and severity of feeding problems. A significant negative correlation was found between mean scores of oral motor skill with frequency ( $P < 0.001$ ,  $r = -0.476$ ) and severity ( $P = 0.001$ ,  $r = -0.424$ ) of feeding problems.

**Discussion:** The majority of children with CP have problems with feeding and oral motor skills. Some skills in the fields of feeding and oral motor should be noticed more by speech-language pathologists and included in their therapeutic program, especially "feeding skills," "closing the lips while feeding with a spoon," and "sucking with straw."

### Keywords:

Cerebral palsy, Feeding and eating disorders, Oral motor skills, Children

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## Highlights

- A total of 80% of 2 to 7-year-old children with cerebral palsy (CP) showed eating problems.
- The most frequent response of children with CP to oral motor skills test was related to the “functional” item, showing slightly compromised oral motor performance.
- A significant relationship was between oral motor skills and the frequency and severity of feeding problems; however, no relationship existed between participants’ age and the frequency and severity of feeding problems.

## Plain Language Summary

The present study investigated the relationship between age and oral motor skills with feeding problems in 2- to 7-year-old children with cerebral palsy. This subject was selected for two reasons: 1) The high prevalence of feeding problems in these children, and 2) The effect of feeding problems on physical and cognitive growth. This study found several problems in oral motor skills related to eating in cerebral palsy children that negatively impacted feeding skills. It was concluded that parents and clinicians should be aware of the adverse effects of oral motor problems on feeding and, consequently, different aspects of their growth, primarily physical and cognitive ones, and follow necessary therapeutic actions.

## Introduction

**C**erebral palsy (CP) is defined as a motor developmental and non-degenerative disorder during brain growth that occurs before the age of 2 years [1-3]. The prevalence of this disorder is an average of 2.5 children per 1000 births [1, 4]. Although motor disability is a core symptom of this disease, it is also characterized by seizures, sensory problems, language problems, visual impairments, hearing problems, speech disorders, cognitive impairment, lower than average intelligence quotient, and feeding problems [3]. Regarding feeding problems in individuals with disabilities, significant studies have been conducted in developed countries [5]; however, studies are scarce in developing countries [6]. The prevalence of feeding disorders in children with CP is relatively high [7-10]. Oral-motor impairments can cause feeding deficits, the existence of primary reflexes, and sensory impairments [11, 12], and approximately up to 89% of children with these problems show some degree of feeding problems [13]. This disorder also may lead to malnutrition and reduced calorie and nutrient intake, affecting brain growth and myelination in the first three years of life [2, 14].

Oral motor problems are common in children with CP, leading to low muscle tone, poor sucking, protruding tongue, open lips, poor control of saliva, decreased range of motion of the tongue, difficulty chewing, and aspiration [13]. The most important clinical sign of abnormalities in the bolus preparation and the onset of swallowing

is malnutrition; however, the clinical significance of aspiration is recurrent chest infections [15].

Dehghan et al. (2019) investigated the rate of oral motor dysfunctions during feeding and the factors affecting that in children with CP. They reported that failure to inhibit primary oral reflexes at the expected time leads to feeding problems that limit the child’s ability to chew, regulate, and swallow food [9]. Johnson et al. (2004) suggested that different factors contributed to feeding problems experienced by these children, including impaired oral motor functions, such as weakness of tongue movement, partial lip obstruction, abnormal oral reflexes, and inappropriate sitting posture [16]. Lacerda et al. (2017) reported that in children with CP, oral motor deficits lead to feeding problems, such as drooling, recurrent coughing, and lack of coordination in sucking, chewing, and swallowing muscles that can be considered the leading cause of death in these children [17]. Various studies have reported that oral-motor dysfunctions play a crucial role and may severely affect oral feeding [2, 18].

