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Evaluate the Effect of Mouth Breathing on Growth and Development of Facial Bones and Malocclusion in Children: A Systematic Review and Meta-Analysis

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Abstract

Background and aim: Mouth breathing changes the temporomandibular joint structure and periarticular muscle groups, resulting in regular mouth breathing. This causes malocclusion (often class II malocclusion) as well as changes in the maxillofacial soft and hard tissues, which in turn affects the maxillofacial appearance and development.The present study was performed to evaluate the effect of mouth breathing on growth and development of facial bones and malocclusion in children.

Method: Databases of PubMed, Scopus, Web of Science, EBSCO and Embase were searched for systematic literature between 2011 to August 2021. For Data extraction, two reviewers blind and independently extracted data from abstract and full text of studies that included.95% confidence interval for mean differences with fixed effect model and in-variance method were calculated. To deal with potential heterogeneity, random effects were used and I^2 showed heterogeneity. Meta-analysis was performed using Stata/MP v.16 software (The fastest version of Stata).

Result: In the initial review, duplicate studies were eliminated and abstracts of 226 studies were reviewed, the full text of 31 studies was reviewed by two authors, finally, seven studies were selected. Mean differences ofANB between Mouth breathing and Nasal Breathingwas 1.34° (MD, 1.34° 95% CI 1.03°, 1.65°). Mean differences of SN-PP, SN-OP, PP-MP and SNGoGNbetween Mouth breathing and Nasal Breathing WERE0.1 (95% CI -1.49, 1.69), 2.72 (95% CI 1.75, 3.70), 4.5 (95% CI 2.16, 6.84), -2.09 (95% CI -2.85, -1.33), respectively.

Conclusion: The present Systematic Review and Meta-Analysis study showed vertical measurement changes were higher and all airway changes were lower in mouth-breathing individuals than in nasal-breathing individuals.

Key words:airway changes, facial bones, malocclusion, mouth breathing, children

Introduction

Mouth breathing is breathing through the mouth(1). This type of breathing is an alternative to nasal breathing and has various causes; Genetic factors, bad mouth habits, or nasal obstruction, nasal polyps, deviation of the nasal septum, etc. can cause this breathing(2). Mouth breathing may also be associated with respiratory allergies, weather conditions, poor sleep patterns, and breastfeeding(3). There is much debate about the effect of mouth breathing on maxillofacial bone growth and comprehensive results have not been reported. Adenoid hypertrophy causes upper airway obstruction and may affect both dental and maxillofacial development. Nasal breathing is partially obstructed due to large adenoids, and this leads to mouth breathing and typical “adenoid face” (4). Mouth breathing changes the temporomandibular joint structure and periarticular muscle groups, resulting in regular mouth breathing. This causes malocclusion (often class II malocclusion) as well as changes in the maxillofacial soft and hard tissues, which in turn affects the maxillofacial appearance and development(5). Various researchers have reported the results of different studies on the effects of mouth breathing on the maxilla and mandible and the position of the maxilla relative to the base of the skull. Some researchers believe that the maxillary respirators through the mouth are more retrogenic and have a lower anterior height of the face, while others disagree (6-9). Studies have reported that facial skeletal growth improves after removal of the cause of oral respiration with surgery or other devices (10-13).Due to the importance of the research, the researchers decided to study the effects of mouth breathing on the growth of facial bone and malocclusion in children and report comprehensive results of the study. Therefore, the present study was performed to evaluate the effect of mouth breathing on growth and development of facial bones and malocclusion in children.

