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# Comparison of oral indices in patients with Down syndrome and healthy individuals: A meta-analysis study

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## ABSTRACT

**Background:** The aim of the present study was to compare dental indexes of pediatric Down syndrome (DS) patients to those who are healthy.

**Materials and Methods:** This study was carried out based on Preferred Reporting Items for Systematic Reviews and Meta-Analysis statement guidelines. The researchers searched title and abstract of major databases, including ProQuest (ProQuest Dissertations and Theses Full Text: Health and Medicine, ProQuest Nursing and Allie Health Source), PubMed, Google Scholar, clinical key, up to date, springer, Cochrane, Scopus, Embase, and Web of Science (ISI), up to September 2020 with restriction to English and Persian language This meta-analysis study had three outcomes: decay/miss/filled index, plaque index, and gingival index. Effect size, including mean difference and its 95% of confidence interval, was calculated. The Newcastle–Ottawa Scale measured the quality of the selected studies. Heterogeneity was performed using the $Q$ test and $I^2$ index, and reporting bias was assessed using a funnel plot and Egger and Begg's tests.

**Results:** Fifteen studies conducted were included in the meta-analysis process.

**Conclusion:** It showed that DS patients had a higher plaque index and gingival index than healthy individuals, which means that the oral health status of these patients is worse and needs more attention.

**Key Words:** Decayed, missing and filled teeth, Down syndrome, gingival index, oral health, plaque index

## INTRODUCTION

Down syndrome (DS) is the most prevalent chromosomal abnormality that affects many organs, including the oral area. Hence, oral, dental, and gingival disorders are some of the most critical problems in DS patients.[1] The most important causes of these problems in DS patients include immune system deficiency and dry mouth, which are usually caused by mouth breathing and taking some medications (anticonvulsant and sedative),[2] slotted lips and tongue,[3] and constant opening of the mouth due to an imbalance in the strength of its muscles. Furthermore, some food stays in the mouth of these patients due to the low tone in their muscles.[4]

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In some studies, there are pieces of evidence of the higher frequency of periodontal diseases and oral disorders in DS patients than in healthy individuals.[5-7] Furthermore, a meta-analysis study was conducted in 2015 to examine the association of tooth decay with DS. This meta-analysis analyzed eight studies and concluded that teeth caries in DS patients were more prevalent than the healthy individuals.[8] However, this study only examined the status of tooth decay in DS and did not evaluate other dental indices. Furthermore, a systematic review study was conducted in 2016 and provided evidence of a higher incidence of tooth decay in DS patients.[9]

Patients with DS are prone to oral and dental diseases in comparison to healthy population. The aim of the present study, therefore, was to compare dental indexes of pediatric patients with DS to those who are healthy.

Due to the differences in the types of oral diseases, there are different indices to assess the status of oral diseases, including decay/miss/filled (DMF), plaque index, and gingival index. Some primary studies assessed these indices in DS patients, but there is no meta-analysis study in this area. This gap was addressed in this meta-analysis study.

## MATERIALS AND METHODS

### Eligibility criteria

We carried out this study based on Preferred Reporting Items for Systematic Reviews and Meta-Analysis statement guidelines. Based on the PECO model, the study was designed as follows: (patients): people with DS (exposure to risk factor): DS (comparison): oral health indicators in people with DS with healthy people (outcome): dental problems, decay, missed and filled teeth (DMFT), periodontal problems.

Three outcomes in this study included: (1) DMF, which defined the number of DMFT and used for 65 years in dentistry,[10] (2) plaque index, which is the amount of visible dental plaque on the lingual surfaces of all teeth,[11] and (3) gingival index which is a method to assessing the severity and quantity of gingivitis scores each site on a 0–3 scale, with 0 being normal and 3 being severe inflammation.[12] All cross-sectional or case-control studies that evaluate these indices in DS patients and healthy control were included irrespective of nationality, race, and publication day. Only the studies in English and Persian language were included in the study.