In previous studies, the prevalence of feeding problems and oral motor dysfunction has been reported in different ranges among children with CP [19-22]. Despite the importance of proper feeding in the cognitive and physical growth of children [2, 3], and the relatively high prevalence of these problems in children with CP [13], as well as the prominent role of age and oral motor abilities in feeding function [18], few studies have examined this topic in these patients in Iran, especially to explore the correlation

of oral motor skills and age simultaneously with feeding problems. Also, the number of studies that have used the screening tool of feeding problems (STEP), as a reliable tool, in children with CP in Iran, is low and their participants were most children with another disease [22]. On the other hand, most sample sizes of previous similar studies have been smaller compared to the present study [1, 20-26]. Detecting the presence of a relationship between these variables can play an impressive role in treating these children; therefore, the present study explores the relationship between age and oral motor skills with feeding problems in 2 to 7-year-old children with CP in Iran.

## Materials and Methods

### Study participants

This was a descriptive-analytical cross-sectional study. This study recruited 60 (26 girls and 34 boys) children with CP aged 2 to 7 years with a mean age of  $4.76 \pm 1.71$  years. The patients were selected from rehabilitation centers in Mashhad City, Iran. The sampling was done via the available sampling method.

The inclusion criteria for patients were 2 to 7 years of age, diagnosed with CP (based on patient's medical record and approval of pediatric neurologist), lack of seizures based on patient's medical documents, no presence of oral structural problems, such as cleft palate (based on a direct evaluation by a trained speech therapist), no presence of pathologic oral reflexes (examined by an experienced speech therapist) [27-30], having normal development in sensory (hearing and vision) processing (based on medical records and caregiver reports), and being able to understand the therapist's instructions. Meanwhile, the exclusion criteria for the patient group were the children who had no cooperation with the parent/careers or examiner and the presence of any problems encountered during the assessments. The children's parents were informed about the study. Besides, the researchers obtained written informed consent from them.

### Study procedure

Individuals who were eligible according to the inclusion criteria were selected. Two different tests were applied to examine feeding and oral-motor skills. All of the tests were completed in a single 45-min session. For all participants, evaluations started with STEP [31, 32], and after a brief break, the oral motor assessment scale (OMAS) [2, 33], was conducted. For all subjects, evaluations were performed by a single examiner in a room with proper light and ventilation and no distractions.

## Study measurements

### STEP test

STEP was used to detect the participant's feeding problems. This test consisted of 23 items and 5 general categories, including aspiration risk, selectivity, feeding skills, food refusal-related behavior problems, and nutrition-related behavior problems [32]. Response to each item of this instrument was based on two domains of severity and frequency and addressed five items rating based on a 3-point Likert scale [34, 35]. On the frequency domain, "0" indicates no occurrence of the behavior, "1" shows the behavior occurred one to ten times, and "2" indicates the occurrence of the behavior more than ten times in the past month. Furthermore, on the severity domain, "0" indicates that the behavior was not problematic, "1" represents that the behavior made small problems, and "2" demonstrates that the behavior caused severe problems in the past month. Total feeding problems were measured by the sum of responses to all 23 items, ranging from 0 to 46 for each domain. Matson et al. (2008) reported the validity of this test as appropriate and calculated its reliability using the Cronbach  $\alpha$  coefficient of 0.89 [33]. In the study of Rezaei et al. (2012), the reliability of the STEP using the Cronbach  $\alpha$  coefficient was 0.84 [31]. It was performed for an individual with mental retardation and their mean age was 8.53 years [31].

### Oral motor assessment scale

This scale is a diagnostic tool to assess oral motor skills in children and adolescents with neuromuscular disorders [36] developed by Ortega et al. in 2009. It also examines oral motor skills during feeding in children with brain injury [23]. The reliability of this tool has been determined for the Persian version in children and adolescents with CP [2, 36]. This scale evaluates the feeding functions of oral closure during feeding, lip ligation during feeding with a spoon, lip ligation during swallowing, food control, and chewing, straw-sucking, and liquid control during ingestion. The mother or child task was asked to give the child a meal naturally to perform the test with one of the following items: Soft food, such as yogurt (if we were faced with a lack of interest in our children, a diluted porridge or dent was used) using a spoon; stiff food, such as wafer (the replacement in the absence of child interest was biscuit); drinking liquid, such as water (or high-sugar juice) from a glass with and without the use of a straw. Then, the examiner observed the child during sucking, chewing, and swallowing, and scores were evaluated for the categories. Each category

