The diagnostic accuracy of RT-PCR from self-collected saliva versus nasopharyngeal sampling

A systematic review and meta-analysis

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ABSTRACT

Objectives: To evaluate the diagnostic utility of self-collected saliva in coronavirus disease-19 (COVID-19) screening procedures.

Methods: A total of 6 databases were reviewed from their inception until August 2021. Sensitivity and specificity were measured by extracting items (true-positive, true-negative, false-positive and false-negative) from each paper. We evaluated the diagnostic accuracy based on Quality Assessment of Diagnostic Accuracy Studies, version 2.

Results: A total of 41 studies were included in the final analysis. The diagnostic odds ratio (OR) of self-collected saliva was 196.2022 (95% confidence interval [CI]: 117.8833-326.5546). The area under the summary receiver operating characteristic curve was 0.955. For detecting COVID-19, self-collected saliva had a moderate sensitivity of 0.8476 [0.8045-0.8826] and positive predictive value of 0.9404 [0.9122-0.9599] but high specificity of 0.9817 [0.9707-0.9887] and negative predictive value of 0.9467 [0.9130-0.9678]. In a subgroup analysis, the diagnostic accuracy of self-collected saliva tended to be higher for symptomatic (vs. asymptomatic) examinees.

Conclusion: Although naso/oropharyngeal swab tests are the most accurate and important diagnostic tools, the saliva-based testing method can be used as a suitable alternative test, with the advantages of increased patient convenience, efficient testing, and the need for fewer medical staff and resources. In particular, simple collecting method such as drooling or spitting without coughing would be effective in evaluating the symptomatic patients.

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Since first detected in 2019, the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) pandemic is still ongoing. This newly discovered coronavirus has a high ability to be transmitted from person to person through respiratory aerosols, droplets, or vomitus. More than 80% of patients infected by coronavirus disease-19 (COVID-19) show symptoms similar to influenza infection or pneumonia. Therefore, most patients do not require hospitalization. Because of these features of COVID-19, significant viral transmission from mildly symptomatic and non-hospitalized patients is concerning. However, COVID-19 can cause severe morbidity or mortality in the elderly, immunocompromised patients, and those with comorbidities such as heart disease, obesity, and diabetes.

Although there are a few known treatments for COVID-19, strict isolation of confirmed patients based on accurate diagnosis of COVID-19 is the key to overcome the pandemic, given the circumstances that only few treatment methods are available. Generally, the definitive diagnostic test of COVID-19 relies mostly on detection via reverse transcription quantitative polymerase chain reaction (RT-qPCR) carried out in respiratory samples. However, the collection of naso/oropharyngeal swab samples can cause nasal pain to the examinees, and health care personnel performing the test should be equipped with individual protective equipment to protect them against the risk of virus exposure. Testing using self-collected saliva methods have been reported to have several advantages of convenience and safety compared with the naso/oropharyngeal swab method because it eliminates close contact when obtaining a sample and the necessity of personal protective equipment. In addition, saliva collection is painless and thus, minimizes inconvenience for the examinees. Recently, published studies have reported that saliva specimens could be an alternative to naso/oropharyngeal specimens, but the evidence is still limited. It is important to clarify the diagnostic power of saliva for COVID-19 to improve the convenience to examinees and inspectors when mass rapid examination is required. Therefore, the aim of this study was to define the diagnostic accuracy of RT-qPCR from saliva compared to naso/oropharyngeal swab results.

**Methods.** This meta-analyses and systematic reviews used terms such as COVID-19, coronavirus, severe acute respiratory syndrome coronavirus-2, saliva, nasopharyngeal swab, oropharyngeal swab, PCR, and diagnostic accuracy as keywords. Database from PubMed, the Cochrane Central Register of Controlled Trials, Embase, Web of Science, SCOPUS, and Google Scholar were searched. Only papers written in English were reviewed. All references of the included articles were assessed to confirm that no significant studies were neglected. Two reviewers independently reviewed candidate studies, conducted title, abstract, full-text reviews, and inclusion of the final agreed papers.

The present study includes: i) prospective or retrospective study protocol; from ii) cases of COVID-19 suspected symptoms or asymptomatic population screening, using iii) index test: RT-qPCR in self-collected saliva specimens to detect SARS-CoV-2, with iv) reference standard (comparator test) of RT-qPCR in naso/oropharyngeal specimens to detect SARS-CoV-2, and v) qualified articles for sensitivity and specificity analysis (Appendix 1). We excluded reviews, case reports, and studies with low diagnostic power in saliva specimens. The search flow diagram was presented in Figure 1.

We calculated the area under the curve (AUC) of summary receiver operating characteristic (SROC) curve designed from diagnostic accuracy (namely, diagnostic odds ratio [DOR]).

Diagnostic odds ratio was defined as true positive x true negative / false positive x false negative, within 95% confidence interval (CI) from a random effect model with intra- and inter-study variations. The higher the value of DOR, the better the performance of the diagnostic method. Diagnostic odds ratio of one means it is not assured whether the disease is present. We calculated the log of DOR to examine an approximate

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![Figure 1 - Summary of the search strategy.](https://smj.org.sa)
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normal distribution. The SROC method derives both sensitivity and specificity through meta-analysis. The SROC curve moves towards the left upper quadrant (namely, sensitivity and specificity to 1 [100%]) as the discriminative force increases. Area under the curve ranges from 0-1 with higher value indicating superior performance. We estimated and compared the accordance of RT-qPCR results between the saliva and naso/oropharyngeal swab samples using Cohen’s kappa coefficient (κ). Data of true-positive, true-negative, false-positive, and false-negative values used to calculate the AUC and DOR were collected. The qualitative agreement across sample types (naso/oropharyngeal swab and saliva sample) was assessed.

Quality examination was carried out by Quality Assessment of Diagnostic Accuracy Studies tool, version 2. Statistical analysis. We used the version 3.6.1 of R software for statistical analysis (R Foundation for Statistical Computing, Vienna, Austria) and Q statistics for homogeneity analysis. Citation management was conducted by EndNote version 20.1 (Clarivate Analytics, PA, USA). Summary receiver operating characteristic curves were drawn from forest plots of sensitivity, specificity, negative predictive value (NPV), and positive predictive value. Coefficients were converted to Fisher’s exact values for normal distribution and variance stabilization between different sample types. After completing the meta-analysis, Fisher’s exact values were converted back to the intra-class correlation coefficient to aid in the interpretation of the results.