### Inclusion criteria

Observational studies (case reports, cohort, and cross-sectional studies) evaluating the prevalence, incidence, or experience of oral and dental diseases in patients with DS (without age limitation) compared to healthy patients that have reported the results in percentage were selected. Moreover, only articles written in Farsi and English that their abstracts and full texts were available were included in the present study. Articles published in valid journals were selected. Furthermore, dissertations evaluating the abovementioned topic were considered.

### Exclusion criteria

Articles written in languages other than Farsi and English as well as those evaluating oral and dental diseases in patients without DS were excluded from the present study. Besides, studies with nonconformity regarding P and O were not evaluated. Furthermore, studies scored <5 after checking the related checklist were excluded from the study. Finally, studies that did not report the outcomes in percentage were not included in the study.

### Search strategy

Three authors searched title and abstract of major databases, including ProQuest (ProQuest Dissertations and Theses Full Text: Health and Medicine, ProQuest Nursing and Allie Health Source), PubMed, Google Scholar, Clinical Key, Up to Date, Springer, Cochrane, Scopus, Embase, and Web of Science (ISI), up to September 2020 with restriction to English and Persian language. The following search terms used for all databases: ((Down * AND syndrome) OR Mongolism OR “Trisomy 21” OR “47, XY, +21” OR “47, XX, +21” OR “Trisomy G” OR “partial trisomy 21” OR (mitotic AND nondisjunction)) AND (DMFT OR dmft OR “Decayed Missed Filled Teeth” OR ((Dent * OR tooth OR teeth OR oral) AND (Caries OR decay * OR Plaque Index * OR Plaque Indices OR periodontal disease * OR Hygiene Index * OR Hygiene Indices OR Health OR Clinics OR Health Surveys OR Diagnosis)) OR ((Periodontal OR gingival OR mouth OR calculus) AND (Disease * OR Index * OR Indices OR rehabilitation)) OR “Community Periodontal Index of Treatment Needs” OR CPITN OR “Gingival Bleeding on Probing” OR “Pyorrhea Alveolaris” OR Parodontos * s).

### Study selection and data extraction

Search results were imported to EndNote software, and duplicate studies were removed. Then two

authors (H. P. and N. M.) screened the title and abstract independently and were removed from irrelevant studies – disagreement between the two authors was solved by discussion with the third author (F. N.). Then, the full text of the most relevant studies was retrieved and screened by two authors. The data from selected studies were extracted and imported to electronic form. These data include the author's name, title, publication year, study design and method, characteristics of participants, age, sample size, statistical analysis, and prominent result. Furthermore, the effect size, including mean difference and 95% confidence interval (CI), comprehensive meta-analysis software for data analysis in this study was applied.

### Methodological quality

The quality of the selected studies was measured by the Newcastle–Ottawa Scale[13] and by two authors. According to this protocol, the following criteria were examined: (1) accuracy of selection of study group (diagnosis of DS based on genetic testing or patients selecting from referral centers and control individuals without any disorders), (2) control of confounders such as drug use and socioeconomic status, and (3) outcome assessment (assessing the dental disorders by an experienced researcher and calibrated tools, existence of clinical criteria for the mentioned disorders, assessing of controls, and reporting of nonresponse cases). For each study, a score of 0–8 was assigned based on these scales and was recorded in electronic form. Finally, the scores of the studies were collected and classified as high quality (score 6–8), medium quality (score 3–5), and low quality (score 0–2).

### Reporting bias and heterogeneity

Heterogeneity was performed using the $Q$ test and $I^2$ index.[14,15] In the case of studies with heterogeneity, we used of random effect model to combine the results. Reporting bias was assessed using funnel plots and Begg tests.[16]

## RESULTS

### Search results and quality assessment

We identified 617 comparative studies through a systematic search. Two hundred and fifty-six studies were excluded before the assessing, and 361 studies were screened. In this step, 317 studies were removed after screening the title and abstract. Finally, 15 studies conducted between 2005 and 2020 were included in the meta-analysis process [Figure 1].

