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Impact of the mouth breathing occurred during childhood in the adult age: Biophotogrammetric postural analysis

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ABSTRACT

Objective: This study aims to evaluate the impact of the mouth breathing occurred during childhood on the body posture in the adult age.
Methods: 24 adults, of both genders, aged from 18 to 30 years old with report of clinical manifestations of mouth breathing during the childhood composed the study group (SG). The control group (CG) was composed by 20 adults in the same age, without any respiratory problem since the childhood up to the present time. All the volunteers underwent a physiotherapeutic evaluation consisted of anamnesis and postural biophotogrammetry (*SAPo v 0.68®*). The comparison between the data of the SG and CG was accomplished by Student's *t*-test.
Results: The biophotogrammetric analysis demonstrated that the SG showed more forward head posture confirmed by the angles A9 ($p = 0.0000$) and CL ($p = 0.0414$) and also by the cervical distance ($p = 0.0079$). Additionally, this group presented a larger angular measure of the lumbar lordosis ($p = 0.0141$) compared to the CG.
Conclusion: The results indicate that adults with mouth-breathing childhood have postural alterations, mainly in the head and lumbar column, which keeps for the whole life.

1. Introduction

Mouth breathing has been studied in a number of studies with emphasis on the infant population. Several authors already described the consequences of this respiratory mode in the different systems of human body [1–6].

As the facial growth has a higher speed in the first years of life, the respiratory mode in this period is fundamental for the adequate development of the structures and functions [7]. Thus, the breathing, when not physiologic and conducted by the mouth, tends to provoke changes in the facial and cervical structures, which may extend to the trunk and limbs [8].

Mouth breathing must be considered as one factor related to the head and neck postural changes and, consequently, to the whole body posture misalignment [9]. The head extension can occur as a functional response to the nasal obstruction in order to facilitate the oral inspiration [10,11].

The influence of the mouth breathing on the head posture seems to be also due to the overuse of the accessory inspiratory muscles as scalene, sternocleidomastoid and upper trapezius [12]. Yet, these muscular unbalance can be progressive [5].

Studies showed positive results on the electrical activity of the cervical muscles, with improvement of the body alignment and the adequacy of respiratory pattern by postural treatment in mouth breathing children [13,14]. Authors have highlighted that the short-term results may not reflect a long-term non-surgical solution for the Mouth Breathing Syndrome. Therefore, they recommended further studies to demonstrate this more objectively, also including the quality of life evaluation.

It was also verified decrease in the craniocervical extension after palate expansion in mouth breathing children [15]. However, the maintenance of these therapeutic results should be evaluated.

Studies regarding the postural aspects of adults with history of mouth breathing during childhood were not found in the literature. For this reason, the present study aims to verify the impact of the mouth breathing occurred in the childhood on the body posture in the adult age.

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2. Materials and methods

2.1. Subjects

This research was carried out in the Service of Speech Therapy Assistance of the Federal University of Santa Maria (SAF/UFSM). It is part of a greater research project titled: "Characterization, evaluation and integrated therapy of the orofacial motricity and body posture disturbances", approved by the Ethics Committee of the Federal University of Santa Maria, under protocol number 23081.015493/2008-91. All the participants signed the term of informed consent.

The study group (SG) was composed by 24 subjects with history of mouth breathing during childhood according records in the in the Service of Speech Therapy Assistance of the Federal University of Santa Maria from 1998 to 2003. The inclusion criteria were: age from 18 to 30 years old; both genders; report of clinical manifestations of mouth breathing during childhood, treated or not, such as: snoring, drooling on the pillow, the mouth open the most part of the day and/or during sleeping. Additionally, the presence of etiological factors, such as allergic rhinitis, enlarged adenoids or tonsils, obstructive deviation of the nasal septum and nasal polypus was considered.

The control group (CG) was composed by volunteers without history of mouth breathing or the presence of respiratory diseases from childhood to the current time. Subjects with neurological problems, morphological changes and cognitive disturbances were excluded.

2.2. Procedures

The participants were submitted to the clinical evaluation constituted by anamnesis and body posture examination. Still, it was investigated if they were undergone to a postural treatment in the childhood.

The body posture was assessed by photographic records with biophotogrammetric analysis. The photographies were obtained in orthostatic position in three views: anterior, right side and posterior. The participants were dressed with swimsuit and barefoot in a scenario constituted by a black background of 3 m × 1.5 m, a plumb line suspended in the roof beside the volunteer, a base with 10 cm × 40 cm × 20 cm of dimensions with the foot outline drawn in an eraser rug. A tripod (Vanguard® – VT 131) was positioned a distance of, at least, 3 m from the digital camera (Sony® Cybershot 7.2 megapixels) and in a height of approximately half of the evaluated subject' stature.