Method

Databases of PubMed, Scopus, Web of Science, EBSCO and Embase were searched for systematic literature between 2011 to August 2021.A review of the results of studies from the last ten years can provide newer results.Use the MeSH Database, to build searches in PubMed:
((((((("Mouth Breathing"[Mesh]) OR ("Mouth Breathing/classification"[Mesh] OR "Mouth Breathing/complications"[Mesh] OR "Mouth Breathing/diagnosis"[Mesh] OR "Mouth Breathing/surgery"[Mesh] OR "Mouth Breathing/therapy"[Mesh])) AND "Malocclusion, Angle Class II"[Mesh]) AND "Facial Recognition"[Mesh]) OR "Polyps"[Mesh]) OR "Nose Deformities, Acquired"[Mesh]) AND "Facial Bones"[Mesh]) AND "Cephalometry"[Mesh].
Key considerations PRISMA was the basis of the present study(14) and PECO strategy to answer theresearch questions showed in Table1.

Selection criteria

*Inclusion criteria: criteria:*Age group under 18 years, children with mouth breathing habits, adenoid facies, Class II malocclusions, Clinical controlled trials, randomized controlled trials, and cohort studies, English language. Case studies, case reports, reviewswere excluded from the study.

Table1. PECO strategy

PECO strategy	Description
P	Population:Children under 18 years old
I	Exposure: Mouth breathinghabits
C	Comparison: without Mouth breathinghabits
O	Outcome: growth and development of facial bones

Study selection, Data Extraction and method of analysis

Studies data were reported by study, years, study design, age, number ofpatients andExposure.

The quality of the randomized control trial studies included was assessed using the Cochrane Collaboration's tool(15). The scale scores for low risk was 1 and for High and unclear risk was 0. Scale scores range from 0 to 6. A higher score means higher quality. Non-randomized Studies (ROBINS-I) tool(13) used to assessed quality of the cohort studies and Clinicalcontrolled trial.

For Data extraction, two reviewers blind and independently extracted data from abstract and full text of studies that included.Prior to the screening, kappa statistics was carried out in order to verify the agreement level between the reviewers. The kappa values were higher than 0.80.

95% confidence interval for mean differences and in-variance method were calculated. To deal with potential heterogeneity, random effects were used and I^2 showed heterogeneity. I^2 values less than 50% indicate low heterogeneity and above 50% indicate moderate to high heterogeneity. Meta-analysis was performed using Stata/MP v.16 software (The fastest version of Stata).

Result

The review of the existing literature using the studied keywords, 231 studies were found. In the initial review, duplicate studies were eliminated and abstracts of 226 studies were reviewed. At this stage, 195 studies did not meet the inclusion criteria, so they were excluded, and in the second stage, the full text of 31 studies was reviewed by two authors. At this stage, 24 studies were excluded from the study due to incomplete data, inconsistency of results in a study, poor studies, lack of access to full text, inconsistent data with the purpose of the study. Finally, seven studies were selected (Figure1).