was observed for about 30 s and the examiner did not interfere with swallowing the food. During the evaluation, if the child was considered to have more than one type of oral motor skill for the same category, the skill that was primarily used would be considered. The final score of oral/motor skills was related to the score that was further repeated. The scoring system in all items was as follows: Passive with a score of "0," which showed severely compromised oral motor performance; sub-functional with a score of "1," indicating moderately compromised oral motor performance; semi-functional with a score of "2," demonstrating slightly compromised oral motor performance, and functional with a score of "3," showing very slightly compromised oral motor performance. The total score was a sum of all items' scores ranging from 0 to 21 [18, 23, 37].

### Statistical analysis

The information was entered into the SPSS software, version 24. The descriptive statistics part calculated the variables' Mean $\pm$ SD, and number (percentage) of values. The Kolmogorov-Smirnov test was used to evaluate the normality of data. The statistical distribution of the data was not normal ( $P>0.05$ ), hence, the nonparametric (the Spearman) test was used for analytic statistics. This study considered age and oral motor function normal and abnormal feeding problems. The Spearman test was used in the analytic statistics part to determine the correlation between age and oral motor skills with feeding problems. Meanwhile,  $P<0.05$  were considered statistically significant.

## Results

### Demographic features

This study investigated the frequency of oral motor skills, frequency, and severity of feeding problems, and the relationship between age and oral motor skills with feeding problems in children 2-7 years old with CP. A total of 60 children with CP participated in this study. The demographic status of participants is demonstrated in Table 1.

### Descriptive findings

#### Frequency of oral motor skills

The frequency of oral motor skills in participants is deAccording to Table 2, the most frequent response of participants to the items of "closing the lips while feeding with a spoon (46.7%)" and "sucking with straw (55.0%)" were "passive." For other items, the most frequent response of examinees was "functional." For the items of "closing the lips while feeding with a spoon" (61.7%), "chewing" (55%), "sucking with straw" (65%), and "control of fluids during swallowing" (68.3%), more responses were "unfunctional." Finally, the mean score of total OMAS was  $12.2\pm6.4$  (Table 3).

#### Frequency and severity of feeding problems

Moreover, the frequency and severity of feeding problems are provided in Table 4.

As shown in Table 4, 48(80%) of the participants indicated feeding problems. "Feeding skills" (51.5%) was the most frequent, and "aspiration risk" (10, 16.7%) was

**Table 1.** Demographic characteristics (n=60)

|                          | Variables       | No. (%)  | Mean $\pm$ SD   |
|--------------------------|-----------------|--|-----------------|
| Participants             | Gender          | Male<br>34(56.6)<br>Females<br>26(43.3)  | -               |
|                          | Age (y)         | -  | $4.76\pm1.71$   |
| Participants'<br>parents | Education level | < High school<br>35(58.33)<br>≥ High school<br>15(25)<br>Academic<br>10(16.67) | -               |
|                          | Age (y)         | Mother<br>-<br>Father<br>52.81 $\pm$ 11.37                                     | $45.91\pm10.99$ |

**Table 2.** Frequency of responses to oral motor skills based on the oral motor assessment scale in 2 to 7-year-old children with cp (n=60)

| OMAS  | No. (%)   |                |                 |            |
|---|-----------|----------------|-----------------|------------|
|   | Responses |                |                 |            |
|   | Passive   | Sub-functional | Semi-functional | Functional |
| Closing the mouth during feeding            | 18(30.0)  | 2(3.3)         | 2(3.3)          | 38(63.3)   |
| Closing the lips while feeding with a spoon | 28(46.7)  | 1(1.7)         | 8(13.3)         | 23(38.3)   |
| Closing the lips while swallowing           | 15(25.0)  | 3(5.0)         | 6(10.0)         | 36(60.0)   |
| Food control                                | 6(10.0)   | 4(6.7)         | 18(30.0)        | 32(53.3)   |
| Chewing                                     | 18(30.0)  | 7(11.7)        | 8(13.3)         | 27(45.0)   |
| Sucking with straw                          | 33(55.0)  | 5(8.3)         | 1(1.7)          | 21(35.0)   |
| Control of fluids during swallowing         | 16(26.7)  | 8(13.3)        | 17(28.3)        | 19(31.7)   |