The total sample size was 1200 in the DS patients and 1235 in the healthy individuals. The mean age was 13.93 ± 9.52 years. Nine studies (60%) in Asia, 4 (26.67%) in South America, and 1 study from Europe and North America were included in the meta-analysis. Characteristics and information of selected studies are presented in Table 1.

Five studies had a score ≥6 (high quality), and 10 studies had a score of <6 (low quality) out of 15 studies included for meta-analysis. Details of the quality assessment results of the articles submitted for meta-analysis are presented in Table 2.

### Synthesis of studies

The mean of DMF index in DS patients was lower than in healthy individuals that were not significant (Hedges' $g$ = −0.28, 95% CI = −0.69–0.13, $P$ = 0.18). Heterogeneity was reported by $I^2$ = 94.52% [Figure 2]. The mean plaque index in DS patients was significantly higher than in healthy individuals (Hedges' $g$ = 2.39, 95% CI = 0.38–4.40, $P$ = 0.02). Heterogeneity was reported by $I^2$ = 98.21% [Figure 3]. The mean gingival index in DS patients was significantly higher than in healthy individuals (Hedges' $g$ = 2.75, 95% CI = 0.71–4.79, $P$ = 0.01). Heterogeneity was reported by $I^2$ = 98.81% [Figure 4].

### Subgroup analysis

The analysis of the DMF means that difference by continent was possible. These results showed that the mean DMF index in DS patients was lower than in healthy individuals in Asian countries that were not significant (Hedges' $g$ = −0.33, 95% CI = −0.83, $P$ = 0.18) and also in South American countries, this finding was similarly observed (Hedges' $g$ = −0.15, 95% CI − 0.40, $P$ = 0.10) [Figure 5].

### Publication bias

There was no evidence of publication bias based on Begg's test. The $P$ value of this test in studies that assessed the effect of DS on DMF, plaque, and gingival index were 0.901, 0.0303, and 0.300, respectively. Hence, there was no evidence of publication bias in studies.

## DISCUSSION

The present study showed that the mean DMFT in DS patients was slightly lower than the healthy

