INTRODUCTION

Humans go through a phase of growth and development of the craniofacial complex transition from deciduous to permanent dentition, in which several adaptive functional changes occur in the temporomandibular joint (TMJ). The morphology of TMJ in newborn presents with flattening of the articular cavity, without the presence of articular eminence for the function of suction is feasible. Subsequently, they begin to perform more elaborated and coordinated mandibular movements, generating the development of the articular eminence that allows the realization of biomechanics, promoting mandibular movements of mouth opening, lateral and protrusion. In this, the condylar movements are not only determined by the articular eminence, disc and the ligaments of the TMJ, as well as for occlusal and neuromuscular factors. The static and dynamic relations between anatomical structures of the TMJ, occlusal areas and their functional relation participate in the normal and pathological process of temporomandibular system functions.
Deviations in TMJ and or its functioning, characterized by the presence of signs and symptoms of TMD (Temporomandibular Dysfunction)\(^6\), although they are more prevalent in adults, they can also be observed in children populations\(^6\), ie, in the stage of growth and development of the craniofacial complex, including the transition from deciduous to permanent dentition. These signs and symptoms are represented by muscle and joint pain, limitation and deviation in the mandibular trajectory\(^7\), joint noises during oral opening and closing, headaches, pains in the neck and ear manifestations, such as ear pain, ear fullness, tinnitus, and others\(^8\)\(^9\)\(^.\)

During the clinical examination, the limitations of mandibular movements represent an important signal for understanding the diagnosis of TMD\(^10\). Thus, knowledge about the mandibular range of motion (MRM) has been the subject of interest of many researchers\(^3\)\(^4\)\(^10\)\(^13\), because this is a relevant tool for the assessment of masticatory functional status\(^10\)\(^12\). In addition, this information enables a valuable follow-up parameter in the treatment of patients affected by TMD\(^11\). Among the studies on mandibular movements in children\(^3\)\(^4\)\(^10\)\(^13\), few are correlated to possible factors that may interfere in the determination of the range of these movements\(^3\)\(^12\)\(^14\). The high variability of the movements makes this assessment difficult\(^3\). Thus, seeking better understanding of mandibular dynamics, this study aimed to identify factors that may influence mandibular range of motion in children.

**METHODS**

This study was registered at SISNEP / CONEP, under No. 307495 and approved by the Research Ethics Committee FOUFBA, in accordance with Opinion No.17/10.

This is a descriptive, cross-sectional, observational study. The research was conducted with 181 students, of both genders, aged 8-12 years, living in São Francisco do Conde, Bahia, and the guardians signed, agreeing to the “Terms of Free and Clear Consentment”.

The study excluded voluntary children who had absence of the central incisors, loss of 5 or more subsequent dental elements, stunted stories of facial trauma, head and neck surgery, a clinical diagnosis of neurologological disorders, craniofacial malformations and non-collaborators. Nor those who had signs and symptoms related to functional disorders of TMJ, according to the contents of the RDC/TMD\(^7\)\(^15\).

Individual assessments were performed and measure of the maximum mouth opening (MMO) range were obtained, as well as right lateral (RL), left lateral (LL) and protrusion (Prot) excursive movements.

- **MMO**: They were asked to perform voluntary mouth opening in the painless limit and considered the maximum interincisive distance, having the incisal edge of the right upper and lower incisors as reference, plus the extent of the vertical trespass\(^13\);
- **Prot**: From the condition of the teeth in occlusion, the distance from the buccal surface of the lower incisor teeth to the incisal face of the upper ones was measured. Then it was asked the volunteer to protrude the jaw, sliding it against the maxilla, followed by measuring the horizontal distance from the buccal surface of the upper incisal to the incisal edge of the lower ones. The sum resulted in the jaw protrusion measurement\(^10\);
- **RL/LL**: It was requested that the child promote maximum displacement of the jaw to the right and measured the horizontal distance between the dental midline of the upper central incisors and lower central ones or between the labial frenulum. The same procedure was used to measure the left lateral excursion\(^10\).

All children were instructed to remain seated with their feet flat on the floor with their head in a resting position. The instrument used for the measurements was the Universal Type Digital caliper Starrett Series 799. Two measurements for each variable studied were performed and their averages obtained.

The anthropometric measurements of height and weight were measured and recorded by a team of nutritionist researchers.

