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# POSTURAL QUALITATIVE ANALYSIS IN MOUTH BREATH CHILDREN

## *Análise qualitativa da postura em crianças respiradoras bucais*

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Félice Mancini

Departamento de Informática em Saúde, Universidade Federal de São Paulo (UNIFESP). São Paulo – SP.  
e-mail: felipe-pg@dis.epm.br

Liu Chiao Yi

Doutora, Departamento de Informática em Saúde, Universidade Federal de São Paulo (UNIFESP). São Paulo – SP.  
e-mail: liu@netcomp.com.br

Ivan Pisa

Doutor, Departamento de Informática em Saúde, Universidade Federal de São Paulo (UNIFESP). São Paulo – SP.  
e-mail: felipe-pg@dis.epm.br – ivan.pisa@unifesp.br

Domingos Alves

Doutor, Departamento de Informática em Saúde, Universidade Federal de São Paulo (UNIFESP). São Paulo – SP.  
e-mail: quiron@fmrp.usp.br

Shirley Pignatari

Doutora, Departamento de Otorrinolaringologia Pediátrica e Cirurgia de Cabeça e Pescoço,  
Universidade Federal de São Paulo (UNIFESP). São Paulo – SP. e-mail: shirley.otor@epm.br

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### **Abstract**

The chronic mouth breath, considered in six months time, can provoke alterations in the corporal posture, besides requiring more effort from the inspiration accessory muscles result in a shorter stimulus from the diaphragm muscle. The objective of this study is to extract features and classify data in a 30 mouth breath children and 22 nasal breath children database containing the posture and distance of the diaphragm muscle excursion variables. Therefore, a model of unsupervised artificial neural networks was used, specifically the self-organizing map (SOM), in order to help the comprehension of postural behavior and its relations towards the diaphragm muscle alterations. From the clusters generated by the SOM two categories of mouth breath children were detected. On the first, it was found cervical lordosis similar to the cluster of nasal breath associated to a lower mean distance of the diaphragm excursion if compared to all other clusters. On the second category it was found a reduction of the cervical lordosis if compared to an mean of nasal breath cluster, associated to a higher distance of the diaphragm muscle excursion if compared to the first category. From these results the authors suggest that when there is a nasal obstruction, there might be a head position anteriorization and cervical lordosis loss to enlarge the air space. This behavior makes easier the air entrance to the inferior airways associated to a bigger effort of the inspiration accessory muscles and from the diaphragm, whenever they try to suppress this demand.

**Keywords:** Posture; Mouth breathing; Diaphragm; Neural networks.

## Resumo

*A respiração bucal crônica, considerada com seis meses de evolução, pode provocar alterações na postura corporal, além de exigir maior esforço dos músculos acessórios da inspiração acarretando em um menor estímulo do músculo diafragma. Este trabalho tem por objetivo extrair características e classificar um repositório de dados contendo variáveis de postura e distância da excursão do músculo diafragma de 30 crianças respiradoras bucais e 22 crianças respiradoras nasais. Para isso, utilizamos um modelo de redes neurais artificiais não-supervisionado, especificamente o mapa-autoorganizável (self-organizing map, SOM), a fim de auxiliar na compreensão do comportamento postural e sua relação frente às alterações do músculo diafragma. A partir dos agrupamentos gerados pelo SOM foram detectadas 2 classes de crianças respiradoras bucais. Na primeira, encontramos a lordose cervical semelhante ao do grupo respirador nasal, associado a uma distância média de excursão do diafragma muito baixo quando comparado com todos os outros grupos deste estudo. Na segunda classe, encontramos uma diminuição da lordose cervical se comparado com a média do grupo respirador nasal, associada à média da distância da excursão do diafragma maior que na primeira classe. A partir destes resultados, os autores sugerem que quando há uma obstrução nasal, pode haver uma anteriorização da posição da cabeça e perda da lordose cervical para ampliar o espaço aéreo e assim facilitar a entrada de ar para vias aéreas inferiores, associado a um maior esforço dos músculos acessórios da inspiração e do diafragma na tentativa de suprimir esta demanda.*

**Palavras-chave:** Postura; Respiração bucal; Diafragma; Redes neurais.

## INTRODUCTION

Breathing is the first vital function developed by birth occasion, settling down as the main function of the organism. The nasal cavity has an important paper in the breathing physiology, promoting the filtration, heating, and humidification of the inspired air, so that when it arrives to the lungs, it is at the ideal temperature, favoring an appropriate oxygenation to the organism. The mouth cavity only intervenes in this process when the inspired air is not enough, usually caused by a nasal obstruction (1, 2).