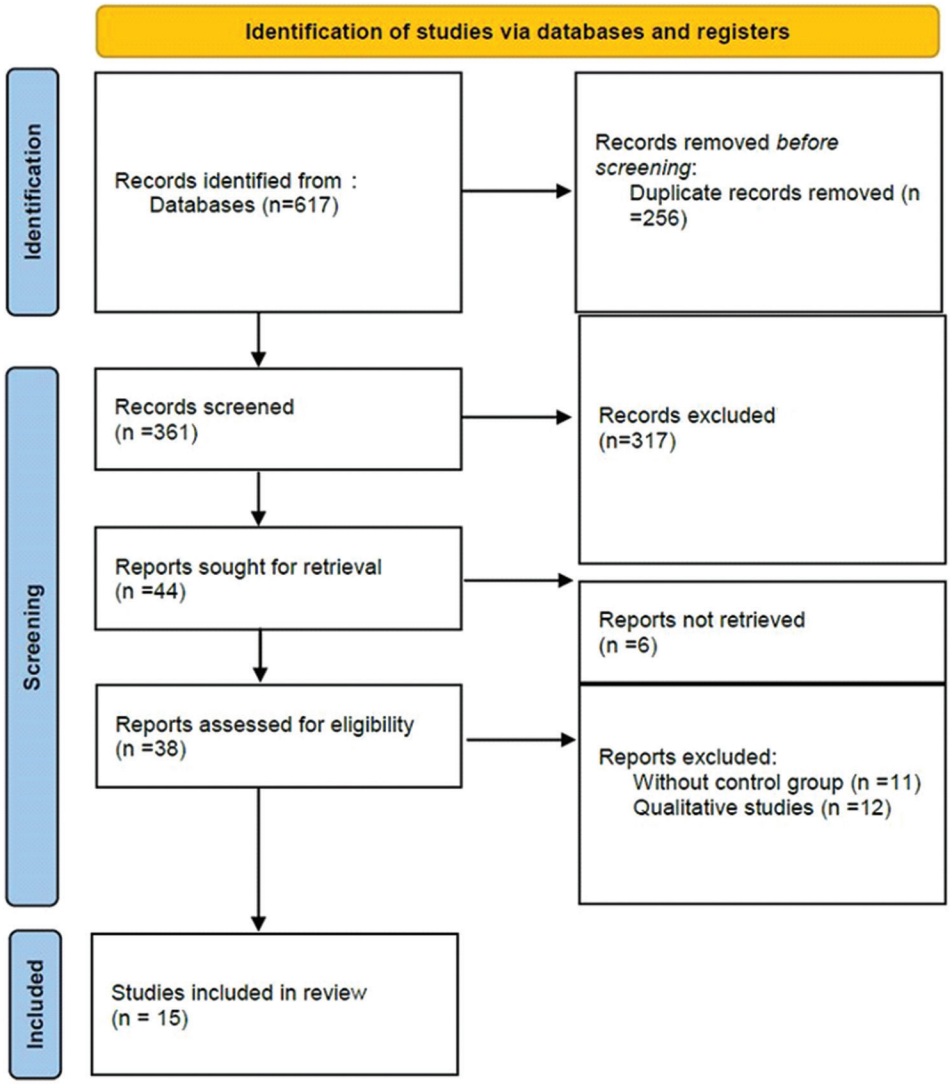


**Figure 1:** Study selecting flowchart.

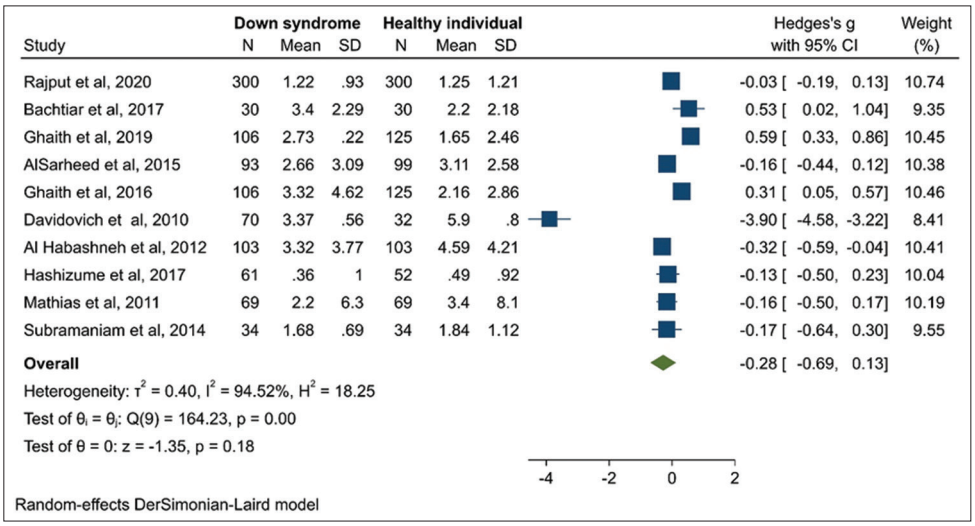


**Figure 2:** The effect of Down syndrome on decay/miss/filled. SD: Standard deviation, CI: Confidence interval.

## Table 1: Characteristics and information of selected studies

| Author | Year of implementation | Country | Study type | Mean/median of age | DMFT index (syndrome down) | DMFT index (healthy people) | Plaque index (syndrome down) | Plaque index (healthy) | Gingival index (syndrome down) | Gingival index (healthy) | Sample size DS | Sample size healthy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rajput S *et al.*, 2020[1] | 2017 | India | Cross sectional | 9–14 years | 1.22±0.93 | 1.25±1.21 | | | | | 300 | 300 |
| Bachtiar ZA *et al.*, 2017[3] | 2017 | Indonesia | Cross sectional | 6–18 years | 3.40±2.29 | 2.20±2.18 | | | | | 30 | 30 |
| Ghaith *et al.*, 2019 | 2019 | United Arab Emirates | Cross sectional | 7–16 years | 2.73±0.22 | 1.65±2.46 | | | | | 106 | 125 |
| AlSarheed *et al.*, 2015 | 2015 | Saudi Arabia | Cross sectional | 3–16 years | 2.66±3.09 | 3.11±2.58 | | | | | 93 | 99 |
| Ghaith *et al.*, 2016 | 2016 | United Arab Emirates | Case–control | 7–16 years | 3.32±4.62 | 2.16±2.86 | | | | | 106 | 125 |
| Davidovich *et al.*, 2010 | 2010 | Israel | Cross sectional | 1–15 years | 3.37±0.56 | 5.9±0.80 | 1.46±0.55 | 1.11±0.43 | 1.29±0.55 | 0.66±0.51 | 70 | 32 |
| Al Habashneh *et al.*, 2012 | 2008 | Jordan | Cross sectional | 12–16 years | 3.32±3.77 | 4.59±4.21 | | | 39.9±9.1 | 15.9±8.0 | 103 | 103 |
| Hashizume *et al.*, 2017 | 2017 | Brazil | Cross sectional | 6–14 years | 3.32±4.62 | 2.16±2.86 | | | | | 61 | 52 |
| Mathias *et al.*, 2011 | 2011 | Brazil | Cross sectional | 13–85 months old | 3.30±2.29 | 2.20±2.18 | | | | | 69 | 69 |
| Subramaniam *et al.*, 2014 | 2014 | India | Cross sectional | 7–12 years old | 1.68±0.69 | 1.84±1.12 | | | | | 34 | 34 |
| Andreeva *et al.*, 2020 | 2020 | Bulgaria | Cross sectional | 3–15 years old | | | 1.81–2.8 | 0.9–2.2 | | | 60 | 60 |