In statistical analysis, the results were expressed as percentage, average and standard deviation and inferential statistical techniques were used: t-student test with equal or unequal variances or Mann-Whitney test F (ANOVA) with Tukey comparisons, Pearson or Spearman correlations, simple and multiple linear regression with variable selection method. The verification of the hypothesis of equality of variances was performed using the F test (Levene). The margin of error used in the decision of the statistical tests was 5.0%. Statistical “software” used to obtain the statistical calculations was the SPSS (Statistical Package for Social Sciences) version 17 and STAT version 11.

**RESULTS**

The sample consisted of 181 students, 91 (50.3%) male and 90 (49.7%) females. The age of respondents ranged from 8 to 12 years, with average of 9.70 ± 1.39 years. Average values of weight and height were 32.23 ± 8.74 kg and 137.42 ± 9.52 cm, respectively. For males the following values were found: 49.59 ± 5.03
Mandibular movements in children

After the correlations were verified, a multivariate regression was applied for all variables mentioned in order to obtain predictors for mandibular range of motion (Table 4). Among all the analysis, the results indicate that the most often found variable to MRM studied were age, height and gender, but the latter was not correlated to the MMO and LL (Tables 1 and 3).

Table 1 – Average and standard deviation of the variables of the mandibular range of motion based on independent variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>MMO</th>
<th>RL</th>
<th>LL</th>
<th>Protrusion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg ± S.D</td>
<td>Avg ± S.D</td>
<td>Avg ± S.D</td>
<td>Avg ± S.D</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>49,59 ± 5,03</td>
<td>8,40 ± 1,74</td>
<td>8,45 ± 1,95</td>
<td>7,60 ± 1,90</td>
</tr>
<tr>
<td>Female</td>
<td>49,06 ± 4,43</td>
<td>7,77 ± 1,87</td>
<td>8,02 ± 1,91</td>
<td>6,89 ± 1,74</td>
</tr>
<tr>
<td><strong>Value of p</strong></td>
<td>p(1) = 0,454</td>
<td>p(1) = 0,019*</td>
<td>p(1) = 0,134</td>
<td>p(1) = 0,009*</td>
</tr>
<tr>
<td><strong>Age (in years)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>47,29 ± 4,99 (A)</td>
<td>7,68 ± 1,91</td>
<td>7,62 ± 1,88 (A)</td>
<td>6,48 ± 2,06 (A)</td>
</tr>
<tr>
<td>9</td>
<td>49,74 ± 4,73 (AB)</td>
<td>7,85 ± 1,83</td>
<td>7,99 ± 2,04 (AB)</td>
<td>7,35 ± 1,63 (AB)</td>
</tr>
<tr>
<td>10</td>
<td>50,80 ± 3,60 (B)</td>
<td>8,10 ± 1,85</td>
<td>8,62 ± 1,96 (AB)</td>
<td>7,30 ± 1,56 (AB)</td>
</tr>
<tr>
<td>11</td>
<td>49,88 ± 4,69 (AB)</td>
<td>8,75 ± 1,40</td>
<td>8,91 ± 1,66 (B)</td>
<td>7,61 ± 1,72 (AB)</td>
</tr>
<tr>
<td>12</td>
<td>49,51 ± 5,01 (AB)</td>
<td>8,48 ± 1,89</td>
<td>8,42 ± 1,88 (AB)</td>
<td>8,04 ± 1,94 (B)</td>
</tr>
<tr>
<td><strong>Value of p</strong></td>
<td>p(2) = 0,008*</td>
<td>p(2) = 0,103</td>
<td>p(2) = 0,031*</td>
<td>p(2) = 0,005*</td>
</tr>
</tbody>
</table>

MMO: Maximum Mouth Opening
RL: Right Laterality
LL: Left Laterality
(1): Significant difference at the level of 5.0%
(2): Through t-Student equal test.
P.S.: If all the letters in brackets are different, there are significant differences between corresponding age groups by Tukey’s pairwise comparisons.

Table 2 – Average and standard deviation of weight and height according to gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>WEIGHT</th>
<th>HEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg ± S.D</td>
<td>Avg ± S.D</td>
</tr>
<tr>
<td><strong>Total group</strong></td>
<td>32,23 ± 8,74</td>
<td>137,42 ± 9,52</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>32,79 ± 8,56</td>
<td>138,16 ± 9,25</td>
</tr>
<tr>
<td>Female</td>
<td>31,65 ± 8,93</td>
<td>136,67 ± 9,78</td>
</tr>
<tr>
<td><strong>Value of p</strong></td>
<td>p(1) = 0,254</td>
<td>p(1) = 0,238</td>
</tr>
</tbody>
</table>

(1): Through Mann-Whitney test.
(’‘): Significant difference at the level of 5.0%
children aged 4 to 15 years also found no differences between genders.