Anatomic points were marked in the voluntary's body with white Styrofoam balls with double-face tape or black circular adhesives of 14 mm of diameter. During the image acquisition, the volunteer were oriented to keep the usual body posture with opened eyes glancing to the horizon line. To change the image's view, the demarked base was turned 90° and the volunteer returned to position over this.

The photogrammetric analysis was carried out in the postural evaluation software (*SAPo v 0.68®*) by a blind examiner. To test the reliability of the measures other two blind examiners accomplished these angular measures of the 24 volunteers of the SG.

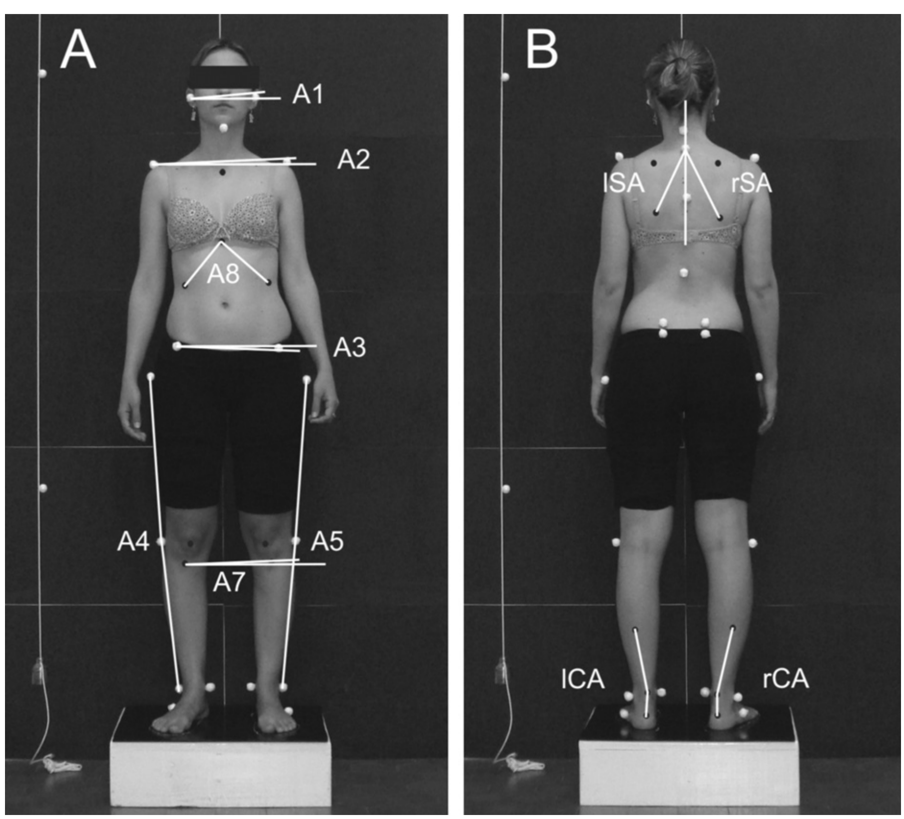

Fig. 1. Representation of the angular and linear measures of the anterior and posterior views. A1: horizontal alignment of the head – angle among the left and right tragus and the horizontal line; A2: shoulder leveling – angle between acromion and a horizontal line; A3: anterosuperior iliac spine (ASIS) leveling with the horizontal; A4: right knee alignment (valgum, varum or neutral) – angle among trocanter, knee-joint line and right lateral malleolus; A5: left knee alignment; A7: horizontal alignment of the tibial tuberosity with a horizontal line; A8: Charpy angle; rCA: calcaneus varism or valgism – right leg/calcaneus angle; lCA: left leg/calcaneus angle; lSA: left scapula angle; rSA: right scapula angle.