Mouth breathing during the childhood is a frequent complaint at the pediatrician, allergology, and otolaryngology clinics. It is known now that the chronic mouth breathing, within six months of evolution, can promote alterations in the odontological craniofacial development as well as the corporal posture (3, 4, 5, 6).

Aragão (7), studied the corporal posture of 26 mouth breath subjects from 6-12 years of age and found out the following alterations predominantly: anterior head and a decrease of the cervical lordosis, winged scapulas, previous depression of the thorax, and abdominal protrusion. Liu et al. (8) and Krakauer (9) also found out the same alterations postural in mouth breath children from 5-12 years of age.

The mouth breath subject projects the head previously to facilitate and to accelerate the air flow passage, taking to a posterior rotation of the cranium and a decrease of the cervical lordosis. The craniomandibular, cervical, hyoid area, and airway biomechanics relationships are considered as indivisible unit. This way, the mouth breathing that determines anatomical alterations in the facial structure reaches the whole corporal structure, due to the fact that the muscles act in a synergic form and are organized in chains (10, 11).

Alterations of the positioning and of the stomatognathic system functions lead to cervical spine curvature compensations and of the thoracic curvature followed by the lumbar and sacral curvatures. In an opposite way, alterations on the sacral and/or lumbar inferior member area lead to compensations of the thoracic and the cervical curvatures followed by positioning alterations and of stomatognathic functions system. Those adaptations happen in an attempt to maintain the corporal segments balance due to the action of the gravity center (12, 13).

Because of the nasal resistance increase the air flow entrance, the mouth breath requires a larger effort of the inspiration accessory muscles. This effort leads to a costal breath that compromises the whole thoracic box dynamics and of the diaphragm muscle excursion, responsible for 70% of all the breathing activity. This muscle, cranially inserted, has a format in the shape of a cup and divides the thorax and the abdomen. It is attached to the anterior face of the spinal cord at the L2/L3 level, to the xiphoid process and to the last six ribs. Liu (14) verified that the distance of the diaphragm excursion is larger in nasal breath children, if compared to mouth breath children.

However, it was not found in the literature any work that objectively describes the relationship between the behavior of the spine curvature and the diaphragm muscle. Besides this, Villmann (15) mentions that biomedical data presents private characteristics such as:

- small data sets;
- non-linear data sets;
- large noise without any clearly reproducible cause;
- scaling and choice of metrics in multidimensional data;
- categorical and no-metric data.

Specifically, conventional statistical models present difficulties in accomplishing of biomedical data qualitative analysis, mainly for presenting limitations in the non-linear behavior recognition between a group of variables or attributes (16). These deficiencies become problematic, mainly when it is necessary to apply statistical models in order to point out categories or to determine data sets patterns.

Artificial neural networks (ANN) (17) are efficient statistics tools to aid in the processing and treatment of biomedical data (18), because they accomplish treatment and data processing, improve the visualization of complex data (16) and use function of associative memory as a way of mapping the knowledge.

Self-organizing map (SOM) is an ANN unsupervised model used for defining clusters from dataset features, concerning topological relationships (19, 20). Among different applications, the SOM can be used to detect classes and clusters in biomedical databases (21, 22).

This work has for objective to point classes of mouth breath children and nasal breath children using the SOM, in order to aid the understanding of the behavior postural and its relationship by the excursion of the muscle diaphragm, being able to like this, best to address the physical rehabilitation.