Results. The present meta-analysis included 41 studies of 14,011 patients. Appendix 2 summarizes the participant characteristics and Appendix 3 shows the quality analysis of methods. A total of 41 observational studies that used self-collected saliva samples for COVID-19 diagnosis were included in this study. The DOR of self-collected saliva for COVID-19 was 196.2022 (95% CI: [117.8833-326.5546], I²=82%; Figure 2) and the AUC was 0.955 (Figure 3). The self-collected saliva samples had a moderate sensitivity of 0.8476 (95% CI: [0.8045-0.8826], I²=87.3%) and PPV of 0.9404 (95% CI: [0.9122-0.9599], I²=83.2%) but a high specificity of 0.9817 (95% CI: [0.9707-0.9887], I²=89%) and NPV of 0.9467 (95% CI: [0.9130-0.9678], I²=96.4%; Appendix 4-7).

In concern of the heterogeneity of diagnostic accuracy, we looked for significant bias among the included studies. Subgroups were analyzed to assess the influence of geographic differences, saliva collection method, and presence or absence of symptoms (Table 1). Through these analyses, it was confirmed that there was no significant difference between continents.

For the saliva collection method, there were 3 subgroups: enhanced saliva (including posterior pharyngeal saliva or induced cough), oral saliva only without cough, and oral saliva only not defined regarding cough. Diagnostic accuracy tended to be lower in the enhanced saliva than the other 2 subgroups (sensitivity: 0.8353 vs. 0.8365 and 0.8919, specificity: 0.9779 vs. 0.9827 and 0.9820, and NPV: 0.8823 vs. 0.9496 and 0.9731; Appendix 8-10, DOR: 127.2254 vs. 215.1566 and 237.4246 except PPV: 0.9654 vs. 0.9202 and 0.8510; Appendix 11-13). Regarding the presence/absence of symptoms in patients during testing, diagnostic accuracy tended to be higher in the symptomatic than non-symptomatic patients (sensitivity: 0.8851 vs. 0.8208 and 0.7049, specificity: 0.9791 vs. 0.9783 and 0.9933, NPV: 0.9522 vs. 0.9164 and 0.9772, PPV: 0.9495 vs. 0.9435 and 0.8483, DOR: 245.6222 vs. 159.4638 and 184.8991). All analyses performed on each subgroup showed high heterogeneity. Based on this, it is difficult to document that subgroup analysis explains heterogeneity.

A total of 16 studies reported the Cohen’s kappa coefficient; the summary intra-class correlation coefficient was 0.8506 (95% CI: [0.8024-0.8877]), and the heterogeneity was high (I²=97.05%). Therefore, the correlation coefficients represented a good qualitative agreement between the standard naso/oropharyngeal swab and saliva samples in this meta-analysis.

Discussion. Because of the rapid global spread of COVID-19 and its high morbidity and mortality rates at older ages, early and accurate diagnosis of COVID-19 is the key to disease management. In particular, the fall-winter season in the northern hemisphere which typically increases the co-circulation of other respiratory viruses, including influenza, which could render the difficulty of distinguishing COVID-19 from other respiratory diseases. Currently, naso/oropharyngeal swab sampling according to RNA extraction and RT-qPCR is the most common methods for SARS-CoV-2 detection. However, the naso/oropharyngeal swab procedure has several short-comings including nasal irritation, pain, and a requirement for technical skill (false-negative results may result from improper procedures). Furthermore, this procedure requires additional medical resources, such as personal protective equipment and sterile swabs.

Considering these factors, the naso/oropharyngeal swab method is quite limited for mass screening or its use in...
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Saliva tests for COVID-19 have been proposed as diagnostic tools for detecting various respiratory virus infections, such as influenza viruses, respiratory syncytial virus, and SARS-CoV. Recent studies have shown that SARS-CoV-2 could also be diagnosed with saliva. In addition, saliva sampling reduces time and costs by eliminating the need for personal protection or virus-carrying solutions.

Two previous meta-analyses evaluated the use of saliva to accurately diagnose COVID-19. The authors suggested that self-collected saliva can be used to diagnose COVID-19. However, there were some limitations to confirm the evidence. Due to the relatively small sample size, a comprehensive analysis and thorough investigation were difficult in previous analysis.

The other analysis evaluated 8 additional studies. The authors suggested that self-collected saliva can be used to diagnose COVID-19. However, there were some limitations to confirm the evidence. Due to the relatively small sample size, a comprehensive analysis and thorough investigation were difficult in previous analysis. The other analysis evaluated 8 additional studies. The authors suggested that self-collected saliva can be used to diagnose COVID-19. However, there were some limitations to confirm the evidence. Due to the relatively small sample size, a comprehensive analysis and thorough investigation were difficult in previous analysis.
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Figure 3 - Area under the summary receiver operating characteristic (SROC) curve of the included studies. CI: confidence interval

studies, but it had methodologic flaws. Previous studies, only one author conducted the search and extracted data from the included studies, and there was no mention of the heterogeneity among the enrolled studies or the strategy for addressing the heterogeneity (for instance, subgroup analysis). Therefore, we did a bivariate meta-analysis with newly included studies focusing on the location and timing of sample harvest. The self-collected saliva samples were compared to samples collected by medical workers using naso/oropharyngeal swabs, and qualitative agreement between the saliva-based test and reference test was assessed. This information could be helpful for citizens to gain easy and early access to the test and for healthcare professionals to minimize the risk of SARS-CoV-2 transmission via specimen contact.

In this study, self-collected saliva testing yielded AUC of 0.955. The AUC was in the range of 0.9-1, suggesting excellent diagnostic accuracy. The virus utilizes the angiotensin converting enzyme 2 receptor for host entry, and it is also expressed at detectable levels in the salivary glands and ducts. In addition, salivary gland epithelial cells are early targets and the virus can dwell inside the cells during the first stage of infection. High correlation coefficients, indicating strong diagnostic agreement between the standard naso/oropharyngeal swab and the saliva collection sample, also could support the diagnostic power of the saliva samples.