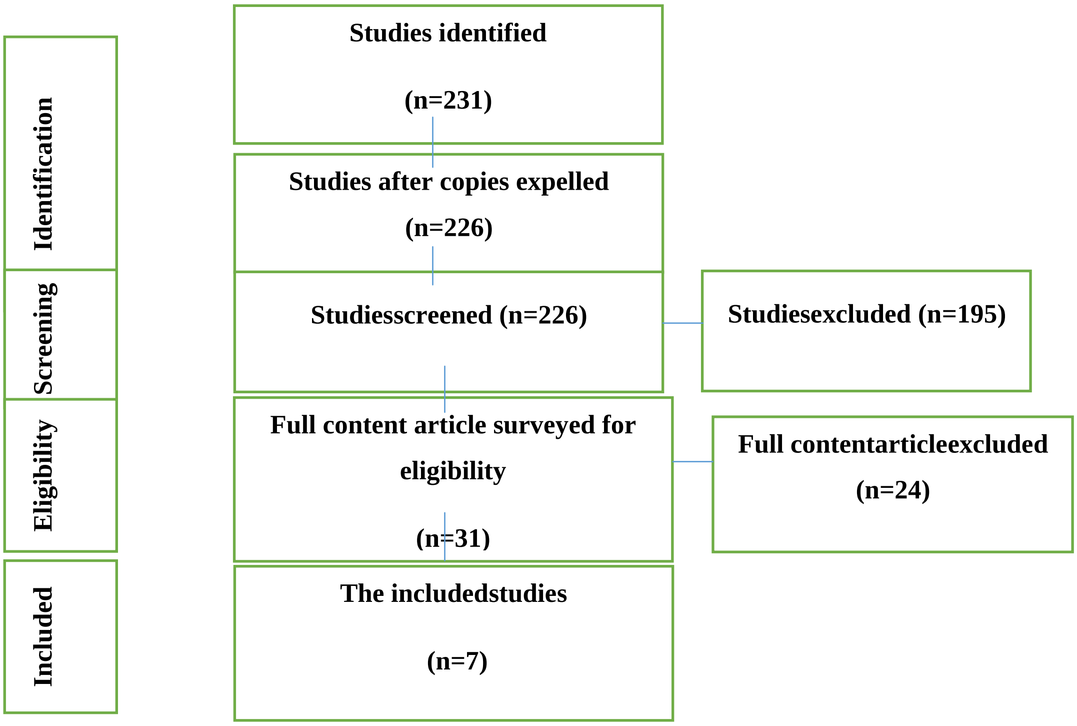

Figure 1. Study Attrition

Characteristics

Sevenstudies (Controlled clinical trials study) have been included in present article. The number of participants in Mouth breathing group and Nasal Breathing group were 478 and 515, respectively and a total was 993 with rangeof age between 2-14 years (Table2).

Bias assessment

According to ROBINS-I tool, fourstudies had moderate risk of bias and three studies had low risk of bias (Table3).

Table2. Studies selected for systematic review and meta-analysis.

Study. years	**Study design**	**Number of participants**		**range of age (years)**	**Exposure**
		Mouth breathing	**Nasal Breathing**		
Agostinho et al., 2015(16)	CCTs	35	35	5-14	Rhinitis
Franco et al., 2015 (17)	CCTs	113	113	3-10	Adenoid Tonsillar hypertrophy
Muñoz et al., 2014 (8)	CCTs	53	65	6-12	Adenotonsillar disease
Franco et al., 2013 (18)	CCTs	55	55	3-10	Adenoid Tonsillar hypertrophy

Juliano et al., 2013(19)	CCTs	52	92	7-14	Obstructive sleep apnea syndrome
Souki et al., 2012 (20)	CCTs	126	126	2-10	Hypertrophy
Mattar et al., 2011 (10)	CCTs	44	29	3-6	Tonsillar hypertrophy

CCTs: Controlled clinical trials

Table3. Risk of bias assessment (ROBINS-I tool)

Study. years	**Biases and Confounding**	**Selection bias**	**classification of interventions**	**deviations from intended**	**missing data**	**measurement**	**outcome**	**Overall bias**
Agostinho et al., 2015(16)	L	M	L	L	L	L	L	M
Franco et al., 2015 (17)	M	M	L	L	L	M	L	M
Muñoz et al., 2014 (8)	L	M	L	L	L	L	L	M
Franco et al., 2013 (18)	M	L	L	L	L	L	L	M
Juliano et al., 2013(19)	L	L	L	L	L	L	L	L
Souki et al., 2012 (20)	L	L	L	L	L	L	L	L
Mattar et al., 2011 (10)	L	L	L	L	L	L	L	L