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the least of them. In the category of “feeding skills,” the most frequent problem was related to the item “cannot feed independently” (42.70%). For the category of “selectivity,” the most frequent problem was “only to eat selected types of food” (22, 36.7%). In categories of “nutrition-related behavior problems” and “food refusal-related behavior problems,” the highest frequency belonged to “only eats a small amount of the food presented” (17, 28.3%) and “spits out their food before swallowing” (23, 38%), respectively. Finally, in the category of “aspiration risk,” the most frequent problem was on the item, “vomits either during or immediately following meals” (8, 13.4%). Additionally, the total mean score of the STEP tool and the mean scores of its subscales are shown in [Table 5](#).

### Analytic findings

#### Correlation between age and STEP

Another part of the obtained results was related to the correlation between age and oral motor skills with feeding problems. The results showed no significant correlation between the age and two domains of feeding problems, frequency and severity ([Table 6](#)).

#### Correlation between the OMAS and the STEP

A significant negative correlation was detected between oral motor skills with frequency ( $P<0.001, r=-0.4$ ) ([Table 7](#)) and severity ( $P=0.001, r=-0.4$ ) ([Table 8](#)) of feeding problems.

According to [Table 7](#), a negative and significant correlation was observed between the frequency of feeding problems with “closing the mouth during feeding” ( $P=0.2, r=-0.2$ ), “closing the lips while feeding with a spoon” ( $P=0.003, r=-0.3$ ), “food control” ( $P=0.02, r=-0.2$ ), “chewing” ( $P<0.001, r=-0.4$ ), “sucking with straw” ( $P=0.001, r=-0.4$ ) and “control of fluids during swallowing” ( $P=0.008, r=-0.3$ ). Furthermore, a negative and significant correlation was between oral motor skills and the frequency of “feeding skills” ( $P<0.001, r=-0.5$ ).

According to [Table 8](#), the results indicated a negative and significant correlation between the severity of feeding problems with “closing the mouth during feeding” ( $P=0.01, r=-0.3$ ), “closing the lips while feeding with a spoon” ( $P = 0.009, r=-0.3$ ), “food control” ( $P=0.04, r=-0.2$ ), “chewing” ( $P<0.001, r=-0.4$ ), “sucking with straw” ( $P=0.005, r=-0.3$ ) and “control of fluids during swallowing” ( $P=0.02, r=-0.2$ ). Also, there was a negative and

**Table 3.** Mean±SD of total score of oral motor skills assessment in 2 to 7-year-old children with CP (n=60)

| Measure                      | Mean±SD  | Range |
|------------------------------|----------|-------|
| Oral motor skills assessment | 12.2±6.4 | 0-21  |

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**Table 4.** Frequency and severity of feeding problem using the STEP tool in children with CP (n=60) reported as No. (%)