However, our results showed that self-collected saliva samples had lower sensitivity and similar specificity compared with naso/oropharyngeal swab specimens for diagnosing COVID-19. This finding was consistent with the previous findings of Kivelä et al. Previous studies reported lower viral loads of SARS-CoV-2 in saliva than in corresponding nasopharyngeal swab specimens. The lower viral load in saliva may explain the higher rate of false negatives (decreasing sensitivity) compared with naso/oropharyngeal specimens. However, relatively low sensitivity of the saliva-based test is acceptable under certain conditions, considering that the saliva sampling test requires fewer medical consumable resources and professional personnel, and minimizes patient’s discomfort.

In this regard, one report recommended standardizing the sampling and testing methods for optimal clinical application of the saliva-based COVID-19 test. Our meta-analysis included various methods (saliva only vs. enhanced saliva [including lower pharyngeal and respiratory secretion]) and clinical conditions (asymptomatic vs. symptomatic examinees). Therefore, we carried out a subgroup analyses according to different geography, saliva collection method, and existence or absence of symptoms. Interestingly, the saliva collection method did not show the significant influence in diagnostic accuracy. A previous study also reported similar results that there was no substantial difference between only oral saliva and enhanced saliva.

In pathophysiology and time course, the main entry points of coronavirus are the nasal epithelial cells as well as the stratified squamous epithelium of oropharynx and laryngopharynx. Through oral-lung aspiration, the virus can spread from oral or nasal passage to the lower respiratory organs. In 80% of infected cases, the virus remains within the upper airway expressing mild symptoms. The enhanced saliva may contain both bronchopulmonary and nasopharyngeal secretions by coughing. The current knowledge of viral progression from proximal to distal airways might explain why oral saliva plus lower respiratory secretion seemed to have the similar diagnostic accuracy with oral saliva only in the community or mass screening. In particular, some patients would feel uncomfortable or have difficulty in coughing to produce mucus. However, simple collecting method such as drooling or spitting could help spread the usage of saliva test for COVID-19.

In addition, the viral loads of samples were significantly high during the first week of symptom development, then gradually decreased over time, and became undetectable approximately 2 weeks after symptom development. These patterns could indicate that the timing of sampling regarding diagnosis was likely to influence accuracy in asymptomatic as well
as symptomatic patients. Caution is recommended when choosing diagnostic tests for screening in terms of the related timing to disease progression. \(^{58}\) Saliva self-collection for SARS-CoV-2 testing was reported not to be influenced by gender, age, race/ethnicity, or educational level in the United States. \(^{19}\) There was no significant heterogeneity of diagnostic accuracy among geographic locations. However, our classification according to geographic location included only one or 2 studies in South America and Oceania. Therefore, future prospective studies with larger numbers of patients evenly grouped by geographic location are needed to analyze the effect of geographic location on the results of test using self-collected saliva.

**Study limitations.** First, the collected data showed significant heterogeneity that required random effect

### Table 1 - Subgroup analysis of ethnicity, saliva collection method, and participants’ symptoms.

| Subgroup                        | Study (n) | DOR      | Sensitivity | Specificity | AUC       | NPV      | PPV       |
|---------------------------------|-----------|----------|-------------|-------------|-----------|----------|-----------|
|                                 |           | (95% CIs) |             |             | (95% CIs) |          | (95% CIs) |
| **Self-collected saliva**       | 41        | 196.2022 | 0.8476      | 0.9817      | 0.955     | 0.9467   | 0.9404    |
| (total)                         |           | [82%]    | [0.8045-0.8826] | [0.9707-0.9887] | 96.4%     | [0.9122-0.9599] |
| **Regions**                     |           |          |             |             |           |          |           |
| **North America**               | 20        | 250.4321 | 0.8798      | 0.9807      | 0.9635    | 0.9275   |
|                                |           | [81.1%]  | [0.8182-0.9224] | [0.9646-0.9896] | 94.1%     | [0.8801-0.9571] |
| **Asia**                        | 12        | 92.3075  | 0.7930      | 0.9766      | 0.9283    | 0.9175   |
|                                |           | [85.6%]  | [0.6970-0.8656] | [0.9297-0.9924] | 91.7%     | [0.8410-0.9589] |
| **Europe**                      | 6         | 212.1821 | 0.8080      | 0.9852      | 0.9143    | 0.9676   |
|                                |           | [85%]    | [0.6984-0.8844] | [0.9751-0.9912] | 95%       | [0.9369-0.9836] |
| **South America**               | 2         | 748.5000 | 0.8462      | 0.9800      | 0.9189    | 0.9839   |
|                                |           | [80.3%]  | [0.7180-0.9559] | [0.9321-0.9992] | 5.2%      | [0.9378-0.9960] |
| **Oceania**                     | 1         | 176.1693 | 0.8095      | 0.9852      | 0.9143    | 0.9676   |
|                                |           | [85%]    | [0.6948-0.8844] | [0.9751-0.9912] | 95%       | [0.9369-0.9836] |
| **P-value**                     |           | 0.1979   | 0.389       | 0.8652      | 0.2833    | 0.079    |
| **Collection method**           |           |          |             |             |           |          |           |
| Only oral cavity saliva        | 26        | 215.1566 | 0.8365      | 0.9827      | 0.9496    | 0.9367   |
|                                |           | [84%]    | [0.7793-0.8812] | [0.9713-0.9896] | 96.1%     | [0.9007-0.9602] |
| Only oral cavity saliva (not defined) | 8         | 237.4246 | 0.8919      | 0.9820      | 0.9731    | 0.9173   |
|                                |           | [85.2%]  | [0.8432-0.9268] | [0.9035-0.9969] | 89.7%     | [0.7993-0.9686] |
| Enhanced saliva                | 7         | 127.2254 | 0.8353      | 0.9779      | 0.8823    | 0.9654   |
|                                |           | [67.0%]  | [0.6844-0.9222] | [0.9338-0.9928] | 70.9%     | [0.9075-0.9875] |
| P-value                         |           | 0.7001   | 0.2282      | 0.928       | 0.2176    | 0.4355   |
| **Patient symptom**            |           |          |             |             |           |          |           |
| Symptomatic                     | 22        | 245.6222 | 0.8851      | 0.9791      | 0.9522    | 0.9495   |
|                                |           | [80.6%]  | [0.8497-0.9130] | [0.9580-0.9898] | 92.2%     | [0.9124-0.9744] |
| Mixed                           | 15        | 159.4638 | 0.8208      | 0.9783      | 0.9164    | 0.9435   |
|                                |           | [83.4%]  | [0.7399-0.8806] | [0.9588-0.9886] | 97.0%     | [0.9003-0.9687] |
| Asymptomatic                    | 4         | 184.8991 | 0.7049      | 0.9933      | 0.9772    | 0.8483   |
|                                |           | [80.3%]  | [0.4705-0.8653] | [0.9673-0.9987] | 97.0%     | [0.8689-0.9345] |
| P-value                         |           | 0.7469   | 0.03        | 0.3924      | 0.329     | 0.0879   |