L: low risk of bias; M: moderate risk of bias; H: high risk of bias

Sagittal measurement changes

Mean differences ofANB between Mouth breathing and Nasal Breathingwas 1.34° (MD, 1.34° 95% CI 1.03°, 1.65°)among five studies and heterogeneity found (I^2=88.59%; P =0.00) (Figure 2).
Mean differences ofSNA between Mouth breathing and Nasal Breathingwas -1° (MD, -1° 95% CI -1.76°, -0.23°)among four studies and heterogeneity found (I^2=0%; P =0.49) (Figure3).
Mean differences ofSNB between Mouth breathing and Nasal Breathingwas -1.78° (MD, -1.78° 95% CI -2.25°, -1.31°)among six studies and heterogeneity found (I^2=87.6%; P =0.00) (Figure 4).
Mean differences of1-NA between Mouth breathing and Nasal Breathingwas 2.65 (MD, 2.65 95% CI 1.21, 4.09)among three studies and heterogeneity found (I^2=11.93%; P =0.32) (Figure 5).
Mean differences of1-NB between Mouth breathing and Nasal Breathingwas 1.10 (MD, 2.651.10 95% CI 0.41, 1.79) among two studies and heterogeneity found (I^2=0%; P =1.00) (Figure 6).

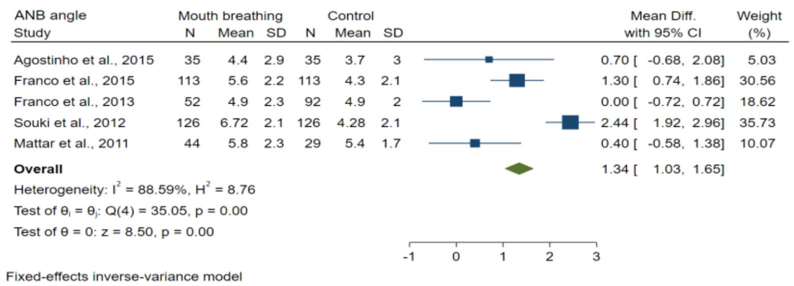

Figure2. Forest plot showed ANB changes between Mouth breathing and Nasal Breathing

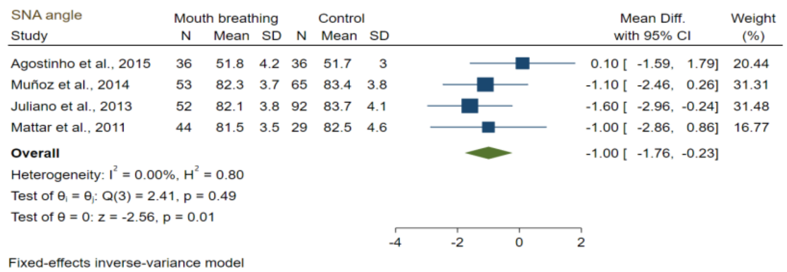

Figure3. Forest plot showed SNA changes between Mouth breathing and Nasal Breathing

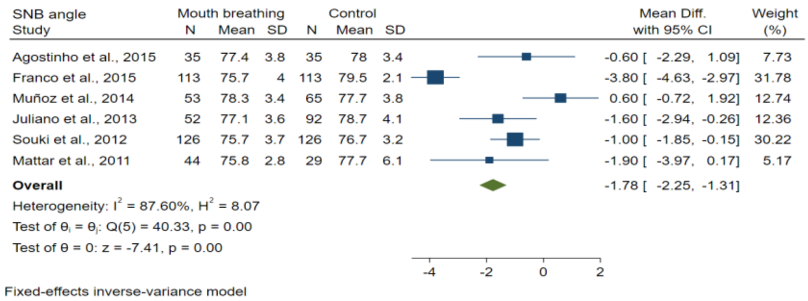

Figure4. Forest plot showed SNB changes between Mouth breathing and Nasal Breathing

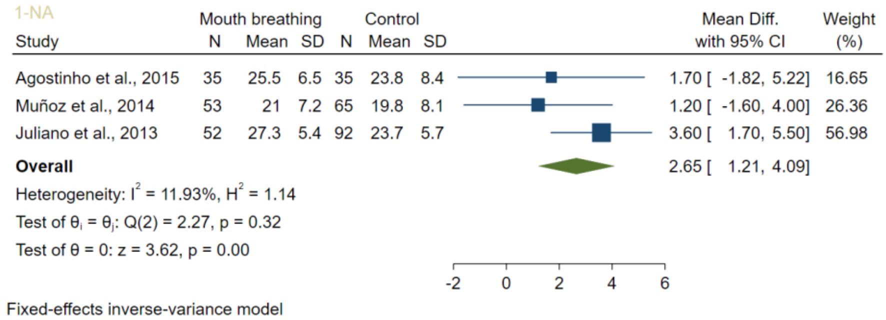

Figure5. Forest plot showed 1-NA changes between Mouth breathing and Nasal Breathing