| Items                                  | No. (%)  |           |          |          |           |          |          |
|--|--|-----------|----------|----------|-----------|----------|----------|
|  | Frequency  |           |          | Severity |           |          |          |
|  | 0  | 1-10      | >10      | Mild     | Moderate  | Severe   |          |
| Feeding skills                         | Individual cannot feed themselves independently  | 18(30)    | 2(3.3)   | 40(66.7) | 18(30.0)  | 1(1.7)   | 41(68.3) |
|  | Individual requires special equipment for feeding  | 56(93.3)  | 1(1.7)   | 3(5)     | 56(93.3)  | 0.0      | 4(6.7)   |
|  | Individual swallows without chewing sufficiently   | 28(46.7)  | 16(26.7) | 16(26.7) | 28(46.7)  | 2(3.3)   | 30(50.0) |
|  | Individual eats a large amount of food in a short period   | 49(81.7)  | 4(6.7)   | 7(11.7)  | 48(80.0)  | 5(8.3)   | 7(11.7)  |
|  | Individual does not demonstrate the ability to chew  | 31(51.7)  | 11(18.3) | 18(30)   | 30(50.0)  | 0.0      | 30(50.0) |
|  | Individual requires special positioning during feeding   | 36(60)    | 4(6.7)   | 18(33.3) | 40(66.7)  | 2(3.3)   | 18(30.0) |
|  | Individual chokes on food  | 33(55)    | 18(30)   | 9(15)    | 34(56.7)  | 0.0      | 26(43.3) |
|  | Individual does not demonstrate the ability to swallow   | 50(83)    | 5(8.3)   | 5(8.3)   | 50(83.3)  | 0.0      | 10(16.7) |
| Total                                  |  | 9(15.0)   | 41(68.3) | 10(16.7) | 7(11.7)   | 41(68.3) | 12(20.0) |
| Selectivity                            | Individual will only eat selected types of food  | 38(63.3)  | 3(5)     | 19(31.7) | 38(63.3)  | 0.0      | 22(36.7) |
|  | Individual prefers a certain setting for eating  | 57(95)    | 2(3.3)   | 1(1.7)   | 55(91.7)  | 0.0      | 11(8.3)  |
|  | Individual will only eat foods of a certain temperature  | 49(81.7)  | 2(3.3)   | 9(15)    | 49(81.7)  | 1(1.7)   | 10(16.7) |
|  | Individual prefers to be fed by a specific caregiver or prefers to be fed rather than independently feed | 41(68.3)  | 6(10)    | 13(21.7) | 42(70.0)  | 0.0      | 18(30.0) |
|  | Individual eats food of only certain texture   | 57(95)    | 1(1.7)   | 2(3.3)   | 56(93.3)  | 0.0      | 4(6.7)   |
|  | Total  | 20(33.33) | 32(53.3) | 8(13.3)  | 20(33.33) | 26(43.3) | 14(23.3) |
| Nutrition-related behavior problems    | Individual steals or attempts to steal food from others during mealtime                                  | 48(80)    | 5(8.3)   | 7(11.7)  | 50(83.3)  | 1(1.7)   | 9(15.0)  |
|  | Individual eats or attempts to eat items that are not food   | 46(76.7)  | 3(5)     | 11(18.3) | 47(78.3)  | 1(1.7)   | 12(20.0) |
|  | Individual steals or attempts to steal food outside of mealtime  | 47(78.3)  | 4(6.7)   | 9(15)    | 47(78.3)  | 3(5.0)   | 10(16.7) |
|  | Individual only eats a small amount of the food presented  | 43(71.7)  | 8(13.3)  | 9(15)    | 44(73.3)  | 0.0      | 16(26.7) |
|  | Individual will continue to eat as long as food is available   | 51(85)    | 1(1.7)   | 8(13.3)  | 51(85.0)  | 3(5.0)   | 6(10.0)  |
|  | Total  | 19(31.7)  | 30(50.0) | 11(18.3) | 22(36.7)  | 24(40.0) | 14(23.3) |
| Food refusal-related behavior problems | Individual spits out their food before swallowing  | 37(61.7)  | 14(23.3) | 9(15)    | 40(66.7)  | 2(3.3)   | 18(30.0) |
|  | Individual problem behaviors increase during mealtime  | 46(76.7)  | 9(15)    | 5(8.3)   | 47(78.3)  | 1(1.7)   | 12(20.0) |
|  | Individual pushes food away or attempts to leave the area when food is presented                         | 47(78.3)  | 5(8.3)   | 8(13.3)  | 48(80.0)  | 1(1.7)   | 11(18.3) |
|  | Total  | 27(45.0)  | 21(35.0) | 12(20.0) | 31(51.7)  | 17(28.3) | 12(20.0) |
| Aspiration risk                        | Individual vomits either during or immediately following meals   | 52(86.7)  | 7(11.7)  | 1(1.7)   | 52(86.7)  | 0.0      | 8(13.3)  |
|  | Individual regurgitates and re-swallows food either during or immediately following meals                | 54(90)    | 4(6.7)   | 2(3.3)   | 50(83.3)  | 1(1.7)   | 9(15.0)  |
|  | Total  | 50(83.3)  | 6(10.0)  | 4(6.7)   | 46(76.7)  | 1(1.7)   | 13(21.7) |
| Feeding problems                       |  | 12(20.0)  | 36(60.0) | 12(20.0) | 12(20.0)  | 34(56.7) | 14(23.3) |