DOR: diagnostic odds ratio, CI: confidence interval, AUC: area under the curve, NPV: negative predictive value, PPV: positive predictive value
models and subgroup analysis. One possible explanation is that RT-qPCR in naso/oropharyngeal samples, which is used as the main diagnostic tool for COVID-19, shows a wide range in sensitivity (56-83%). This might have led to misclassification and diagnostic bias, causing heterogeneity. Secondly, the nature of cross-sectional designs can over- or under-estimate the real prevalence. Thirdly, there was a lack of methodological homogeneity and inadequate reporting of methods.

In conclusion, this study indicated that RT-qPCR detects SARS-CoV-2 with lower sensitivity using self-collected saliva compared to conventional naso/oropharyngeal samples. However, saliva samples are easily obtained by drooling or spitting in a sample container. The saliva-based test has the advantage of not requiring healthcare workers or personal protective equipment for sample collection. This advantage could be useful in situations in which mass screening is needed or medical resources are scarce.

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Appendix 1 - Participants, interventions, comparisons, outcomes, timings, and study design (PICOTS).

| PICOTS component | Details |
|------------------|---------|
| Participants     | Patients with COVID-19 suspected symptoms or asymptomatic population screening |
| Interventions    | Saliva specimens RT-qPCR results of detect SARS-CoV-2 |
| Comparisons      | Naso/oropharyngeal specimens RT-qPCR results of detect SARS-CoV-2 |
| Outcomes         | Diagnostic accuracy, specificities, and negative predictive values analysis |
| Timings          | From inception to August 2021 |
| Study design     | A systematic review and meta-analysis |

COVID-19: coronavirus disease-19, RT-qPCR: reverse transcription quantitative polymerase chain reaction, SARS-CoV-2: severe acute respiratory syndrome coronavirus-2
## Appendix 2 - Study characteristics.