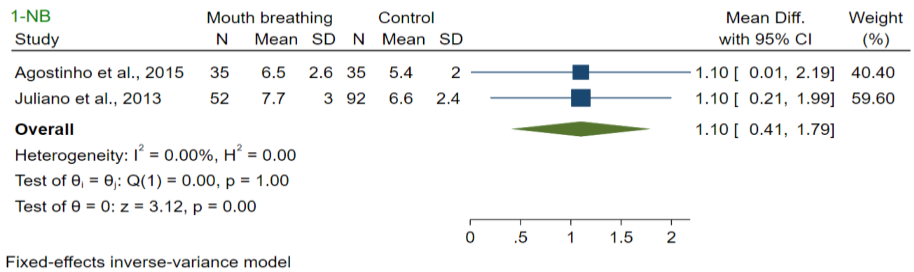

Figure6. Forest plot showed 1-NB changes between Mouth breathing and Nasal Breathing

Vertical measurement changes

Subgroup meta-analysis showed Mean differences of SN-PP, SN-OP, PP-MP and SNGoGNbetween Mouth breathing and Nasal Breathing WERE0.1 (95% CI -1.49, 1.69), 2.72 (95% CI 1.75, 3.70), 4.5 (95% CI 2.16, 6.84), -2.09 (95% CI -2.85, -1.33), respectively. Overall Vertical measurement changes were 0.02 (MD 0.02; 95% CI -0.52, 0.57). This result showed all Vertical measurement changes were higher in mouth-breathing individuals than in nasal-breathing individuals (Figure7).