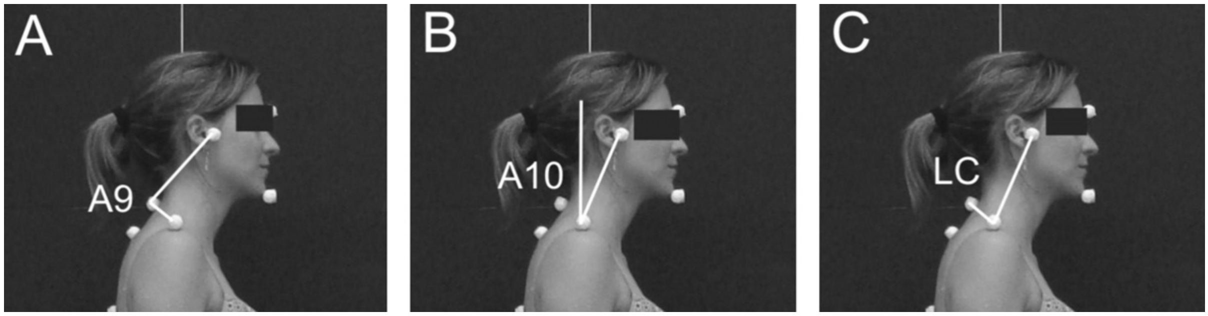

Fig. 2. Representation of the angular measures of the head in the lateral view. A9: head horizontal alignment (A); A10: head vertical alignment (B); CL: cervical lordosis (C).

Fig. 1 shows the representation of the angular and linear variables of the anterior and posterior views. The lower limbs length (A6) was measured by the distance between anterosuperior iliac spine (ASIS) and right and left internal malleolus. The measures obtained in the side view are presented in Figs. 2–4.

The linear and angular measures were based on the software *SAPo* protocol. Beyond the protocol measures, it was analyzed the Charpy angle proposed by Ricieri et al.; the CL, TC, LL and P1 measures suggested by Yi et al.; AA angle measured by Iunes et al.; CD and LD measures suggested by Munhoz et al. [5,16–18]. In the posterior view, the scapular asymmetry was analyzed separately, following the same points recommended by the protocol.

2.3. Statistics analysis

The *STATISTICA* 7 (*Statistica for Windows – release 7.0 Stat Soft*) and the SPSS 13 (*Statistical Package for Social Sciences*) programs were used to analyze the data. To identify the differences between the groups related to age and gender, Student's *t*-test and the Chi square tests were used, respectively. The normal distribution of the data was tested by Lilliefors test. The comparison between the study and the control group was carried out by Student's *t*-test.

The inter-examiner reliability of the angular and linear measures was tested by the intraclass correlation coefficient (ICC). ICC values below 0.4 are not acceptable, between 0.4 and 0.75 are acceptable and, above 0.75 are excellent [19]. The significance level considered for all the results was 95% ($p < 0.05$).

3. Results

The SG was composed by 24 volunteers, nine men and 15 women, with mean age of 22.62 ± 3.09 years old. In the CG, 20 volunteers took part, three men and 17 women with mean age of 24.6 ± 1.41 years old. No significant difference was detected between the groups related to age (p = 0.06) and gender (p = 0.26). The postural treatment was accomplished in four of the 24 subjects of the SG, in the childhood.