| Study | Study design | Number | Gender (male/female) | Age (years), median (range) or mean and SD | Nationality | Participants | Collecting method | Correlation | TP | FN | FP | TN |
|-------|--------------|--------|----------------------|-------------------------------------------|-------------|--------------|------------------|-------------|-----|-----|-----|-----|
| Williams et al,18 | case-control | 89 | NR | NR | Australia | asymptomatic saliva | Only oral cavity | 0.851 | 33 | 6 | 1 | 49 |
| Landry et al,15 | cohort | 124 | NR | NR | USA | symptomatic saliva | Oral cavity saliva (defined) | 53 | 5 | 0 | 106 |
| Griesemer et al,16 | cohort | 463 | 246/117 | 14-77 | USA | mixed saliva | Oral cavity saliva (not reported) | 91 | 14 | 13 | 345 |
| Bhattacharya et al,17 | case-control | 74 | NR | NR | India | asymptomatic saliva | Oral cavity saliva | 0 | 0 | 0 | 0 |
| Byrne et al,18 | cohort | 110 | 61/49 | NR | England | symptomatic saliva | Oral cavity saliva (not reported) | 0.912 | 34 | 22 | 14 | 1869 |
| Cauley et al,19 | cohort | 1939 | NR | NR | Canada | mixed saliva | Oral cavity saliva | 0 | 0 | 0 | 0 |
| Hanso et al,14 | cohort | 354 | 188/166 | 35 (18-75) | USA | symptomatic saliva | Oral cavity saliva | 0.912 | 75 | 5 | 6 | 268 |
| Moreno-Contreras et al,15 | cohort | 182 | 116/137 | 41±14.4 | Mexico | symptomatic saliva | Oral cavity saliva (not reported) | 0 | 0 | 0 | 0 |
| Pasomsub et al,17 | cross-sectional | 200 | 69/131 | NR | Thailand | symptomatic saliva | Oral cavity saliva | 0.851 | 16 | 3 | 2 | 179 |
| Skolimowska et al,11 | cohort | 131 | 43/89 | NR | England | symptomatic saliva | Oral cavity saliva | 0 | 0 | 0 | 0 |
| Vaz et al,16 | cohort | 155 | 46/103 | NR | Brazil | symptomatic saliva | Oral cavity saliva | 0.922 | 67 | 4 | 2 | 82 |
| Yokota et al,8 | cohort | 1763 | 927/832/4/9 (unknown) | 33.5 (22.6-47.4) | Japan | asymptomatic saliva | Only oral cavity saliva | 0 | 0 | 0 | 0 |
| Yokota et al,9 | cohort | 161 | 44/26/39 (unknown) | 44.9 (29.8-66.6) | Japan | asymptomatic saliva | Oral cavity saliva (not reported) | 4 | 1 | 0 | 1758 |
| Güçük et al,12 | cohort | 64 | 37/27 | 51.0±14.7 | Turkey | symptomatic saliva | Oral cavity saliva | 0.744 | 23 | 4 | 4 | 33 |
| Senok et al,13 | cross-sectional | 401 | 329/72 | 35.5±9.5 | UAE | asymptomatic saliva | Oral cavity saliva | 0.68 | 19 | 7 | 9 | 366 |
| Alrawallah et al,18 | cohort | 891 | NR | NR | Kuwait | symptomatic saliva | Oral cavity saliva | 0.814 | 287 | 57 | 18 | 529 |
| Procop et al,13 | cohort | 224 | NR | NR | USA | symptomatic saliva | Oral cavity saliva | 0 | 0 | 0 | 0 |
| Kandel et al,13 | cohort | 429 | 295/134 | 42 (30-54) | Canada | mixed saliva | Oral cavity saliva | 0.9 | 39 | 4 | 3 | 383 |
| Brazy-Silva et al,20 | cohort | 201 | 75/126 | 40 (31-52) | Brazil | symptomatic saliva | Oral cavity saliva | 55 | 15 | 0 | 131 |
| Babady et al,12 | cohort | 87 | NR | NR | USA | symptomatic saliva | Oral cavity saliva | 16 | 1 | 1 | 69 |
| Dogan et al,21 | cohort | 98 | NR | NR | Turkey | symptomatic saliva | Oral cavity saliva | 0 | 0 | 0 | 0 |
| Wong et al,22 | retrospective | 229 | NR | NR | China | mixed saliva | Oral cavity saliva | 104 | 18 | 37 | 70 |
| Iwasaki et al,23 | cross-sectional | 66 | NR | NR | Japan | symptomatic saliva | Oral cavity saliva | 0 | 0 | 0 | 0 |
| Kojima et al,24 | cohort | 45 | NR | NR | USA | asymptomatic saliva | Only oral cavity saliva (not defined) | 0.874 | 8 | 1 | 1 | 66 |
| McCormick-Baw et al,25 | cohort | 155 | NR | NR | USA | symptomatic saliva | Oral cavity saliva | 20 | 3 | 6 | 16 |
| Müller et al,26 | cross-sectional | 91 | NR | NR | USA | symptomatic saliva | Oral cavity saliva | 47 | 2 | 1 | 105 |
| Vogels et al,27 | cohort | 67 | NR | NR | USA | mixed saliva | Oral cavity saliva | 33 | 1 | 1 | 56 |
| Boerger et al,24 | cohort | 281 | NR | NR | USA | symptomatic saliva | Oral cavity saliva | 30 | 3 | 2 | 246 |
| Toppings et al,28 | cross-sectional | 63 | NR | NR | USA | symptomatic saliva | Oral cavity saliva | 0 | 0 | 0 | 0 |
| Xun et al,29 | cohort | 104 | NR | NR | USA | symptomatic saliva | Oral cavity saliva | 0 | 0 | 0 | 0 |
| Massa et al,30 | cohort | 143 | 63/80 | 35 (22.5-40) | France | symptomatic saliva | Oral cavity saliva | 0.89 | 51 | 5 | 2 | 85 |
| Sasikala et al,30 | prospective | 200 | 140/60 | 37.9±12.8 | India | symptomatic saliva | Oral cavity saliva | 128 | 46 | 0 | 26 |
| Mohd Thabit et al,30 | prospective | 96 | 66/30 | 34±12.95 (12-95) | Malaysia | asymmetric saliva | Only oral cavity saliva | 0.69 | 45 | 11 | 4 | 36 |
| Fernandes et al,30 | cohort | 226 | 91/135 | NR | Portugal | asymptomatic saliva | Only oral cavity saliva | 0 | 0 | 0 | 0 |
| Marx et al,30 | cross-sectional | 730 | 420/310 | NR | USA | asymptomatic saliva | Only oral cavity saliva | 0.92 | 46 | 8 | 6 | 436 |
| Abasiyanik et al,30 | cohort | 92 | NR | NR | USA | mixed saliva | Only oral cavity saliva | 0 | 0 | 0 | 0 |
| Alkhateeb et al,31 | prospective | 48 | 26/22 | 39.9±15.5 | USA | mixed saliva | Oral cavity saliva | 12 | 3 | 0 | 18 |
| Bidkar et al,32 | cross-sectional | 80 | 49/31 | 36.4 | India | mixed saliva | Oral cavity saliva | 0 | 0 | 0 | 0 |
| Stokes et al,33 | prospective | 145 | 75/70 | 39.4 | Canada | symptomatic saliva | Oral cavity saliva | 121 | 17 | 2 | 5 |
| Fernández-Gonzalez et al,34 | prospective | 229 | 91/128 | 39 (21-48) | Spain | asymptomatic saliva | Oral cavity saliva | 0.85 | 39 | 7 | 4 | 171 |
| Herrera et al,35 | cross-sectional | 2107 | NR | NR | Mexico | asymptomatic saliva | Oral cavity saliva | 0.852 | 139 | 34 | 10 | 1867 |
| Trıbajo-Sanmartín et al,36 | prospective | 674 | 374/300 | NR | Spain | mixed saliva | Oral cavity saliva | 0.91 | 168 | 156 | 3 | 309 |

**SD:** standard deviation, **TP:** true positive, **FN:** false negative, **FP:** false positive, **TN:** true negative **NR:** not reported
## Appendix 3 - Methodological quality of all included studies