## **MATERIALS AND METHODS**

For this study it was used a database, collected at Image Diagnosis Department and Pediatric Otorhinolaryngology Department of Federal University of São Paulo (UNIFESP), Brazil. 52 children were analyzed and out of that 30 previously diagnosed as mouth breath subjects and 22 diagnosed as nasal breath subjects. The database attributes are shown in Table 1, and the mean value of each attribute for each patient's category (mouth breath and nasal breath) is presented in Table 2. The image reception of the diaphragm excursion was obtained using the videofluoroscopy technique.

The image of the diaphragm muscle excursion was registered on the right and left sides. For each side it was recorded four idle breathing cycles in orthostatic position, with ante posterior incidence (AP) x-ray, with no interference for the postural correction. From the four recorded breathing cycles, a single cycle with harmonic motion was selected for analysis. The cycles that presented abrupt trunk movements were excluded, such as coughs, sneezes, laughs, frights, or speeches.

TABLE 1 - Attributes of database

<b>Antropometrics</b>	<b>Diaphragm</b>	<b>Posture</b>
Sex		Cervical Lordosis
Age	Excursion size on the right side (PD)	Lumbar Lordosis
Weight	Excursion size n on the left side (PE)	
Height		Thoracic Kyphosis
BMI		Pelvis Posture
Race		

After obtaining this information, the software Adobe Photoshop® were used to analyze the diaphragm muscle excursion distance. The corporal posture evaluation was accomplished through pictures obtained in the left lateral norm. The Software for Posture Evaluation (SAPO) (23) was applied to analyze the spine curvatures behavior.

TABLE 2 - Means value of each attribute for each patients category, in which NB represents nasal breath patients category and MB represents mouth breath patients category

	<b>Age</b>	<b>Weight</b>	<b>Height</b>	<b>PD</b>	<b>PE</b>	<b>Cervical Lordosis</b>	<b>Lumbar Lordosis</b>	<b>Thoracic Kyphosis</b>	<b>Pelvis Posture</b>
<b>NB</b>	9.2	37.7	1.4	1.3	1.3	52.2	120.0	41.0	7.0
<b>MB</b>	8.0	30.0	1.3	0.9	0.9	60.3	102.0	46.0	10.0

The package SOM Toolbox (24) from Information and Science Laboratory of Helsinki's University Computation was applied to implement SOM. This package allows the implementation of SOM through Matlab® (The MathWorks Inc., Natick, MA, USA).

Figure 1 lists the points and angles used in the children postural evaluation. For the analysis, when the terms cervical lordosis, thoracic kyphosis, lumbar lordosis, and pelvis posture are mentioned, it must be taken into account three points and shown angles, as presented: (a) cervical lordosis: ear of the tragus, acromion and C7, being the acromion to vertex of the angle; (b) thoracic kyphosis: L1, acromion, T7, being L1 to vertex of the angle; (c) lumbar lordosis: antesuperior iliac spine, L1 and large trochanter, being the antesuperior iliac spine to vertex of the angle; (d) pelvis position: lateral face of the knee interarticular space, antesuperior iliac spine and large trochanter, being lateral face of the knee interarticular space to the angle vertex. Table 2 displays the mean value of each attribute for each children category (mouth and nasal breath).