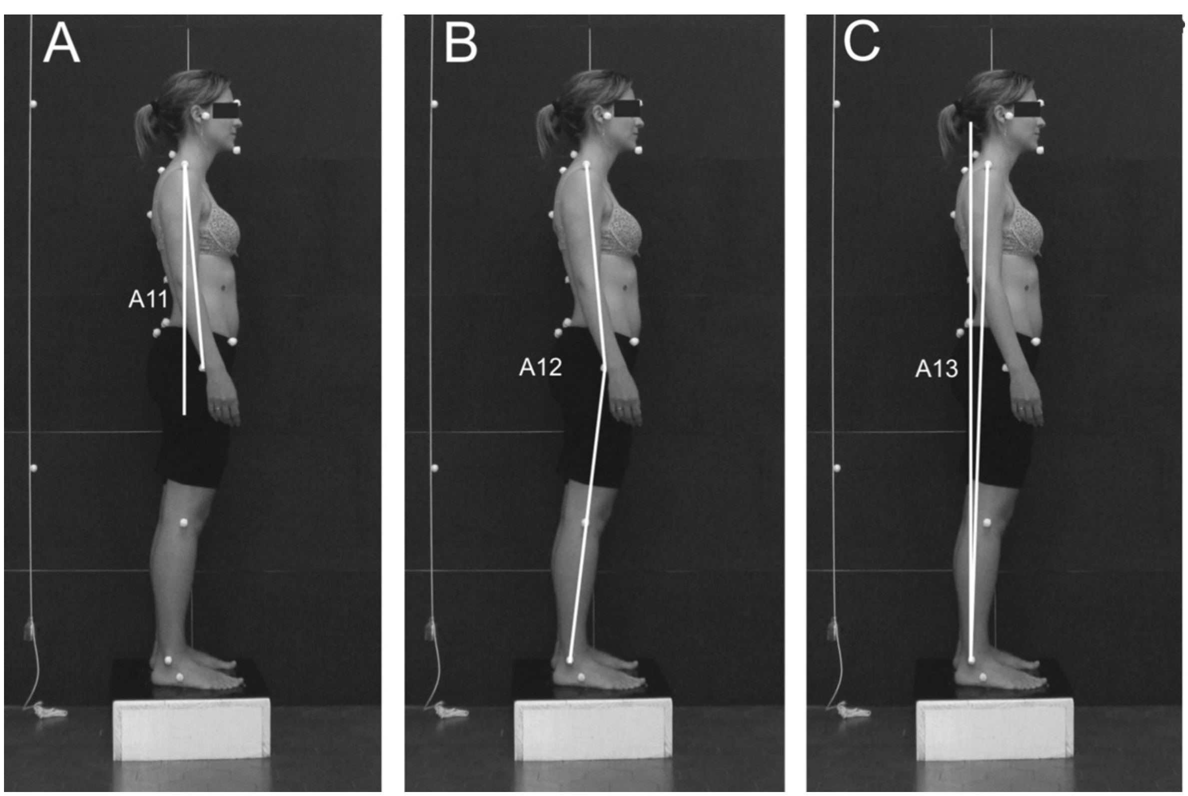

Fig. 3. Representation of the angular measures of the trunk in the side view. A11: trunk vertical alignment (A); A12: hip angle – trunk and thigh (B); A13: body vertical alignment (C).

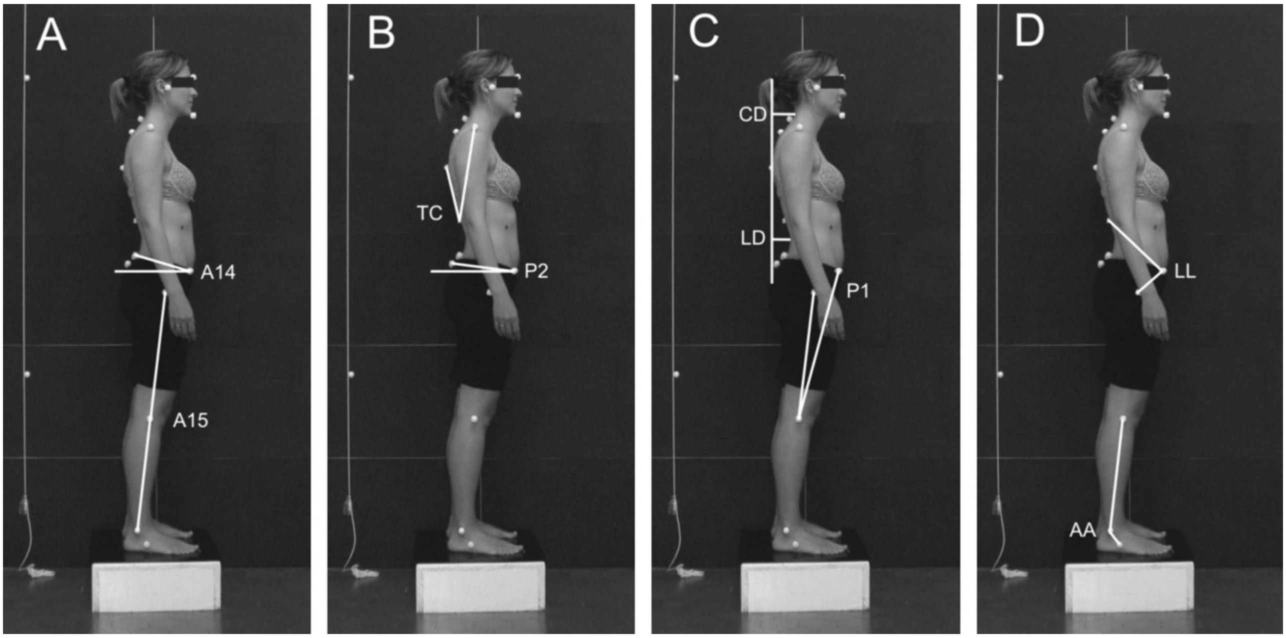

Fig. 4. Representation of the angular and linear measures of the trunk and the lower limbs in the side view. A14: pelvic horizontal alignment; A15: knee angle (A); TC: thoracic ciphosis and P2: antero-superior and posturo-superior iliac spine alignment with a horizontal line (B); CD: cervical distance; LD: lumbar distance and P1: pelvic position (C); LL: lumbar lordosis and AA: ankle angle (D).