| Reference                      | Risk of bias | Concerns about application |
|--------------------------------|--------------|----------------------------|
|                                | Patient selection | Index test | Reference standard | Flow and timing | Patient selection | Index test | Reference standard |
| Williams et al,\(^{10}\)       | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Landry et al,\(^{13}\)         | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Griesemer et al,\(^{19}\)      | Low           | Low         | Low                   | Low             | Low               | Low        | Unclear               |
| Bhattacharya et al,\(^{27}\)   | Low           | Low         | Un unclear            | Low             | Un unclear        | Low        | Low                   |
| Byrne et al,\(^{26}\)          | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Cauley et al,\(^{20}\)         | Low           | Low         | Un unclear            | Low             | Low               | Low        | Low                   |
| Hanson et al,\(^{14}\)         | Low           | Low         | Low                   | Low             | Low               | Unclear    | Low                   |
| Moreno-Contreras et al,\(^{12}\)| Low           | Low         | Unclear               | Low             | Unclear           | Low        | Low                   |
| Pasomsb et al,\(^{7}\)         | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Skolimowska et al,\(^{22}\)    | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Vaz et al,\(^{16}\)            | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Yokota et al,\(^{8}\)          | Low           | Low         | Low                   | Un unclear      | Low               | Unclear    | Low                   |
| Güçlü et al,\(^{17}\)          | Low           | Low         | Low                   | Low             | Low               | Un unclear | Low                   |
| Senok et al,\(^{21}\)          | Low           | Low         | High                  | Low             | Low               | Low        | Low                   |
| Altawalah et al,\(^{18}\)      | Low           | Low         | High                  | Low             | Low               | Low        | Low                   |
| Procop et al,\(^{15}\)         | Low           | Low         | Low                   | Unclear         | Low               | Low        | Low                   |
| Kandel et al,\(^{23}\)         | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Braz-Silva et al,\(^{24}\)     | Low           | Low         | Unclear               | Low             | Low               | Low        | Low                   |
| Babady et al,\(^{22}\)         | Unclear       | Low         | Low                   | Unclear         | Low               | Low        | Low                   |
| Dogan et al,\(^{27}\)          | Low           | Low         | Low                   | Unclear         | Low               | Unclear    | Low                   |
| Wong et al,\(^{24}\)           | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Iwasaki et al,\(^{29}\)        | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Kojima et al,\(^{38}\)         | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| McCormick-Baw et al,\(^{31}\)  | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Miller et al,\(^{32}\)         | Low           | Low         | Low                   | Low             | Low               | Low        | Unclear               |
| Vogels et al,\(^{35}\)         | Low           | Low         | Low                   | High            | Low               | Low        | Low                   |
| Boerger et al,\(^{34}\)        | Low           | Low         | Low                   | High            | Low               | Low        | Low                   |
| Toppings et al,\(^{35}\)       | Low           | Low         | Low                   | Unclear         | Low               | Low        | Low                   |
| Xun et al,\(^{36}\)            | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Mase et al,\(^{37}\)           | Low           | Low         | Low                   | Unclear         | Low               | Low        | Low                   |
| Sasikala et al,\(^{38}\)       | Unclear       | Low         | Low                   | Unclear         | Low               | Low        | Low                   |
| Mohd’ Thabit et al,\(^{35}\)   | Low           | Low         | Low                   | Unclear         | Low               | Low        | Low                   |
| Fernandes et al,\(^{40}\)      | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Marx et al,\(^{42}\)           | Low           | Low         | Low                   | Unclear         | Low               | Low        | Low                   |
| Abastianik et al,\(^{42}\)     | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Alkhateeb et al,\(^{43}\)      | Low           | Low         | Low                   | Unclear         | Low               | Unclear    | Low                   |
| Bidkar et al,\(^{44}\)         | Low           | Low         | Low                   | Unclear         | Low               | Unclear    | Low                   |
| Stokes et al,\(^{45}\)         | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
| Fernández-González et al,\(^{46}\) | Low           | Low         | Low                   | High            | Low               | Low        | Low                   |
| Herrera et al,\(^{48}\)        | Low           | Low         | Low                   | Unclear         | Low               | Low        | Low                   |
| Trobajo-Sanmartín et al,\(^{47}\) | Low           | Low         | Low                   | Low             | Low               | Low        | Low                   |
Appendix 4 - Forest plots of the sensitivity of the included studies.
### Appendix 5 - Forest plots of the specificity of the included studies.

| Study                  | Events | Total | Proportion | 95%-CI          |
|------------------------|--------|-------|------------|-----------------|
| Akgun 2020             | 38     | 43    | 0.884      | [0.749; 0.961]  |
| Williams 2020          | 49     | 50    | 0.980      | [0.894; 0.999]  |
| Landry 2020            | 89     | 89    | 1.000      | [0.959; 1.000]  |
| Griesemer 2020         | 345    | 358   | 0.964      | [0.939; 0.981]  |
| Bhattacharya 2020      | 106    | 106   | 1.000      | [0.966; 1.000]  |
| Byrne 2020             | 96     | 96    | 1.000      | [0.962; 1.000]  |
| Cauliey 2020           | 1889   | 1883  | 0.993      | [0.988; 0.999]  |
| Hanson 2020            | 268    | 274   | 0.978      | [0.953; 0.992]  |
| Moreno-Conrreras 2020  | 102   | 130   | 0.785      | [0.704; 0.852]  |
| Pasomsunb 2020         | 179    | 181   | 0.989      | [0.961; 0.999]  |
| Skolimowska 2020       | 112    | 113   | 0.991      | [0.952; 1.000]  |
| Vaz 2020               | 82     | 84    | 0.976      | [0.917; 0.997]  |
| Yokota, airport 2020   | 1758   | 1756  | 1.000      | [0.998; 1.000]  |
| Yokota, contact 2020   | 114    | 120   | 0.950      | [0.894; 0.981]  |
| Guclu 2020             | 33     | 37    | 0.892      | [0.746; 0.970]  |
| Senk 2020              | 366    | 375   | 0.976      | [0.955; 0.989]  |
| Altawalah 2020         | 529    | 547   | 0.967      | [0.948; 0.980]  |
| Procop 2020            | 177    | 178   | 0.994      | [0.969; 1.000]  |
| Kandeil 2020           | 383    | 386   | 0.992      | [0.977; 0.998]  |
| Braz-Silva 2020        | 131    | 131   | 1.000      | [0.972; 1.000]  |
| Esther Babady 2020     | 69     | 70    | 0.986      | [0.923; 1.000]  |
| Cheuk 2020             | 70     | 107   | 0.654      | [0.556; 0.744]  |
| Iwasaki 2020           | 66     | 67    | 0.985      | [0.920; 1.000]  |
| Kojima 2020            | 16     | 22    | 0.727      | [0.498; 0.893]  |
| McCormick-Baw 2020     | 105    | 106   | 0.991      | [0.949; 1.000]  |
| Miller 2020            | 56     | 57    | 0.982      | [0.906; 1.000]  |
| Vogels 2020            | 30     | 33    | 0.909      | [0.757; 0.981]  |
| Boerger 2021           | 246    | 248   | 0.992      | [0.971; 0.999]  |
| Toppings 2021          | 33     | 33    | 1.000      | [0.984; 1.000]  |
| Xun 2021               | 73     | 74    | 0.986      | [0.927; 1.000]  |
| Masse 2021             | 85     | 87    | 0.977      | [0.919; 0.997]  |
| Sasikala 2021          | 26     | 26    | 1.000      | [0.868; 1.000]  |
| Mohd Thabit 2021       | 36     | 40    | 0.900      | [0.763; 0.972]  |
| da Costa Fernandes 2021| 142    | 146   | 0.973      | [0.931; 0.992]  |
| da Costa Fernandes 2021| 16     | 16    | 1.000      | [0.794; 1.000]  |
| Marx 2021              | 147    | 150   | 0.980      | [0.943; 0.996]  |
| Marx 2021              | 292    | 295   | 0.990      | [0.971; 0.998]  |
| Marx 2021              | 436    | 442   | 0.986      | [0.971; 0.995]  |
| Abashtianik 2021       | 69     | 76    | 0.908      | [0.819; 0.962]  |
| Alkhateeba 2021        | 18     | 18    | 1.000      | [0.815; 1.000]  |
| Alkhateeba 2021        | 3      | 3     | 1.000      | [0.282; 1.000]  |
| Alkhateeba 2021        | 20     | 21    | 0.952      | [0.762; 0.999]  |
| Bidka 2021             | 33     | 35    | 0.943      | [0.808; 0.983]  |
| Stokes 2021            | 5      | 7     | 0.714      | [0.290; 0.963]  |
| Fernández-González 2021| 171    | 175   | 0.977      | [0.943; 0.994]  |
| Herrera 2021           | 189    | 1877  | 0.995      | [0.990; 0.997]  |
| Trobajo-Sanmartín 2021 | 309    | 312   | 0.990      | [0.972; 0.998]  |