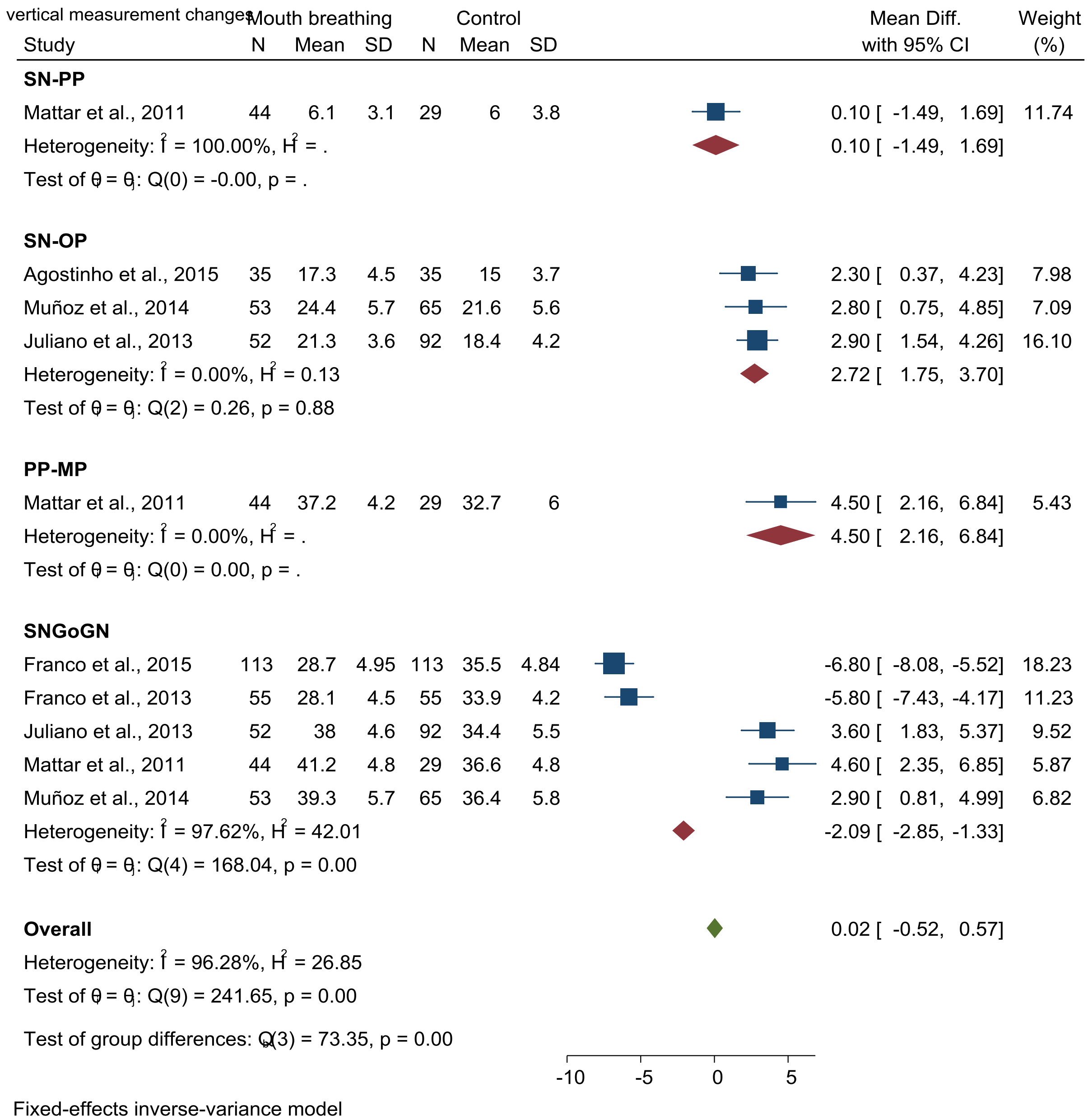

Figure7. Forest plot showed Vertical measurement changesbetween groups

Airway changes

Subgroup meta-analysis showed Mean differences of SPAS, PAS, and 3C-H between Mouth breathing and Nasal Breathing were-4.92 (95% CI -5.45,-4.38), -1.91 (95% CI -2.62, -1.19), 4.31 (95% CI 3.52, 5.11), respectively. Overall Airway changes were -2 (MD -2.00; 95% CI -2.62, -1.19).

This result showed all Airway changes were e lower in mouth-breathing individuals than in nasal-breathing individuals (Figure8).