The results obtained in the anterior and posterior view are presented in Table 1, which larger values of the A2 angle was observed in the SG. In the posterior view no angular measure was statistically different between the groups.

In the side view, the A9 angle was smaller and the CL angle and the cervical distance measures (CD) were larger in the SG compared to CG (Table 2). All these results mean more accentuated forward head posture in the SG subjects. The LL angle was smaller in the SG, meaning greater lumbar lordosis in these subjects than in the CG (Table 2).

All postural measures presented an excellent inter-examiners reliability, except A6 with a moderate ICC (0.735).

4. Discussion

The visual assessment of body posture, in which the patient is observed for a qualitative investigation of the symmetries and postural deviation, is a method frequently used for the vertebral column analysis [20]. However, despite widely used, the reliability of the visual method can be affected by the examiner's experience [9].

The biophotogrammetry is a reliable tool that has been spread in researches [17,21,22]. In the present study, 24 out of 25 evaluated measures showed high agreement among the examiners. Only the A6 measure (lower limb length) had moderate agreement. Ferreira et al. evaluated the reliability of the SAPo's protocol and found disagreement among the examiners only in four of the 29 measures, among these, the difference of inferior limb length [21], as observed in the present study.

The mouth breathing has been cited as one of the causes of the changes in the head posture [9,10], which can affect to the whole body posture. In the anterior view, the only difference was in the acromium alignment (A2), with greater asymmetry in the SG. In an ideal posture, the alignment in the frontal plane prioritizes the

Table 1
Angular and linear measures obtained in the photogrammetric evaluation in the anterior and posterior views of the SC and CG.

View	Angles and distances	SG (n = 24) (mean ± SD)	CG (n = 20) (mean ± SD)	p
Anterior	A1	1.67 ± 1.76°	1.40 ± 1.09°	0.5588
	A2	1.82 ± 0.98°	1.18 ± 0.77°	0.0219*
	A3	1.75 ± 1.45°	1.42 ± 1.45°	0.4504
	A4	2.78 ± 1.83°	3.36 ± 1.78°	0.2983
	A5	2.89 ± 2.41°	3.04 ± 1.76°	0.8153
	A6	0.90 ± 0.74 cm	0.75 ± 0.68 cm	0.4880
	A7	1.40 ± 0.96°	1.35 ± 1.08°	0.8592
	A8	96.16 ± 13.37°	90.10 ± 8.64°	0.0983
Posterior	APRd	11.47 ± 4.60°	13.21 ± 4.29°	0.2059
	APRe	10.79 ± 4.92°	12.47 ± 5.27°	0.2827
	AEd	29.48 ± 6.27°	28.02 ± 4.17°	0.3793
	AEe	28.82 ± 5.73°	26.58 ± 4.43°	0.1616

SG: study group; CG: control group; SD: standard deviation; A1: horizontal alignment of the head – angle among the left and right tragus and the horizontal line; A2: shoulder leveling – angle between acromion and a horizontal line; A3: anterosuperior iliac spine (ASIS) leveling with the horizontal; A4: right knee alignment (valgum, varum or neutral) – angle among trocanter, knee-joint line and right lateral malleolus; A5: left knee alignment; A6: difference of length in the lower limbs A7: horizontal alignment of the tibial tuberosity with a horizontal line; A8: Charpy angle; rCA: calcaneus varism or valgism – right leg/calcaneus angle; lCA: left leg/calcaneus angle; rSA: right scapula angle; lSA: left scapula angle.

* $p < 0.05$ (t-test).

Table 2
Angular and linear measures obtained in the photogrammetric evaluation in the side view of the SG and CG.