| Khocht *et al.*, 2014 | 2013 | USA | Cross sectional | 18–56 years old | | | 1.56±0.01 | 1.25±0.08 | 0.92±0.04 | 0.68±0.03 | 55 | 88 |
| Figueiredo *et al.*, 2005 | 2005 | Brazil | Cross sectional | 17–35 years old | | | 2.75±0.2 | 1.76±0.3 | | | 30 | 30 |
| Komatsu T *et al.*, 2013[12] | 2013 | Japan | Cross sectional | 1–62 years | | | | | 0.26–0.40 | 0.13–0.73 | 66 | 71 |

DS: Down syndrome; DMFT: Decay, missed and filled teeth

## Table 2: Quality assessment using Newcastle–Ottawa Scale for cross-sectional studies[§]

| Study | Selection | | | | Comparability | | Outcome | | Study score |
|---|---|---|---|---|---|---|---|---|---|
| | Representativeness of the sample | Sample size | Nonrespondents | Ascertainment of the exposure | The individuals in different outcome groups are comparable | Confounding factors are controlled | Assessment of outcome | Statistical test | |
| Rajput *et al.*, 2020 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 5 |
| Bachtiar *et al.*, 2017 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 5 |
| Ghaith *et al.*, 2019 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| AlSarheed *et al.*, 2015 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Ghaith *et al.*, 2016 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Davidovich *et al.*, 2010 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 6 |
| Al Habashneh *et al.*, 2012 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 7 |
| Hashizume *et al.*, 2017 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Mathias *et al.*, 2011 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Subramaniam *et al.*, 2014 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Andreeva *et al.*, 2020 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 4 |
| Khocht *et al.*, 2014 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Figueiredo *et al.*, 2005 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 5 |
| Komatsu *et al.*, 2013 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7 |

[§]Study score <4 indicates poor, a score of 4–6 represents good, and a score of 7 or higher indicates as excellent