**Random effects model**

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Heterogeneity: $I^2 = 89\%$, $T^2 = 2.0146$, $p < 0.01$
Appendix 6 - Forest plots of the negative predictive value of the included studies.
### Appendix 7 - Forest plots of the positive predictive value of the included studies.

| Study                        | Events | Total | Proportion | 95% CI            |
|------------------------------|--------|-------|------------|-------------------|
| Akgun 2020                   | 30     | 35    | 0.857      | [0.697; 0.952]    |
| Williams 2020                | 33     | 34    | 0.971      | [0.847; 0.999]    |
| Landry 2020                  | 30     | 30    | 1.000      | [0.884; 1.000]    |
| Griesemer 2020               | 91     | 104   | 0.875      | [0.796; 0.932]    |
| Bhattarcharya 2020           | 53     | 53    | 1.000      | [0.933; 1.000]    |
| Byrne 2020                   | 12     | 12    | 1.000      | [0.735; 1.000]    |
| Caulley 2020                 | 34     | 48    | 0.708      | [0.559; 0.830]    |
| Hanson 2020                  | 75     | 81    | 0.926      | [0.846; 0.972]    |
| Moreno-Contreras 2020        | 41     | 69    | 0.594      | [0.469; 0.711]    |
| Pasomsub 2020                | 16     | 18    | 0.889      | [0.653; 0.986]    |
| Skolimowska 2020             | 15     | 16    | 0.938      | [0.898; 0.998]    |
| Vaz 2020                     | 67     | 69    | 0.971      | [0.889; 0.999]    |
| Yokota, airport 2020         | 4      | 4     | 1.000      | [0.398; 1.000]    |
| Yokota, contact 2020         | 38     | 44    | 0.864      | [0.726; 0.948]    |
| Gudu 2020                    | 23     | 27    | 0.852      | [0.663; 0.958]    |
| Senok 2020                   | 19     | 28    | 0.679      | [0.476; 0.841]    |
| Altawalah 2020               | 287    | 305   | 0.941      | [0.908; 0.965]    |
| Procop 2020                  | 38     | 39    | 0.974      | [0.865; 0.999]    |
| Kandel 2020                  | 39     | 42    | 0.929      | [0.805; 0.985]    |
| Braz-Silva 2020              | 55     | 55    | 1.000      | [0.935; 1.000]    |
| Esther Babady 2020           | 16     | 17    | 0.941      | [0.713; 0.999]    |
| Cheuk 2020                   | 104    | 141   | 0.738      | [0.657; 0.808]    |
| Iwasaki 2020                 | 8      | 9     | 0.889      | [0.518; 0.997]    |
| Kojima 2020                  | 20     | 26    | 0.769      | [0.564; 0.910]    |
| McCormick-Baw 2020           | 47     | 48    | 0.979      | [0.889; 0.999]    |
| Miller 2020                  | 33     | 34    | 0.971      | [0.847; 0.999]    |
| Vogels 2020                  | 32     | 35    | 0.914      | [0.769; 0.982]    |
| Boerger 2021                 | 30     | 32    | 0.938      | [0.795; 1.000]    |
| Toppings 2021                | 28     | 28    | 1.000      | [0.877; 1.000]    |
| Xun 2021                     | 28     | 29    | 0.966      | [0.822; 0.999]    |
| Masse 2021                   | 51     | 53    | 0.962      | [0.870; 0.995]    |
| Sasikala 2021                | 128    | 128   | 1.000      | [0.972; 1.000]    |
| Mohd Thabit 2021             | 45     | 49    | 0.918      | [0.804; 0.977]    |
| da Costa Fernandes 2020      | 67     | 71    | 0.944      | [0.862; 0.984]    |
| da Costa Fernandes 2021      | 60     | 60    | 1.000      | [0.938; 1.000]    |
| Marx 2021                    | 44     | 47    | 0.936      | [0.825; 0.987]    |
| Marx 2021                    | 2      | 5     | 0.400      | [0.053; 0.853]    |
| Marx 2021                    | 46     | 52    | 0.885      | [0.766; 0.956]    |
| Abasianjik 2021              | 16     | 23    | 0.696      | [0.471; 0.868]    |
| Alkhateeba 2021              | 12     | 12    | 1.000      | [0.735; 1.000]    |
| Alkhateeba 2021              | 4      | 4     | 1.000      | [0.398; 1.000]    |
| Alkhateeba 2021              | 16     | 17    | 0.941      | [0.713; 0.999]    |
| Bidikia 2021                 | 13     | 15    | 0.867      | [0.595; 0.983]    |
| Stokes 2021                  | 121    | 123   | 0.984      | [0.942; 0.998]    |
| Fem?ndez-Gonz?lez 2021       | 39     | 43    | 0.907      | [0.779; 0.974]    |
| Herrera 2021                 | 139    | 149   | 0.933      | [0.880; 0.967]    |
| Trobajo-Sanmart?n 2021       | 168    | 171   | 0.982      | [0.950; 0.996]    |