View	Angles and distances	SG ($n = 24$) (mean ± SD)	CG ($n = 20$) (mean ± SD)	p
Side	A9	47.19 ± 3.66°	51.95 ± 3.40°	0.0000*
	A10	19.45 ± 7.06°	16.44 ± 6.96°	0.1637
	A11	2.71 ± 2.05°	4.11 ± 2.64°	0.0555
	A12	7.65 ± 4.13°	10.52 ± 4.91°	0.0415*
	A13	1.36 ± 0.87°	1.16 ± 0.53°	0.3671
	A14	9.29 ± 4.76°	10.72 ± 6.05°	0.3876
	A15	3.94 ± 2.76°	4.67 ± 2.81°	0.3926
	CL	85.88 ± 16.77°	72.88 ± 16.79°	0.0141*
	TC	23.53 ± 3.88°	22.67 ± 3.58°	0.4979
	LL	88.52 ± 6.05°	93.73 ± 8.04°	0.0184*
	P1	7.65 ± 1.57°	7.15 ± 2.29°	0.3968
	P2	4.96 ± 3.88°	4.67 ± 3.88°	0.7973
	AA	134.24 ± 5.38°	131.94 ± 5.67°	0.1743
	CD	8.66 ± 1.84 cm	7.35 ± 1.14 cm	0.0079*
	LD	5.33 ± 1.20 cm	5.54 ± 1.36 cm	0.6053

SG: study group; CG: control group; SD: standard deviation; A9: head horizontal alignment; A10: head vertical alignment; A11: trunk vertical alignment; A12: hip angle – trunk and thigh; A13: body vertical alignment; A14: pelvic horizontal alignment; A15: knee angle; CL: cervical lordosis; TC: thoracic ciphosis; LL: lumbar lordosis; P1: pelvic position; P2: antero-superior and posturo-superior iliac spine alignment with a horizontal line; AA: ankle angle; CD: cervical distance; LD: lumbar distance.
* $p < 0.05$.

horizontality of the ears, shoulders, pelvic waist and styloid processes [26]. Lima et al. did not find any difference in the measures of the scapular waist in the comparison of obstructive and vicious mouth breathing children with nasal breathers [2]. The shoulder asymmetry can be related to the upper limb dominance influence and in a typical posture pattern the right shoulder is lower than left in right-hand people [24]. Also, a natural asymmetry in the shoulders height is a common finding in the general [25].

In the side view, the three measures related to the head and cervical column (A9, CL and CD) showed significant difference between the SG and CG. The A9 angle was smaller in the SG, demonstrating a greater forward head posture. Several authors used this measure to evaluate the head and cervical posture [9,25,26]. Neiva et al. did not find differences in the photogrammetric evaluation of mouth and nasal breathing children, yet the forward head was predominant in the mouth breathers according the visual examination [28]. The forward head posture intensifies the inspiratory effort and decrease in the respiratory muscular strength due to a biomechanical disadvantage in the accessory inspiratory muscles, which supports the association between the respiratory and the postural dysfunction [14,27]. This was demonstrated by Corrêa and Berzin, who obtained a reduction in the electrical activity of these muscles with correction of head posture, suggesting an improvement of the mouth breathing reinforced by the forward head posture and the overuse of the accessory muscles of respiration [14].

Yi et al. found increased craniocervical angle which characterizes an extension of the head and decrease in the cervical lordosis in mouth breathing children [5]. In the present study, it was also observed but in adults, mouth breathers during childhood. This change in the craniocervical posture seems to be a typical postural behavior of the mouth breather [9–11]. Such finding is explained by the Ricketts' theory in which a head extension can occur as a functional response to the nasal obstruction in order to facilitate the inhalation through the mouth [10]. However, Sforza et al. trying to relate the inducted mouth breathing with to the craniocervical posture, observed significant changes in the head posture, yet without a defined pattern [28].

The cervical distance was greater in the SG compared to the CG. In a clinical evaluation, the distance of the middle cervical region to a vertical line tangent to the thoracic apex must be of 6 cm or vary from 6 to 8 cm [23,29,30]. In this study, this distance presented a mean value of 8.66 and 7.35 cm in the SG and CG, respectively.

In the side view, two angles (A12 and LL) with reference points in the trunk and lower limbs presented significant difference between the groups. The A12 angle, formed by the acromion, greater femoral trochanter and lateral malleollus, was greater in the SG. There is no reference value for this angle, although this point should be vertically aligned, based in a biomechanical principle [24]. As higher this angle, greater the misalignment among these points, that means a greater asymmetry between the trunk and the hip in the SG.

The LL angle was smaller in the SG than CG, which means more accentuated lumbar lordosis, once as smaller this angle greater is the lumbar lordosis [5]. The lumbar hyperlordosis was one of the main postural changes observed in mouth breathing children, according Yi et al.'s studies [31].

The others angular measures were not different between the groups. These results should be considered with cautious, once it can be attributed to the type II error, due to the low statistical power of the non significant variables.