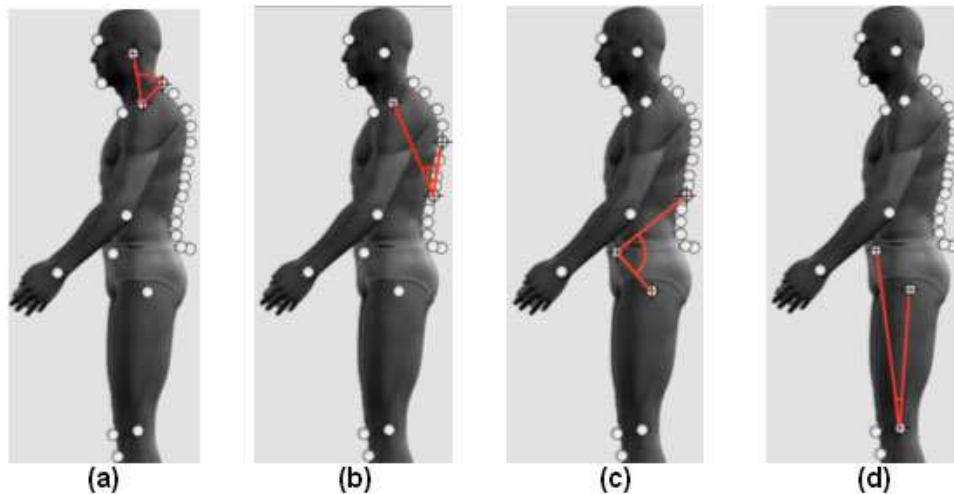


FIGURE 1 - Representation of the points and angles used in the postural evaluation, indicating (a) cervical lordosis; (b) thoracic kyphosis; (c) lumbar lordosis; (d) pelvis posture

## RESULTS

Figure 2 was obtained after the SOM training by using the model and the input pattern listed in the methodology of this study. Figure 2 presents two well defined categories. Neurons 1, 2, 3, 4 and 7 are only represented by the mouth breath children. Similar, neurons 5, 6, 8 and 9 are represented generically only by the nasal breath children. Table 3 shows the means of each attribute for each neuron, determined by the groupings presented in Figure 2.

Through Figure 2 and the values presented at Table 3 were detected typical mouth and nasal breath children classes:

- Typical nasal breath children class - The typical nasal breath children class, represented by the patients contained in neuron 9 of Figure 2 presented means values close to nasal breath children means. Only PD and PE values are superior to the nasal breath children means, being these the largest values shown in all clusters studied herein.
- Typical mouth breath children class – Two typical mouth breath children subclasses were detected:
  - o Subclass 1 is represented by the subjects that are in neuron 1 of Figure 2. These subjects present a very small distance of the diaphragm muscle excursion (50% smaller compared to typical nasal breath children class) and an accentuated lumbar lordosis and pelvis anteversion. Cervical lordosis shows a value close to the nasal breath means subjects.
  - o Subclass 2 is represented by the subjects that are in neurons 4 and 7. These subjects present the distance of the diaphragm muscle excursion about 25% larger compared to typical mouth breath children subclass 1. Cervical lordosis presents a value 27% smaller compared to typical nasal breath subjects. The lumbar lordosis and pelvis position values are close to subclass 1.

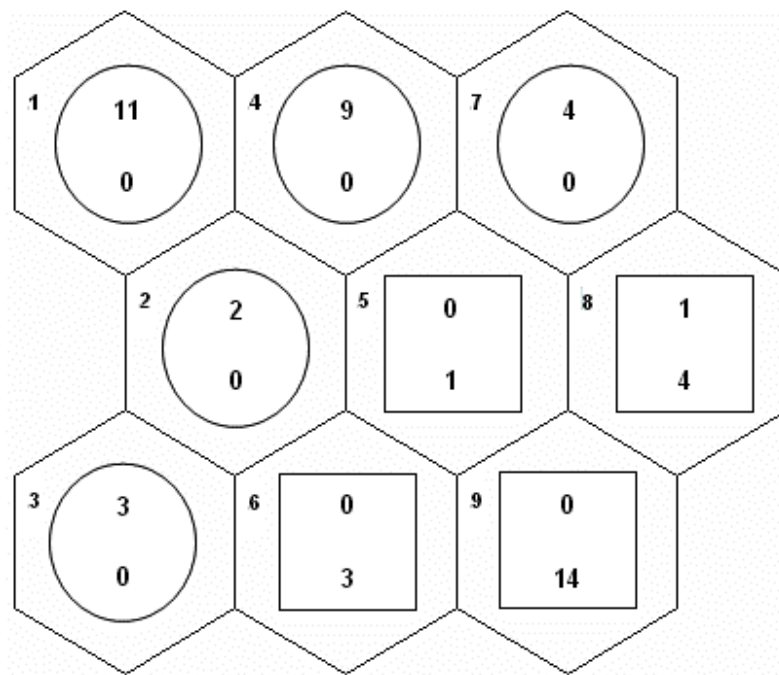


FIGURE 2 - Map generated after the SOM training. Each hexagon represents a neuron, which is identified on the left superior side. Internally in each hexagon there is a circle or square. The square classifies the neuron of nasal breath children clusters and the circle classifies the neuron of mouth breath children clusters. In each circle and square it is shown the amount of mouth breath children (number above) and the amount of nasal breath children (number below) clustered.