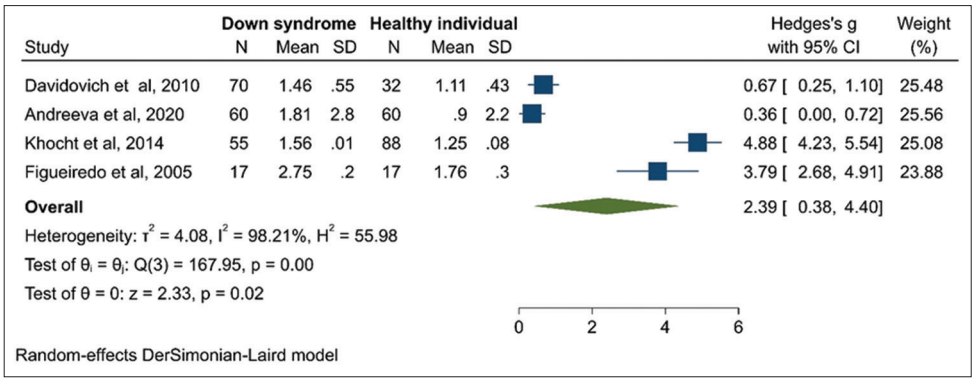


**Figure 3:** The effect of Down syndrome on plaque index. SD: Standard deviation, CI: Confidence interval.

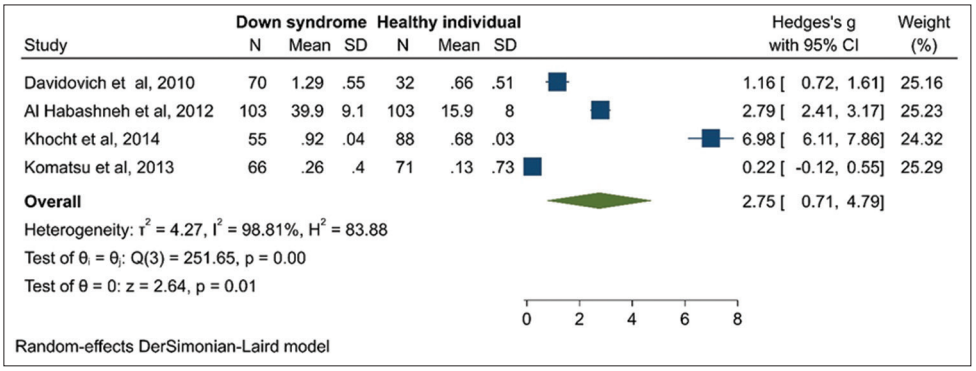


**Figure 4:** The effect of Down syndrome on gingival index. SD: Standard deviation, CI: Confidence interval.

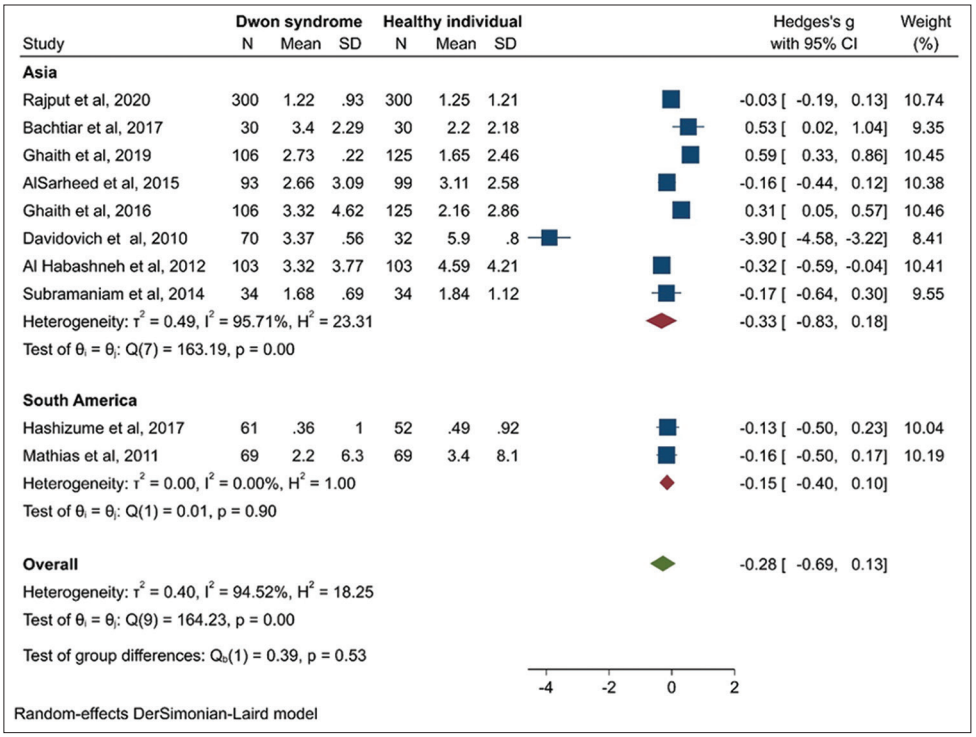


**Figure 5:** The effect of Down syndrome on decay/miss/filled by continent. SD: Standard deviation, CI: Confidence interval.

individuals, which were not significant. Heterogeneity in this finding was above 90%.

There have been various studies on the association between DS and some dental indicators, and

some studies showed that DS had no effect on the DMF index and even reduced it in line with our study.[17-19] In a study by Teng *et al.*,[20] the oral health of hospitalized patients was lower than the general population and was ignored by the patients themselves. In a study by Kebede *et al.*,[21] the gingival index was also affected by psychiatric disorders.In a study by AlSarheed,[22] there was no significant difference in caries incidence between children with and without DS. DS may involve the salivary glands. As a result, the salivary environment may produce a different electrolyte, which reduces caries in children with DS.[2] Al Habashneh *et al*.[5] concluded a similar level of caries in the two groups with and without DS. However, the adolescents with DS had more dental malformations and poor periodontal health than primary school children of the same age and gender. In a meta-analysis study by Deps *et al*.,[8] DS patients also had less tooth decay than individuals without it. There are several factors in studies to explain the lower rate of caries in DS patients. One of the most common causes is related to oral features in the face of DS patients.[23] Dental malformations are up to 10 times more prevalent in DS patients than in healthy populations. These malformations include microdontia, diastema, agenesis, delayed eruption, tooth morphology, and the increased prevalence of gritted teeth.