Analyzing the results of this study, it is important to mention that the differences observed between the groups were observed in the head, neck and trunk regions. Therefore, mouth breathing seems to influence, in a more specific way, the upper body segments more directly linked to the head and the thorax. Based on this, it is suggested a greater attention to these segments, when treating the postural consequences of the mouth breathing.

Yip et al. observed a positive correlation between the craniovertebral angle and neck pain and disability [32]. They also verified a positive correlation between age and these symptoms and negative between age and the craniovertebral angle. This means that the lower the angle, more forward is the head. This postural deviation was one of the most observed in the volunteers of this study and it can bring important clinical consequences, once as they will get older this angle decreases and the symptoms increase.

The physiotherapy for the postural treatment in the childhood and adolescence was carried out in only four subjects in the study group, what may have influenced the negative impact of the mouth breathing in the adults' body posture. Positive results were demonstrated after postural treatment in mouth respiratory children [14] and postural correction and re-education is suggested for prevention and management of neck pain [32].

The postural changes in adult subjects with history of mouth breathing in or since the childhood indicates the necessity of the attention to this aspect and the physiotherapeutic intervention in the multiprofessional staff involved in the mouth breathing treatment. So, more definitive therapeutic results could be obtained, not only in the body posture, but also in the other professional interventions, due to the influence of the postural system on the stomatognathic system and vice versa.

Certain limitations were evident in this investigation, mainly regarding the number of volunteers and the absence of significance in some measures with low statistical power. In spite of this, the findings were satisfactory by being a novel subject, not yet explored in the scientific community. Further studies are necessary to investigate the same and other aspects related to the consequences of mouth breathing.

5. Conclusion

Mouth breathing during the childhood determines postural alterations, mainly in the head and lumbar column, and these perpetuated to the adult age, in the subjects of this study.

Conflict of interest statement

The authors have no conflict of interest to declare.