Random effects model          | 2534   | 0.940  | [0.912; 0.960] |
Appendix 8 - Forest plots of A) the sensitivity, B) the specificity, C) the negative predictive value, and D) the positive predictive value regarding the effect of geographic differences on self-collected saliva for COVID-19.
Appendix 9 - Forest plots of A) the sensitivity, B) the specificity, C) the negative predictive value, and D) the positive predictive value regarding the effect of saliva collection method on self-collected saliva for COVID-19.
Appendix 10 - Forest plots of A) the sensitivity, B) the specificity, C) the negative predictive value, and D) the positive predictive value regarding the effect of presence or absence of symptoms on the diagnostic odds ratios on self-collected saliva for COVID-19.
Appendix 11 - The effect of geographic differences on the diagnostic odds ratios of self-collected saliva for COVID-19.

| Study                  | Experimental Events | Control Events | Odds Ratio | OR     | 95%-CI | Weight |
|------------------------|---------------------|----------------|------------|--------|--------|--------|
| Akgun 2020             | 30                  | 35             | 1.03       | 1.05   |        |        |
| Bhattacharya 2020      | 53                  | 53             | 1.00       | 1.00   |        |        |
| Pasomsub 2020          | 16                  | 18             | 0.91       | 0.77   |        |        |
| Yokota, airport 2020   | 4                   | 4              | 1.00       | 1.00   |        |        |
| Yokota, contact 2020   | 38                  | 44             | 0.89       | 0.76   |        |        |
| Guclu 2020             | 23                  | 27             | 0.89       | 0.76   |        |        |
| Senok 2020             | 19                  | 28             | 0.69       | 0.53   |        |        |
| Akwawaa 2020           | 287                 | 305            | 0.96       | 0.81   |        |        |
| Cheuk 2020             | 104                 | 141            | 0.75       | 0.63   |        |        |
| Iwaseki 2020           | 8                   | 9              | 1.00       | 1.00   |        |        |
| Sasaki 2021            | 128                 | 128            | 1.00       | 1.00   |        |        |
| Mohd Thabit 2021       | 45                  | 49             | 0.91       | 0.77   |        |        |
| BDKA 2021              | 13                  | 15             | 0.91       | 0.77   |        |        |

Random effects model

Heterogeneity: $I^2 = 0.00$, $Q^2 = 2.3028$, $p = 0.10$

| Study                  | Experimental Events | Control Events | Odds Ratio | OR     | 95%-CI | Weight |
|------------------------|---------------------|----------------|------------|--------|--------|--------|
| Byrnes 2020            | 12                  | 12             | 1.00       | 1.00   |        |        |
| Skolimowska 2020       | 15                  | 16             | 0.96       | 0.81   |        |        |
| Massa 2021             | 51                  | 53             | 0.97       | 0.83   |        |        |
| da Costa Fernandes 2021| 67                  | 71             | 0.91       | 0.77   |        |        |
| Ferreira 2021          | 16                  | 17             | 0.91       | 0.77   |        |        |
| Trebajo-Samantar 2021  | 168                 | 171            | 0.91       | 0.77   |        |        |

Random effects model

Heterogeneity: $I^2 = 0.00$, $Q^2 = 2.3028$, $p = 0.10$

| Study                  | Experimental Events | Control Events | Odds Ratio | OR     | 95%-CI | Weight |
|------------------------|---------------------|----------------|------------|--------|--------|--------|
| Landry 2020            | 30                  | 30             | 1.00       | 1.00   |        |        |
| Greiser 2020           | 104                 | 104            | 1.00       | 1.00   |        |        |
| Castle 2020            | 24                  | 26             | 0.92       | 0.78   |        |        |
| Hanson 2020            | 76                  | 81             | 0.95       | 0.81   |        |        |
| More 2020              | 11                  | 11             | 1.00       | 1.00   |        |        |
| Procop 2020            | 38                  | 39             | 0.91       | 0.77   |        |        |
| Kandeli 2020           | 39                  | 42             | 0.89       | 0.76   |        |        |
| Esther Babady 2020     | 16                  | 17             | 0.91       | 0.77   |        |        |
| Kojima 2020            | 20                  | 26             | 0.95       | 0.81   |        |        |
| McCormick-Baw 2020     | 47                  | 48             | 0.95       | 0.81   |        |        |
| Miller 2020            | 33                  | 34             | 1.00       | 1.00   |        |        |
| Vogels 2020            | 32                  | 32             | 1.00       | 1.00   |        |        |
| Boerger 2021           | 30                  | 32             | 0.96       | 0.81   |        |        |
| Toppings 2021          | 28                  | 28             | 1.00       | 1.00   |        |        |
| Xun 2021               | 21                  | 22             | 0.95       | 0.81   |        |        |
| Marx 2021              | 44                  | 47             | 0.95       | 0.81   |        |        |
| Marx 2021              | 5                   | 5              | 1.00       | 1.00   |        |        |
| Marx 2021              | 46                  | 52             | 0.88       | 0.75   |        |        |
| Akhateeb 2021          | 12                  | 12             | 1.00       | 1.00   |        |        |
| Akhateeb 2021          | 4                   | 4              | 1.00       | 1.00   |        |        |
| Akhateeb 2021          | 16                  | 17             | 1.00       | 1.00   |        |        |
| Stokes 2021            | 121                 | 123            | 1.00       | 1.00   |        |        |
| Hervera 2021           | 139                 | 143            | 1.00       | 1.00   |        |        |

Random effects model

Heterogeneity: $I^2 = 0.00$, $Q^2 = 2.3028$, $p = 0.10$

| Study                  | Experimental Events | Control Events | Odds Ratio | OR     | 95%-CI | Weight |
|------------------------|---------------------|----------------|------------|--------|--------|--------|
| Williams 2020          | 33                  | 34             | 1.00       | 1.00   |        |        |

Random effects model

Heterogeneity: not applicable

| Study                  | Experimental Events | Control Events | Odds Ratio | OR     | 95%-CI | Weight |
|------------------------|---------------------|----------------|------------|--------|--------|--------|
| Vaz 2020               | 62                  | 69             | 0.88       | 0.75   |        |        |
| Braz-Silva 2020        | 55                  | 55             | 1.00       | 1.00   |        |        |

Random effects model

Heterogeneity: $I^2 = 0.00$, $Q^2 = 2.3028$, $p = 0.10$

Residual heterogeneity: $I^2 = 80.0$, $p = 0.00$
Appendix 12 - The effect of saliva collection method on the diagnostic odds ratios of self-collected saliva for COVID-19.
Appendix 13 - The effect of presence or absence of symptoms on the diagnostic odds ratios of self-collected saliva for COVID-19.