**Table 5.** Frequency and severity of feeding problem using the STEP tool in children with CP (n=60) reported as Mean±SD

| Items                                  | Mean±SD   |            | Range |
|--|-----------|------------|-------|
|  | Frequency | Severity   |       |
| Aspiration risk                        | 0.28±0.74 | 0.58±1.17  | 0-4   |
| Selectivity                            | 1.70±1.65 | 1.98±1.90  | 0-10  |
| Feeding skills                         | 4.95±3.31 | 5.70±3.70  | 0-16  |
| Food refusal-related behavior problems | 1.20±1.44 | 1.43±1.80  | 0-6   |
| Behavioral problems                    | 1.82±1.74 | 1.90±1.99  | 0-10  |
| Feeding problems (total)               | 9.95±5.63 | 11.60±7.01 | 0-46  |

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**Table 6.** The correlation between age and the mean scores of two domains of screening tool of eating problems in 2 to 7-year-old children with CP (n=60)

| Variable | Severity of Feeding Problems |  | Frequency of Feeding Problems |
|----------|------------------------------|--|-------------------------------|
|          |                              |  |                               |
| Age      | -0.02 <sup>†</sup>           |  | 0.001 <sup>†</sup>            |

<sup>†</sup>P>0.05 based on the Spearman test.

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significant correlation between oral motor skills with the severity of “selectivity” ( $P=0.03$ ,  $r=-0.2$ ) and “feeding skills” ( $P<0.001$ ,  $r=-0.4$ ).

## Discussion

This study investigated the frequency of response to oral motor skills, the frequency and severity of feeding problems, and finally the relationship between age and

oral motor skills with feeding problems among children with CP aged 2-7 years.

Controlling of fluids or foods in the mouth, chewing, sucking, and swallowing is needed for proper and synchronous functional movements of the lips, cheeks, and tongue [38]. In this study, the most severe problem encountered in oral motor skills was sucking with a straw (55%). Also, closing the mouth during feeding is the

**Table 7.** Correlation coefficients between the mean scores of the oral motor assessment scale and the frequencies of eating problems using the STEP tool in children with CP (n=60)

| Variables                                   | Aspiration Risk | Selectivity | Feeding Skills | Food Refusal-related Behavior Problems | Nutrition Related Behavior Problems | Feeding Problems (Total) |
|---|-----------------|-------------|----------------|--|-------------------------------------|--------------------------|
| Closing the mouth during feeding            | -0.03           | -0.2        | -0.4**         | -0.1                                   | 0.1                                 | -0.2*                    |
| Closing the lips while feeding with a spoon | 0.07            | -0.1        | -0.5**         | -0.1                                   | 0.01                                | -0.3**                   |
| Closing the lips while swallowing           | 0.04            | 0.2         | -0.3*          | -0.007                                 | -0.09                               | -0.1                     |
| Food control                                | -0.2            | -0.04       | -0.3**         | -0.1                                   | -0.1                                | -0.2*                    |
| Chewing                                     | -0.1            | -0.3**      | -0.5**         | -0.2                                   | 0.1                                 | -0.4**                   |
| Sucking with straw                          | -0.1            | -0.2        | -0.4**         | -0.2                                   | -0.2                                | -0.4**                   |
| Control of fluids during swallowing         | -0.1            | -0.2*       | -0.3**         | -0.1                                   | -0.05                               | -0.3**                   |
| Oral motor skills (total)                   | -0.1            | -0.2        | -0.5**         | -0.2                                   | -0.01                               | -0.4**                   |

<sup>\*</sup>P<0.05, <sup>\*\*</sup>P≤0.001 based on the Spearman test.