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References

[1] R.C. Di Francesco, G. Passerotti, B. Paulucci, A. Miniti, Mouth breathing in children: different repercussions according to the diagnosis, Revista Brasileira de Otorrinolaringologia 70 (5) (2004) 665–670.
[2] L.O.C. Lima, M.A. Baraúna, M.J.J. Sologurem, R.S.T. Canto, A.C. Gastaldi, Postural alterations in children with mouth breathing assessed by computerized biophotogrammetry, Journal of Applied Oral Science 12 (3) (2004) 232–237.
[3] M.G. Pires, R.C. Di Franceso, J.F.M. Junior, A.S. Grumach, Chest modification secondary to the enlarged tonsils and adenoids, Arquivos Internacionais de Otorrinolaringologia 11 (2) (2007) 99–105.
[4] A. Branco, G.F. Ferrari, S.A.T. Weber, Orofacial alterations in allergic diseases of the airways, Revista Paulista de Pediatria 25 (3) (2007) 266–270.
[5] L.C. Yi, J.R. Jardim, D.P. Inoue, S.S.N. Pignatari, The relationship between excursion of the diaphragm and curvatures of the spinal column in mouth breathing children, Jornal de Pediatria 84 (2) (2008) 171–177.
[6] D.M. Cattoni, F.D.M. Fernandes, R.C. Di Francesco, M.R.D.O. Latorre, Quantitative evaluation of the orofacial morphology: anthropometric measurements in healthy and mouth-breathing children, International Journal of Orofacial Myology 35 (2009) 44–59.
[7] K.L. Moore, Dalley A.F., Clinically Oriented Anatomy, 5th ed., Guanabara Koogan, Rio de Janeiro, 2007.
[8] D.A. Falcão, S. Grinfeld, A. Grinfeld, M.V.R. Melo, Oral breathers clinically diagnosed and by autodiagnosed, body posture consequences, International Journal of Dentistry 2 (2) (2003) 250–256.
[9] J.F.P. Belli, T.C. Chaves, A.S. Oliveira, D. Bevilaqua-Grossi, Analysis of body posture in children with mild to moderate asthma, European Journal of Pediatrics 168 (10) (2009) 1207–1216.
[10] R.M. Ricketts, Respiratory obstruction syndrome, American Journal of Orthodontist 54 (7) (1968) 495–507.
[11] A. Cuccia, M. Lotti, C. Caradonna, Oral breathing and head posture, Angle Orthodontist 78 (1) (2008) 77–82.
[12] T.C. Chaves, T.S.A. Silva, S.A.C. Monteiro, P.C.A. Watanabe, A.S. Oliveira, D.B. Grossi, Craniocervical posture and hyoid bone position in children with mild and moderate asthma and mouth breathing, International Journal of Pediatric Otorhinolarygology (2010).
[13] E.C.R. Corrêa, F. Bérzin, Efficacy of physical therapy on cervical muscle activity and body posture in school-age mouth breathing children, International Journal of Pediatric Otorhinolaryngology 71 (2007) 1527–1535.
[14] E.C.R. Corrêa, F. Bérzin, Mouth breathing syndrome: cervical muscles recruitment during nasal inspiration before and after respiratory and postural exercises on Swiss Ball, International Journal of Pediatric Otorhinolaryngology 72 (2008) 1335–1343.
[15] S. Tecco, S. Caputi, F. Festa, Evaluation of cervical posture following palatal expansion: a 12-month follow-up controlled study, European Journal of Orthodontics 29 (2007) 45–51.
[16] D.V. Ricieri, J.R. Costa, N.A.R Filho, Asthma impaction body posture in children aged 8 and 14 years analyzed by biophotogrammetry, Acta Fisiátrica 15 (4) (2008) 214–219.
[17] D.H. Iunes, F.A. Castro, H.S. Salgado, I.C. Moura, A.S. Oliveira, D. Bevilaqua-Grossi, Intra and inter-examiner reliability and method repeatability of postural evaluation via photogrammetry, Revista Brasileira de Fisioterapia 9 (3) (2005) 327–334.
[18] W.C. Munhoz, A.P. Marques, J.T.T Siqueira, Evaluation of body posture in individuals with internal temporomandibular joint derangement, The Journal of Craniomandibular Practice 23 (4) (2005) 269–277.
[19] J.R. Landis, G.G. Koch, The measurement of observer agreement for categorical data, Biometrics 33 (1) (1977) 159–177.
[20] C. Fedorak, N. Ashworth, J. Marshall, H. Paull, Reliability of the visual assessment of cervical and lumbar lordosis: how good are we? Spine 28 (16) (2003) 1857–1859.
[21] E.A.G. Ferreira, M. Duarte, E.P. Maldonado, T.N. Burke, A.P. Marques, Postural assessment software (PAS/SAPO): validation and reliability, Clinics 65 (7) (2010) 675–681.
[22] A. Cuccia, C. Caradonna, The relationship between the stomatognathic system and body posture, Clinics 64 (1) (2009) 61–66.
[23] B. Bricot, Posturologia, Ícone, São Paulo, 2004.
[24] F.P. Kendall, E.K. McCreary, P.G. Provance, Muscles: Testing and Function with Posture and Pain, Manole, São Paulo, 2007.
[25] S. Raine, L.T. Twomey, Head and shoulder posture variations in 160 asymptomatic women and men, Archives of Physical Medicine and Rehabilitation 78 (11) (1997) 1215–1223.
[26] P.D. Neiva, R.N. Kirkwood, R. Godinho, Orientation and position of head posture, scapula and thoracic spine in mouth-breathing children, International Journal of Pediadric Othorhinolaryngology 73 (2009) 227–236.
[27] E. Kapreli, E. Vourazanis, E. Billis, J.A. Oldham, N. Stimpakos, Respiratory dysfunction in chronic neck pain patients. A pilot study, Cephalalgia 29 (7) (2009) 701–710.
[28] C. Sforza, A. Colombo, M. Turci, G. Grassi, V.F. Ferrari, Induced oral breathing and craniocervical relations: an experimental study in healthy young adults, The Journal of Craniomandibular Practice 22 (1) (2004) 21–26.
[29] M. Rocabado, Biomechanical relationship of the crânio and hyoid regions, Journal of Craniomandibular Practice 1 (3) (1983) 61–66.
[30] D.G. Simons, J.G. Travell, L.S. Simons, Myofascial Pain and Dysfunction: The Trigger Point Manual, 2nd ed., Artmed, Porto Alegre, 2005.
[31] L.C. Yi, Z.C.F. Guedes, S. Pignatari, L.L.M. Weckx, Posture study on oral breathing of children aged 5 through 12 years old, Revista Fisioterapia Brasil 16 (3) (2003) 29–33.
[32] C.H.T. Yip, T.T.W. Chiu, A.T.K. Poon, The relationship between head posture and severity and disability of patients with neck pain, Manual Therapy 13 (2) (2008) 148–154.