In an analysis conducted with 303 children aged 6 to 14 which investigated the influence of gender on the MRM, did not show any difference between these variables. Unlike what was found in studies in children, researches show statistically significant differences between genders in populations comprised of adolescents and adults, revealing that sexual maturity, in which the differentiation of various physical characteristics of humans occurs, seems to be impactful, also, regarding the mandibular range of motion. Comparing the ages, it was observed that there was only statistically significant difference for the MMO between 8 years old (47.29 ± 4.99 mm) and 10 years old (50.80 ± 3.60), for LL between 8 years old (7.62 ± 1.88 mm) and 11 years old (8.91 ± 1.66), for Prot at ages 8 years (6.48 ± 2.06 mm) and 12 years (8.04 ± 1.94) (Tab.2). I.e., there was difference in average values of 8 years old for other ranges and few changes were observed in the later age groups.

The findings of this study are in agreement with Souza et al. who also found similar differences when investigated the mandibular range of motion.

### DISCUSSION

The present study determined some variables that might be interfering in mandibular movements. Compared between genders, the MRM does not present statistically significant differences, except for the movements of RL 8.40 ± 1.74 mm in males and 7.77 ± 1.87 mm for females and Prot 7.60 ± 1, 90mm, for male and 6.89 ± 1.74 mm for females (p < 0.05).

In this research, it was observed that although not significant, the average values of MRM were higher in boys than in girls, unlike what was found in the study that investigated the mandibular movement of children between 6 and 10 years old, divided into TMD symptomatic groups and asymptomatic. As a result, the authors concluded that for the opening of the mouth, when compared between genders, there was a higher average in girls, though the representation was also not significant.

Research conducted with a sample of 212 children aged 3 to 11 years, revealed no significant differences between the mandibular range of motion and gender, agreeable conclusion to the findings of this study. About-Atme et al. in their study of 102 children aged 4 to 15 years also found no differences between genders.

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The findings of this study are in agreement with Souza et al. who also found similar differences when investigated the mandibular range of motion.

### Table 3 – Spearman correlation between age and each variable of the mandibular range of motion

<table>
<thead>
<tr>
<th>Variable</th>
<th>MMO</th>
<th>RL</th>
<th>LL</th>
<th>Protrusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>0.176 (0.018*)</td>
<td>0.197 (0.008*)</td>
<td>0.224 (0.002*)</td>
<td>0.268 (&lt; 0.001*)</td>
</tr>
<tr>
<td>Height&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>0.277 (&lt; 0.001*)</td>
<td>0.170 (0.022*)</td>
<td>0.134 (0.072)</td>
<td>0.214 (0.004*)</td>
</tr>
<tr>
<td>Weight&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>0.224 (0.002*)</td>
<td>0.095 (0.201)</td>
<td>0.063 (0.399)</td>
<td>0.142 (0.056)</td>
</tr>
</tbody>
</table>

MMO: Maximum Mouth Opening
RL: Right Laterality
LL: Left Laterality
(1): Spearman Correlation.
(2): Pearson Correlation.
(*): Statistically different from zero at the level of 5.0%

### Table 4 – Results of mandibular range of motion regression with independent variables

<table>
<thead>
<tr>
<th>MRM</th>
<th>Variable</th>
<th>Coefficient</th>
<th>Value of p</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMO</td>
<td>Height</td>
<td>0.14</td>
<td>p &lt; 0.001*</td>
</tr>
<tr>
<td>MMO</td>
<td>Height</td>
<td>0.03</td>
<td>p = 0.033*</td>
</tr>
<tr>
<td>MMO</td>
<td>Age</td>
<td>0.029</td>
<td>p = 0.005*</td>
</tr>
<tr>
<td>MMO</td>
<td>Gender</td>
<td>0.61</td>
<td>p = 0.026*</td>
</tr>
</tbody>
</table>

MMO: Mandibular Range of Motion
RL: Right Laterality
LL: Left Laterality
Prot: Protrusion
(*): Significant difference at the level of 5.0%

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in children 6-14 years old. The research by Axe, Medeiros and Felicio \(^\text{10}\) revealed differences among children 6-12 years old. These researchers worked with three different age groups, where GROUP I consisted of children aged 6 and 8 years, the GROUP II from 8.1 to 10 years, and GROUP III consisted of children 10-12 years. Regarding MMO, RL, LL and Prot variables, the authors concluded that the values assigned to Group I were lower than those granted to other groups.