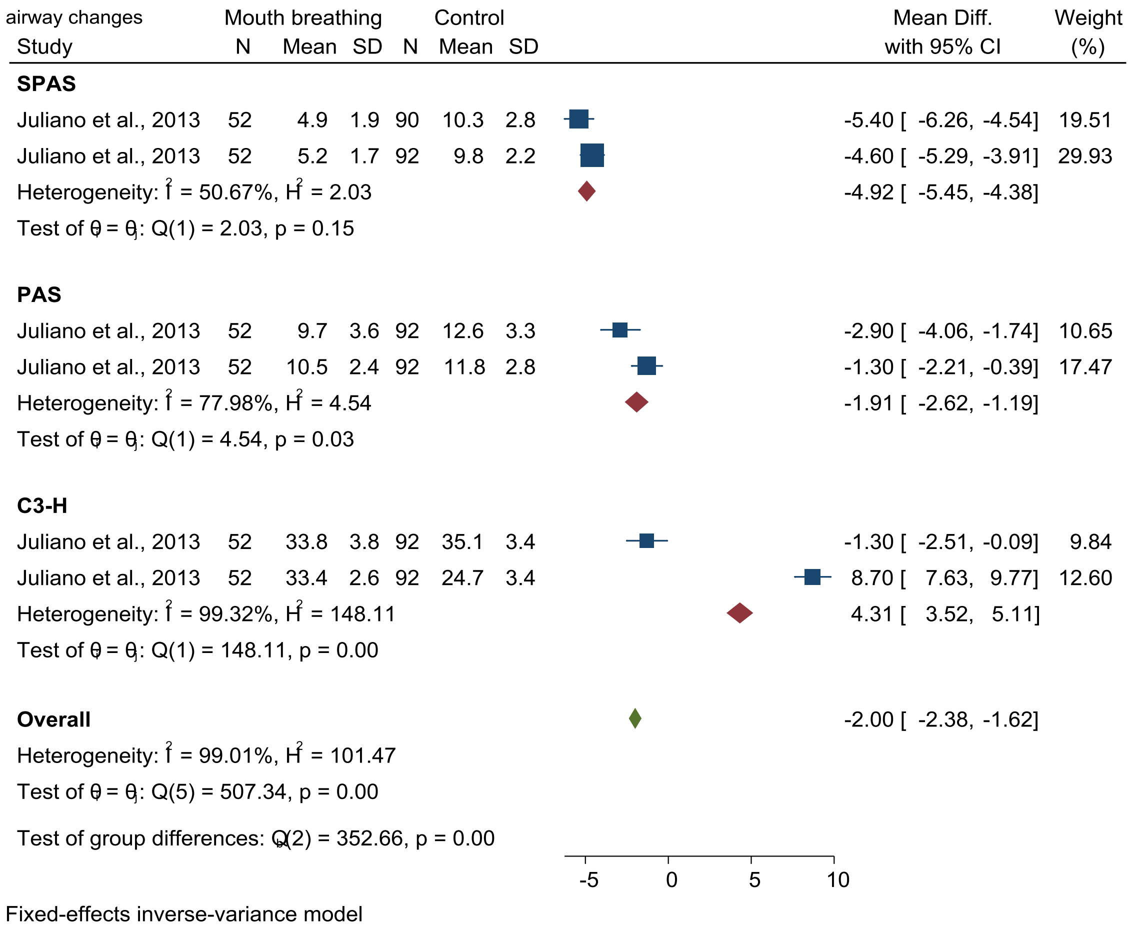

Figure8. Forest plot showed Airway changesbetween groups

Discussion

The aim of current Systematic Review and Meta-Analysis wasevaluate the effect of mouth breathing on growth and development of facial bones and malocclusion in children. Epidemiological studies have shown that the prevalence of mouth breathing in children varies between 12 and 55% (21-25).The prevalence of adenoid hypertrophy is also reported to be about 50 %(26).Due to the high prevalence of mouth breathing and adenoid hypertrophy in children, prevention should be considered in this area; surgical procedures, orthodontic treatment can increase the quality of life in these children.The type of breathing (mouth, nose) and development of facial bones has been discussed by many experts for years(27, 28).In meta-analysis studies, it was found that preoperative children with oral respiration had higher mandibular plate angle and posterior mandibular rotation than children with nasal respiration, and most had class II malocclusion after surgery and correction. Breathing patterns can greatly improve the development of children's faces (11, 13, 29).In the present study, the effects of oral respiration on facial skeletal development in children were investigated; seven studies were selected and reviewed. In some of the studied variables, high heterogeneity was observed between the results of the studies. However, the risk of bias in studies was considered low to moderate.One of the confounding factors in the present study is the age and gender of children, which has not been studied but can affect the final results.The findings of the meta-analysis of the present study showed that oral respiration can prevent the development of the jaw in children; accordingly, the mandible has an obvious tendency to rotate due to the position of the skull. These findings are inconsistent with the two studies(8, 30).While in one study it was observed that the upper jaw also tends to rotate backwards(31).In addition, Kim et al., 2015 suggested that children with mouth breathing may also have maxillary shortness(32).

Conclusion

Based on the meta-analysis of the present study all vertical measurement changes were higher and all airway changes were lower in mouth-breathing individuals than in nasal-breathing individuals, also the mandible and maxilla rotate backward and downward, and the occlusal plate is steep in children with oral respiration.

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