TABLE 3 - Means of each attribute for the patients clustered in each neuron, as shown in Figure 2

Neuron	Cervical Lordosis	Lumbar Lordosis	Thoracic Kyphosis	Pelvis Posture	PD	PE
1	56.30	97.40	48.50	11.00	0.71	0.77
2	50.00	109.30	46.20	10.70	0.90	0.92
3	53.10	113.10	47.00	7.70	0.93	0.95
4	65.60	100.00	44.20	10.00	0.92	0.91
5	58.50	105.30	42.20	7.80	1.20	1.20
6	43.10	117.90	44.00	6.40	1.20	1.00
7	65.50	109.10	41.50	8.90	0.94	1.00
8	63.10	117.30	39.70	7.20	1.00	1.00
9	51.70	121.40	41.40	6.90	1.46	1.47

## FINAL REMARKS

In subclass 1 of typical mouth breath class it was found a cervical lordosis similar to the typical nasal breath class, associated to an means distance of a very low diaphragm muscle excursion. Godfrey et al. (25) evaluated the thoracoabdominal mobility in subjects with and without increase of the airways resistance, through the plethysmography in which electrodes were coupled in the thorax and the spirometry was performed concomitantly. It was verified that the airways increase resistance alters the antero posterior and latero lateral thorax enlargement, suggesting that there is a compromising descent of the diaphragm muscle. The smallest distance of the diaphragm muscle excursion in subclass 1 of the mouth breath class suggests a smaller amount of lung volume entrance via nasal resistance increase.

Ribeiro e Soares (11) evaluated the lung function of mouth breath children from 8 to 12 years old before and after the physiotherapy intervention through spirometry and ventilometry. Before the intervention, a larger tendency to bronchia obstruction was verified, by a significant alteration for the forced expiratory flow (FEF) 25-75% and in the maximum volunteer ventilation (MVV). They observed that with the nasal resistance increase of the superior airway by the nasal obstruction there was also a bronchia obstruction, possibly because of the turbulence generated by the flow increase, once 50% of the airway resistance is located in the inferiorly.

In subclass 2 typical mouth breath class it was found a much reduced cervical lordosis, if compared to the nasal breath subjects means associated to the distance means of the diaphragm muscle excursion larger than in subgroup 1. Ribeiro e Soares (11) applied electromyography registrations in the sternocleidomastoidei muscles and superior trapeze in mouth breath children. They (11) observed larger electric activity of those muscles when compared to the nasal breath group, concluding that the nasal obstruction takes a larger inspiratory effort, due to the nasal resistance increase and to the adaptation of head and neck positions. We suggest that when there is a nasal occlusion there is an anterior head position and a cervical lordosis loss in order to amplify the airways. There is a major effort of the diaphragm and inspiration accessory muscle in the attempt of suppressing this demand.

Liu (14) verified that the lumbar lordosis is accentuated and the cervical lordosis decreased in the mouth breath children and that the values of the diaphragm excursion distance are larger in the nasal breath children. However, significant linear correlation was not detected among those variables. In order to detect non-linear relationships among variables through topologic connections present in their distributions similarities (26), SOM pointed mouth and nasal breath children classes, allowing the analysis of the postural behavior and its relationship facing up the diaphragm muscle excursion distance. Through this study, it is shown that ANN is a non-conventional statistical model capable of accomplishing qualitative analysis of a biomedical dataset, characterized by executing a non-linear and non-parametric inspection of a group of variables or attributes.

The results of this study show that is possible to preview interventions related to treatment and to postural and respiratory orientation. The next step refers mainly to future investigation in order to establish the chronological age and the clinic characteristics adequate to thoracoabdominal and postural balances, once there are adjustments related to a chronicle nasal obstruction to be made.

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