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**Table 8.** Correlation coefficients between the mean scores of the oral motor assessment scale and the severity of eating problems using the STEP tool in children with CP (n=60)

| Variables                                   | Aspiration Risk | Selectivity | Feeding Skills | Food Refusal-Related Behavior Problems | Nutrition Related Behavior Problems | Feeding Problems (Total) |
|---|-----------------|-------------|----------------|--|-------------------------------------|--------------------------|
| Closing the mouth during feeding            | -0.05           | -0.2*       | -0.3*          | -0.1                                   | 0.07                                | -0.3*                    |
| Closing the lips while feeding with a spoon | -0.04           | -0.1        | -0.4**         | -0.1                                   | -0.04                               | -0.3*                    |
| Closing the lips while swallowing           | 0.002           | 0.05        | -0.1           | 0.01                                   | -0.1                                | -0.1                     |
| Food control                                | -0.3*           | -0.08       | -0.2           | -0.1                                   | -0.09                               | -0.2*                    |
| Chewing                                     | -0.2*           | -0.3*       | -0.5**         | -0.1                                   | 0.06                                | -0.4**                   |
| Sucking with straw                          | -0.1            | -0.2        | -0.3           | -0.1                                   | -0.1                                | -0.3*                    |
| Control of fluids during swallowing         | -0.1            | -0.2        | -0.3*          | -0.06                                  | 0.02                                | -0.2*                    |
| Oral motor skills (total)                   | -0.1            | -0.2*       | -0.4**         | -0.1                                   | -0.04                               | -0.4**                   |

\*P<0.05, \*\*P≤0.001 based on the Spearman test.

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lightest problem among our participants in the current study. The muscles related to the tongue (in skills such as sucking) than labial movements are neurologically more important during the feeding procedure [33]. The results are consistent with the study of Usman et al. (2017). They showed that of 30 patients with CP, 30% had inadequate feeding skills, with the most severe problem reported in that study being a lack of fluid control (66.7%) [12]. Therefore, the high prevalence of oral motor dysfunctions in children has been shown in several studies [21, 24, 38]. Reilly et al. (1996) found the prevalence of oral motor dysfunction, sucking, and swallowing problems in the first 12 months of life were more than 90%, 57%, and 38%, respectively [21]. Gangil et al. (2001) reported all of their examinees had oral motor dysfunction, also children with spastic quadriplegic and hypotonic CP had significantly worse feeding problems (P<0.001) [38]. In 2009, Wilson et al. performed a parental report study and their results indicated children with CP who have no oral motor dysfunction, were involved significantly more in problems including self-feeding, coughing, and choking [24].

Moreover, this study's evaluations with OMAS revealed that most participants responded passively to "closing the lips while feeding with a spoon" and "sucking with a straw," which means they did not react to stimulation (severe problem). However, in other skills, most examinees performed functionally. Accordingly, they have slight problems with those skills, as they can close their mouth during feeding and controlling food. Additionally, they chewed functionally and did not lose fluid during swallowing. The poor labial status of the

participants was more effective for these functions but has not been enough for holding a straw or spoon in the mouth and also for creating sufficient pressure inside the mouth to suck [26]. Finally, the frequency of other responses including sub-functional (moderate problem) and semi-functional (slight problem) was less among our participants. Correspondingly, in the survey of 61 children with CP, Min et al. (2021) found that the items with the most functional impairment were "straw sucking" and "lip closure while feeding with a spoon" as well [25]. Chung et al. (2010) and Chigira et al. (1994) separately showed in their studies that movement problems in the lips indicated the highest correlation with swallowing disorders [26, 39]. It may also support the close association between oral motor function and dysphagia.

The results of the STEP in this study showed that the prevalence of feeding problems in children with CP was high (80%) and ranged from moderate (56.7%) to severe (23.3%), similar to the results of the study of Pinto et al. [6]. Similarly, in the study by Bell et al. (2019), a high percentage of participants had feeding problems (67%). Of these, 29% had severe problems [40]. Although different tests were used for evaluation in these two studies, the results are almost similar. Likewise, Riley et al. (1996) found that 90% of children with CP in their study may have nutritional problems [21]. In the present study, 16.7% of children with CP had moderate to severe aspiration risk, which was almost similar (12.4%) to the results of the survey by Bell et al. (2019) [40]. In a study by Wilson and Hustad (2009), which described and determined the type and severity of nutritional problems in children