[24] Diastema is prevalent in DS patients due to microdontia and agenesis. Hence, the prevalence of proximal caries lesions is significantly reduced due to many diastema presents.[25] Theoretically, short-distance teeth with delayed tooth eruption reduce the food stagnation between teeth and smooth surfaces for the presence and establishment of caries bacteria.[26] Furthermore, some studies suggested that low caries experience in DS patients is due to saliva composition (saliva pH and higher bicarbonate levels) and differences in microbiota composition (number of *Streptococcus mutants*).[27] In addition, studies reported that changes in the oral ecosystem in DS patients can lead to physiological changes in the flow and composition of saliva.[28] In general, according to these contents, the results of the present study and previous studies are consistent with each other and confirmed the findings of this study.

In the present study, it was found that the mean plaque index was significantly higher in DS patients than in healthy individuals. The 95% CI was from 0.38 to 4.6, which means that the average plaque index in DS patients is higher up to 4.6 than in healthy individuals. Furthermore, the results showed that the mean of a gingival index in DS patients was significantly 2.75 more than in healthy individuals. In some studies, similar results approved our findings.[2,28-30]

## CONCLUSION

Based on the result of the present research, it showed that DS patients had a higher plaque index and gingival index than in healthy individuals, which means that the oral health status of these patients is worse and needs more attention. According to the present study results, it is recommended that oral health status and plaque and gingival indices in DS patients be regularly monitored to prevent severe oral disorders and additional costs.

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### Conflicts of interest
The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

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