Low values of MMO are found in children with deciduous dentition and slightly lower in children with mixed dentition, hence it is concluded that the difference of these measurement may be subject to various stages of tooth eruption which are unique at different ages \(^\text{12}\). Finally, regarding the age, Track-Atme et al. \(^\text{3}\) argue that there is a wide variety of measurement of MRM found in research involving children.

Regarding the weight, only MMO was significantly correlated, consistent with the research findings of Abou-Atme et al. \(^\text{10}\) performed in 102 children with an average age of 9.1 years old. The authors found a strong correlation between MMO and variable weight \(p<0.001\). In the other analyzed mandibular movements (RL, LL and Prot.), there was no correlation between these and the weight (Table 3). Differing from the present research, Souza et al. \(^\text{14}\) analyzed the MRM in 303 children aged between 6 and 14 years and also found a positive correlation to the movements of RL, LL and Prot., besides MMO in children who were entered in the weight range 17.30kg to 46.50kg.

In the comparison between the height and range of the other mandibular movements, significant differences for the MMO, RL and protrusion were found. The results are in agreement with the records of the scientific literature, since correlations between this variable and mandibular movements in children were observed \(^\text{5,12,14}\). The same behavior seems to repeat in adult populations, as suggested by the study that identified a correlation of height with MMO \(^\text{11}\). The authors believe that, in some circumstances, height seems to have a greater influence on MMO than age, since although growth is not continuous and constant in years, at certain periods it can happen faster and in others slower \(^\text{3}\), different, and therefore, the findings among the studied population.

Taking into account the obtained and commented results so far, it should be noted that scientific research to MRM mentions more often MMO with a lack of analyzes involving the lateral excursions of the mandible and protrusion \(^\text{10,14,18}\).

### CONCLUSION

Based on the findings of this study, the most prevalent factors that interfered with the range of motion of MMO, RL, LL, Prot. were gender, age and height for the studied sample. However, the gender showed little significance, since there was no correlation for MMO and LL as well as non-interfering after regression applied to the MRM, except for the protrusive movement. It is suggested that in clinical evaluations, the MRM is recorded, taking into account the mentioned variables, especially the age and height for children who are aged between 8 and 12 years.
RESUMO

Objetivo: identificar os fatores que possam influenciar na amplitude dos movimentos mandibulares (AMMs) em crianças. Métodos: participaram 181 escolares, ambos os gêneros, 8 a 12 anos, assintomáticos para Disfunção Temporomandibular (DTM), segundo o RDC/TMD. Realizou-se a mensuração da amplitude da abertura oral máxima (AOM), movimentos excursivos de lateralidade direita (LD), esquerda (LE) e protrusão (Prot), sendo aferidas medidas milimétricas com o Paquimetro Digital Starret Série 799. Nutricionistas registraram as avaliações antropométricas de peso e altura. Resultados: dados médios do peso e altura foram 32,23 ± 8,74 kg e 137,42 ± 9,52 cm, respectivamente. Para o gênero masculino encontrou-se os valores: 49,59 ± 5,03mm, na AOM; 8,40 ± 1,74mm, na LD; 8,45 ± 1,91, nas LE e 7,60± 1,90mm, na Prot e no gênero feminino: 49,06± 4,43mm, na AOM; 7,77 ±1,87mm, na LD; 8,02 ±1,91mm, na LE e 6,89± 1,74, na Prot. A correlação entre a amplitude dos movimentos mandibulares e o peso não se mostrou significante (P>0,05). As variáveis mais influentes para a AMMs foram gênero, idade e altura. No entanto, o gênero não se mostrou correlacionado com a abertura oral máxima e lateralidade esquerda, e sem interferência, após aplicada a regressão, para os movimentos mandibulares estudados, exceto a protrusão (p=0,001). Conclusão: os fatores interferentes na amplitude dos movimentos de abertura oral máxima, lateralidade direita, lateralidade esquerda e protrusão foram: idade, gênero e altura para a amostra estudada, sendo o gênero, a variável menos expressiva. Sugere-se nas avaliações clínicas, que a amplitude dos movimentos mandibulares seja registrada, considerando as variáveis mencionadas, especialmente a idade e altura, para crianças de idade entre 8 e 12 anos.

DESCRITORES: Articulação Temporomandibular; Amplitude de Movimento Articular; Criança; Transtornos da Articulação Temporomandibular

REFERENCES