with and without oral motor involvement, oral-motor involvement was clinically visible in 78% of children with CP, almost similar to this study. It was also found that children with oral-motor involvement had a higher mean frequency of cough and suffocation than children without oral-motor involvement [24]. Furthermore, in their study, the prevalence of coughing, gagging, or choking ranged from 56% to 69% [24], a finding comparable to Reilley et al. (1996), who reported that 71% of children with CP aged 12-72 months had shown frequent coughing and choking [21]. The choking results in the current study were similar to this range (45%), as well. A recent study by Qureshi in 2020 indicated a lower prevalence of feeding problems (21%) than this study [41]. The difference in results may be related to two factors. Firstly, they studied 6-12 years of children with CP. Secondly, their tools were a functional feeding assessment scale taken from a multi-disciplinary feeding profile [34].

Our results showed that the most frequent and severe feeding problems were related to "feeding skills," especially "inability to feed independently" and the least frequent and severe of them was related to "aspiration risk" as "re-swallowing of food either during or immediately following meals" was the least frequent and "vomiting during or immediately following meals" was the lightest. Our participants had the least problem in the pharyngeal swallow phase but they were very dependent on their caregivers for feeding. According to Shahbazet al.'s study (2020), one of the most severe feeding problems is the refusal to eat, leading to the inability to maintain proper nutrition and diet due to insufficient intake of food and fluids [15]. These results and the abstinence in this study are different, that is 55% vs 97.6%.

Despite no significant relationship between children's age and the severity and frequency of feeding problems, the present study found that better oral motor skills result in less frequent and milder feeding problems. Most oral motor dysfunctions are likely to lead to more self-feeding problems, an increased chance of coughing and choking, and delayed feeding of solid foods [42]. Similarly, Clancy et al. (2011) studied longitudinal (30 months) changes in feeding behaviors and its different variables on the severity of twenty-three children with CP. They showed that children with generalized eating behaviors and severe motor-oral involvement were stable over time. However, children with moderate to mild severity changed slightly over time and had fewer problems than those in the severe groups [43]. The findings of Clancy (2011) and Wilson's study (2009) were similar to this study which showed that children with CP

with oral-motor problems have more persistent feeding problems [24, 43].

Accordingly, feeding disorders are critical because they can negatively affect the child's health, cause poor nutritional status, and reduce his quality of life [43]. In this group of patients, possibly, the amount of food and nutrients consumed is not enough to ensure optimal growth for their height and weight. In addition, the recurrence of aspiration can jeopardize the pulmonary condition through recurrent aspiration pneumonia [14]. Due to the possibility of severe respiratory complications, if there is a cough or suffocation should be referred for formal swallowing evaluation [24].

## Conclusion

A high frequency of non-active or inappropriate responses to more oral motor skills during swallowing, sucking, and chewing, a high prevalence and intensity of feeding problems, and a significant reverse relationship between these variables in children with CP indicated that it is necessary to attend more these problems among this group. Accurate assessment and diagnosis of these problems and setting them in a rehabilitation program of patients can be an essential step in the positive prognosis of their interventions.

## Suggestions for future studies

Although this study faced some limitations, including the difficulty of cooperation of some children, it is recommended that the researchers perform similar studies with larger sample sizes. Besides, it seems better to perform physiologic and instrumental assessments of feeding skills in children of different ages and types of dysfunctions. In addition, it is suggested that feeding problems, oral motor dysfunctions, and their relationship were compared between different groups of children with CP or other sensory-motor dysfunctions.

## Ethical Considerations

### Compliance with ethical guidelines

This study was approved by the Ethics Committee of Zahedan University of Medical Sciences (Code: IR.ZAUMS.REC.1401.388).

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## Authors' contributions

Conceptualization, methodology, and supervision: Mohadeseh Gholamiyan Arefi; Data collection: Leila Esmaeili; Data analysis: Mohadeseh Gholamiyan Arefi, Reihaneh Saber-Moghadam and Sediqe Safaeyan; Formal analysis, investigation, writing and final approval: All authors.

## Conflict of interest

The authors declared no conflict of interest.

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